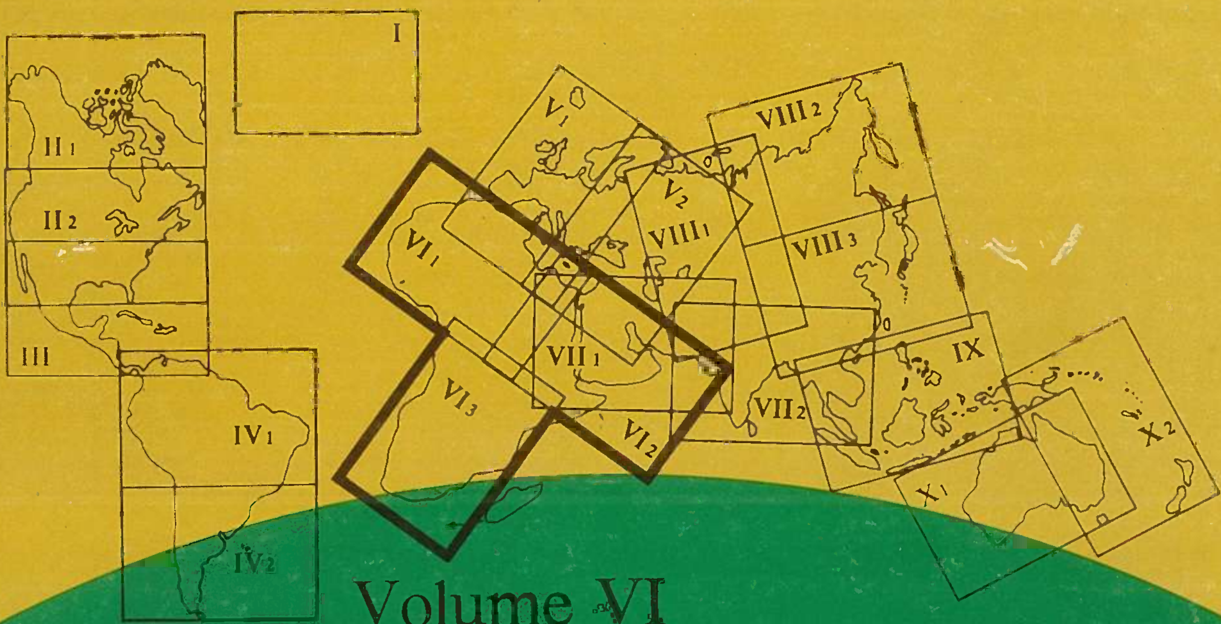
FAO-Unesco

Soil map of the world

1:5 000 000



Volume VI
Africa

Unesco

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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION

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1 : 5 000 000

Volume VI
Africa

Prepared by the Food and Agriculture Organization
of the United Nations

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PREFACE

The project for a joint FAO/Unesco Soil Map of the World was undertaken following a recommendation of the International Society of Soil Science. It is the first attempt to prepare, on the basis of international cooperation, a soil map covering all the continents of the world in a uniform legend, thus enabling the correlation of soil units and comparisons on a global scale. The project, which started in 1961, fills a gap in present knowledge of soil potentialities throughout the world and provides a useful instrument in planning agricultural and economic development programmes.

The project has been carried out under the scientific authority of an international advisory panel, within the framework of FAO and Unesco programmes. The different stages of the work included comparative studies of soil maps, field and laboratory work, and the organization of international expert meetings and study tours. The secretariat of the joint project, located at FAO Headquarters, was vested with the responsibility of compiling the technical information, correlating the studies and drafting the maps and text. FAO and Unesco shared the expenses involved in the realization of the project, and Unesco undertook publication of its results. For the preparation of the Soil Map of Africa and its explanatory text, the services of experts were made available by the Governments of Belgium, France and the Netherlands to work on the project.

The present volume, covering the soils of Africa, is the sixth of a set of ten which make up the complete publication of the Soil Map of the World. The first volume records introductory information and presents the definitions of the elements of the legend which are used uniformly throughout the publication. Each of the nine following volumes comprises an explanatory text and the corresponding map sheets covering the main regions of the world.

FAO and Unesco wish to express their gratitude to the governmental institutions, the International Society of Soil Science, and the many individual soil scientists who have contributed so much to this international project.

CONTENTS

SUMMARY

This volume describes the African section of the FAO/Unesco 1 : 5 000 000 Soil Map of the World. In 1964, the Commission for Technical Cooperation in Africa South of the Sahara (Commission de coopération technique en Afrique au Sud du Sahara - CCTA) produced and published a 1 : 5 000 000 map of Africa and an explanatory monograph. However, recent surveys and the need to correlate all existing maps and make a uniform legend compelled FAO to entirely redesign the CCTA map within the framework of the Soil Map of the World.

The maps

The three map sheets composing the Soil Map of Africa are drawn on topographic base maps of the 1 : 5 000 000 series of the American Geographical Society. The map units are associations of soil units divided into texture and slope classes. They are marked on the maps by symbols, letters and figures. Dominant soils are shown by colours while phase differences are shown by overprints.

A small inset map shows the three soil information reliability classes.

Detailed definitions of the soil units and full description of all the terms used may be found in Volume I.

The text

The first chapter describes the development of the project in Africa and gives some notes on uses of the map. The second acknowledges the cooperation of the agencies and individuals who contributed to the maps and text, and the third gives a summary of the material in Volume I on the maps and legend. The fourth, fifth and sixth chapters deal with environmental conditions, soils and land use.

Environmental conditions

Chapter 4 deals with the environmental factors that are important in the development of soils: climate, vegetation, geomorphology, geology and lithology.

Climate is discussed in terms of 12 broad climatic regions. The climatic map which supplements the soil map should be consulted for the transfer of crop information from one part of the world to another (Fig. 1).

Vegetation is divided into nine broad vegetation regions and 38 subregions distinguished according to the physiognomy and structure of the plant cover. The subregions are outlined on a small-scale map (Fig. 2).

Geomorphology is examined in terms of 18 regions, each of which is divided into a number of subregions. The various regions and subregions are shown on a small-scale map (Fig. 3).

Geology and *lithology* are considered together under 30 regions. Two small-scale maps outline the geological regions and lithology of Africa (Figs. 4 and 5, respectively).

Soils and land use

Chapter 5 outlines the soils of the continent according to 53 broad soil regions and contains an extensive table of soil associations. Chapter 6 treats the soils in depth, discussing distribution, climate, plant cover, land use and soil suitabilities for agriculture.

The table of soil associations lists all the map units in alphabetical order of symbols. Other columns show associated soils, inclusions, phases, area of units in thousands of hectares, climate symbols, countries of occurrence, vegetation symbols, and lithology or parent materials.

The distribution of major soils is discussed on the basis of 53 broad soil regions outlined on a small-scale map (Fig. 6).

Present land use and suitabilities for agriculture are discussed at first in general with a small-scale map of population distribution (Fig. 7) and an account of the different farming systems used in Africa. The main soils are then considered separately in terms of their present use and their suitability for both traditional and modern farming.

Only a small area of Africa is at present under cultivation. Huge regions have yet to be exploited, and some of them probably never will be owing to the large area occupied by desert regions. The land under cultivation is generally managed by traditional methods and yields are only slightly over those of a subsistence economy. Agricultural production can be substantially increased if the unexploited land resources are utilized and better use is made of land already under cultivation by increasing yield without causing soil degradation.

Conclusions

Agriculture in Africa is affected by a number of limitations. Vast regions in the Sahara, in Somalia and in the Namib and Kalahari deserts suffer from a deficiency of water. Even if underground water resources are utilized or recourse is had to sea water distillation, the irrigated areas will always be small in relation to the total land area, especially as the soils in these regions are often too stony, sandy or saline for agriculture. Soils such as Yermosols, Xerosols, Regosols, Vertisols and Fluvisols are frequently rich in chemicals, but lack of nitrogen is a limiting factor.

Large areas covered with dense rain forests have a favourable climate, but their soils, e.g. Ferralsols, Acrisols and Ferralic Arenosols, have a low natural fertility. After deforestation they are extremely susceptible to degradation through erosion, disappearance of organic matter and leaching of fertilizing elements. Fertilizers can maintain fertility and produce satisfactory yields, but are not economic at present.

Savannas or dry forest found between high forest and semidesert zones seem to be more suitable because their soils, e.g. Chromic and Ferric Luvisols, Vertisols, Planosols and Arenosols, have a richer chemical composition and receive sufficient rainfall. However, the morphology of Luvisols and the heavy precipitation in these zones facilitate rapid erosion which must be kept under control. Vertisols are difficult to cultivate with machinery, Planosols are poorly drained, and Arenosols in Senegal, Niger and Chad often lack nutrient elements and water-absorbing capacity and occur with very poor paleosol ironpans (Ferralsols and Acrisols). Extensive livestock raising is a solution, although cultivation may be feasible in rich valleys put under supplementary irrigation.

Highlands such as those in Ethiopia and Lesotho often have a basement of volcanic rock, and if not eroded have fairly favourable humus soils such as Andosols, Ferralsols and Nitosols. The climate is also more temperate.

The Mediterranean [1] zones of northern and southern Africa have rich soils (Luvisols, Chromic Cambisols, Calcaric and Eutric Cambisols and Kastanozems) and are generally more suitable for cultivation, but erosion is severe and often produces Lithosols.

Steeplands are not numerous in Africa. They often coincide with the richest soils (Andosols, Eutric Nitosols and Eutric Cambisols) but are difficult to reclaim.

Extensive areas with poor drainage occur in the Niger and Congo basins and in the Sudd region in Sudan, and often in many valleys in the humid and tropical zones. They can be used for rice cultivation and pasture but are difficult to manage for other crops.

The yield of both the continent's cultivated and uncultivated soils can be increased. If economic conditions change and the population increases, it is probable that some soils currently regarded as unsuitable will be put under cultivation in the future with proper management, including the application of fertilizers in humid zones and irrigation in semiarid zones.

The Appendix

Site and profile data, including profile descriptions and analyses, are given in the Appendix for some of the main soil units.

[1] " Mediterranean " refers to a climatic type.

RÉSUMÉ

Le présent volume décrit la partie relative à l'Afrique de la Carte mondiale des sols FAO-Unesco au 1 : 5 000 000. La Commission de coopération technique en Afrique au sud du Sahara (CCTA) avait déjà dressé et publié en 1964 une carte d'Afrique à la même échelle accompagnée d'un mémoire explicatif. Mais à la lumière des travaux de cartographie récents et devant la nécessité d'uniformiser la légende avec celles des cartes des autres continents, le dessin de cette carte a dû être entièrement repris dans le cadre du projet conjoint FAO-Unesco de la Carte mondiale.

Les cartes

Les trois feuilles cartographiques qui constituent la carte des sols de l'Afrique ont été établies d'après le fond topographique au 1 : 5 000 000 de l'American Geographical Society. Les unités cartographiques sont des associations d'unités pédologiques auxquelles on a attribué la texture et la pente du sol dominant. Elles sont indiquées sur la carte par des symboles, lettres et chiffres. Les sols dominants sont représentés par des couleurs alors que les différences de phase sont indiquées en surcharge.

Une carte à petite échelle reproduite comme carton sur la carte principale indique trois degrés de fiabilité des renseignements pédologiques d'après lesquels la carte a été établie.

On trouvera dans le volume I de cette série des définitions détaillées des unités pédologiques et une description complète de tous les termes utilisés.

Le texte

Le premier chapitre, ou introduction, fait l'historique du projet en Afrique et donne quelques informations sur l'utilisation des cartes. Le deuxième chapitre rend hommage aux institutions et à ceux qui ont collaboré à l'établissement des cartes et du texte. Le troisième donne un résumé du volume I relatif aux cartes et aux légendes. Les chapitres suivants traitent du milieu, des sols et de leur utilisation.

LE MILIEU

Le chapitre 4 expose les facteurs du milieu dont dépend étroitement la répartition des sols: climat, végétation, physiographie, géologie et lithologie.

Le *climat* est traité d'une manière générale, puis sont distinguées les 12 grandes régions climatiques d'Afrique. Une carte climatique (figure 1) — établie selon le système Papadakis, c'est-à-dire dont les unités sont délimitées en tenant compte des critères les plus importants pour la croissance des plantes (humidité et température) — complète la carte des sols et doit être consultée pour le transfert des renseignements sur les cultures d'une partie du monde à une autre.

La *végétation* est répartie en neuf grands types de formations végétales et 38 sous-types, selon la physionomie et la structure de la végétation. Ces sous-types sont localisés sur une carte à petite échelle (figure 2) et délimitent les grandes zones de végétation africaines.

La *physiographie* est étudiée dans le cadre de 18 régions physiographiques, affectées d'une lettre, et d'un certain nombre de sous-régions, affectées d'un chiffre. Une carte à petite échelle montre les divers éléments du modelé africain (figure 3).

La *géologie* et la *lithologie* sont traitées ensemble par grandes régions numérotées de 1 à 30 et localisées sur la carte des grandes régions géologiques (figure 4). Une carte simplifiée de la lithologie a été dessinée à petite échelle (figure 5).

SOLS ET LEURS UTILISATIONS

Les chapitres 5 et 6 contiennent un tableau détaillé des associations de sols trouvées en Afrique, une étude de leur répartition par grandes régions pédologiques et un examen de l'utilisation des sols et de leur vocation agricole.

Le tableau des associations énumère toutes les unités cartographiques dans l'ordre alphabétique des symboles. Les autres colonnes sont consacrées aux rubriques suivantes: sols associés, inclusions, phases, superficie en milliers d'hectares, localisation par pays, climat, végétation, lithologie ou matériaux originels.

La répartition des principaux sols est faite en 53 grandes régions pédologiques figurées sur une carte à petite échelle (figure 6).

L'utilisation actuelle des sols et leur vocation agricole sont étudiées d'abord d'une manière générale à l'aide d'une carte de répartition de la population à petite échelle (figure 7) et d'une description des différents systèmes agricoles utilisés en Afrique. Les principaux types de sols sont ensuite étudiés séparément en ce qui concerne leur utilisation actuelle et leur aptitude à l'agriculture, tant traditionnelle que moderne.

Une faible superficie de l'Afrique est actuellement cultivée. D'immenses régions ne sont pas encore exploitées; certaines ne le seront sans doute jamais car les régions désertiques occupent une vaste surface. Mais les terres actuellement cultivées le sont la plupart du temps selon les méthodes traditionnelles et les rendements ne dépassent guère ceux de l'économie de subsistance. Il est donc possible d'augmenter considérablement la production agricole, d'une part en mettant en valeur des ressources en sol encore inutilisées, d'autre part en tirant un meilleur parti des sols actuellement cultivés en augmentant leur rendement sans pour cela conduire à une dégradation physique et chimique de ces sols.

Conclusions

L'Afrique présente un certain nombre de facteurs limitants pour l'agriculture. De vastes régions manquent d'eau: ce sont les régions désertiques du Sahara, de Somalie, du Namib et du Kalahari. Même si on exploite les nappes souterraines ou si on procède à la distillation de l'eau de mer, les surfaces irriguées seront toujours petites par rapport à la surface totale, d'autant plus que ces régions ont souvent des sols trop caillouteux, trop sableux ou trop salés, qui par contre, sont souvent riches chimiquement, en particulier les yermosols, xérosols, régosols, vertisols, fluvisols. Toutefois, le principal facteur limitant est l'insuffisance d'azote.

De vastes régions couvertes de forêt dense ombrophile présentent au countraire un climat favorable mais des sols de faible fertilité naturelle: ferralsols, acrisols, arénosols ferraliques. Après défrichement, ils sont très exposés à la dégradation par érosion, disparition de la matière organique, lessivage des éléments fertilisants. Les engrais permettent de maintenir la fertilité et d'obtenir des rendements satisfaisants mais actuellement leur utilisation n'est pas rentable.

Les zones de savane, ou de forêt sèche intermédiaire entre grande forêt et semi-désert, paraissent plus favorables car moins pauvres chimiquement (luvisols chromiques et ferriques, vertisols, planosols, arénosols, etc.) et à pluviosité suffisante. Mais la morphologie des luvisols et les pluies brutales de cette zone conduisent à une érosion rapide qu'il faut essayer de limiter. Les vertisols sont difficiles à cultiver mécaniquement, les planosols sont mal drainés et les arénosols manquent souvent d'éléments nutritifs et n'ont qu'une faible capacité de rétention d'eau, et il subsiste souvent dans ces régions des paléosols très pauvres et cuirassés: ferralsols et acrisols. L'élevage extensif est une solution mais la culture peut aussi s'étendre dans les vallées, souvent riches grâce à une irrigation complémentaire.

Les zones d'altitude (Ethiopie, Lesotho, etc.), souvent sur roche volcanique, présentent, si elles ne sont pas érodées, des sols humifères (andosols, ferralsols, nitosols, etc.) assez favorables, le climat étant d'ailleurs plus tempéré.

Les zones à climat méditerranéen (Afrique du Nord, Afrique du Sud) sont en général plus favorables à la culture et leurs sols sont riches (luvisols, cambisols chromiques, cambisols calcaires, eutriques, kastanozems, etc.) mais l'érosion y est intense et aboutit bien souvent aux lithosols.

Les régions à forte pente ne sont pas nombreuses en Afrique. Elles coïncident souvent avec les sols les plus riches (andosols, nitosols eutriques, cambisols eutriques) mais présentent des difficultés de mise en valeur.

Les vastes étendues mal drainées sont le bassin intérieur du Niger, la région du Sudd au Soudan, le bassin du Congo, mais beaucoup de vallées dans la zone équatoriale et tropicale humide présentent aussi des caractères de mauvais drainage. Elles peuvent être utilisées pour la riziculture et comme pâturage mais elles sont difficiles à aménager pour d'autres cultures.

Toutefois, il reste des sols productifs non encore cultivés et des sols cultivés dont le rendement peut être augmenté. Si les conditions économiques changent et si la pression démographique s'accroît, il est d'ailleurs probable que certains sols jugés peu favorables actuellement pourront être mis en culture dans l'avenir avec des aménagements adéquats, notamment l'apport d'engrais en zones humides et l'irrigation en zones semi-arides.

Annexe

On trouvera dans l'annexe des renseignements concernant les sites et les profils, y compris des descriptions de profils et des analyses concernant certaines des principales unités pédologiques.

РЕЗЮМЕ

В данном томе описывается африканская часть Почвенной карты мира масштаба 1 : 5 000 000. В 1964 году CCTA (Commission de coopération technique en Afrique) подготовила и опубликовала карту Африки такого же масштаба, сопровождаемую пояснительным текстом. Однако более поздние картографические работы и необходимость унификации легенды с другими континентами заставили ФАО предпринять полную переработку содержания карты в рамках проекта ФАО/ЮНЕСКО Почвенной карты мира.

Карты

Три листа карты, составляющие почвенную карту Африки, созданы на основе топографических карт Американского географического общества (серия карт масштаба 1 : 5 000 000. Картографические единицы - это ассоциации почвенных единиц, подразделяющиеся по механическому составу и рельефу доминирующей почвы. Они показаны на карте индексами, буквенными и цифровыми. Доминирующие почвы показаны окраской, а фазовые различия - различными надпечатками.

Небольшая карта-врезка показывает три степени надежности информации о почвах.

Детальные определения почвенных единиц и полные описания использованных терминов можно найти в томе I настоящего издания.

Текст

Первая глава, или введение, описывает развитие проекта в Африке и содержит некоторые замечания по использованию карты. Во второй главе выражается благодарность за сотрудничество учреждениям и большому числу лиц, которые приняли участие в составлении карты и текста. В третьей главе дано краткое резюме содержания I тома относительно карт и легенды. Последующие главы посвящены условиям окружающей среды, почвам и их использованию.

УСЛОВИЯ ОКРУЖАЮЩЕЙ СРЕДЫ

Глава 4 описывает факторы окружающей среды, имеющие непосредственное отношение к географии почв: климат, растительность, геоморфологию, геологию и литологию.

Климат характеризуется сначала в общей форме, после чего выделяются крупные климатические регионы Африки. Климатическая карта (фиг. 1), основанная на системе Пападакиса, в которой единицы выделяются в соответствии с наиболее важными факторами роста растений (влажность и температура), дополняет почвенную карту и должна приниматься во внимание при перенесении информации о культурах из одной части мира в другую.

Растительность подразделяется на девять крупных типов растительных формаций, и 38 подтипов различаются в соответствии с обликом и структурой растительности. Эти подтипы показаны на мелкомасштабной карте (фиг. 2) и характеризуют основные растительные зоны Африки.

Геоморфология рассмотрена в рамках 18 физикогеографических регионов, отмеченных буквами, и ряда подрегионов, отмеченных цифрами. Различные компоненты физической географии Африки показаны на мелкомасштабной карте (фиг. 3).

Геология и литология рассматриваются вместе по основным регионам, пронумерованным от 1 до 30 и показанным на карте основных геологических регионов (фиг. 4). Упрощенная карта литологии дана в мелком масштабе (фиг. 5).

ПОЧВЫ И ИСПОЛЬЗОВАНИЕ ЗЕМЛИ

Главы 5 и 6 содержат сводную таблицу почвенных ассоциаций, встречающихся в Африке, их географическое распространение в основных почвенных регионах и обсуждение использования земли и пригодности почв для земледелия.

Таблица почвенных ассоциаций содержит все картографические единицы в алфавитном порядке индексов. Другие колонки показывают: сочетающиеся почвы, включения, фазы, площадь в 1000 га, страны распространения, индексы климата, индексы растительности, литологию и материнские породы.

Распространение основных почв обсуждается на основе 43 крупных почвенных регионов, показанных на мелкомасштабной карте (фиг. 6).

Современное использование земли и пригодность для земледелия обсуждается в общей форме с помощью мелкомасштабной карты распределения населения (фиг. 7) и на основе различных систем земледелия, используемых в Африке. Основные почвы затем рассмотрены отдельно в отношении их современного использования и пригодности для традиционного и современного земледелия.

Только небольшая часть территории Африки обрабатывается в настоящее время. Огромные территории до сих пор еще не использованы; часть из них, вероятно, и никогда не будут использоваться, поскольку значительные пространства составляют пустынные районы. Обрабатываемые земли обычно используются традиционными способами, и урожаи лишь едва превышают экономику самосуществования, а соответствующие культуры часто способствуют деградации почв. Существенное увеличение сельскохозяйственного производства, таким образом, возможно, как путем использования почвенных ресурсов, сейчас неиспользуемых, так и путем улучшения использования обрабатываемых земель посредством увеличения урожаев без физической или химической деградации почв.

ВЫВОДЫ

Земледелие в Африке страдает от ряда ограничений. На огромных пространствах нет воды, то есть в пустынных районах Сахары, Сомали, Намиба и Калахари. Даже если подземные воды будут использоваться, а также опресненные морские воды, все же орошаемые земли всегда будут составлять лишь небольшую часть общей площади, поскольку почвы этих районов часто слишком каменистые, песчаные или засоленные. С другой стороны, они часто богаты минеральными веществами; таковы ермосоли, ксеросоли, регосоли, вертисоли и флювисоли. Однако, азот является главным лимитирующим фактором.

Обширные районы, покрытые плотными дождевыми лесами, имеют благоприятный климат, но почвы низкого естественного плодородия, такие, как ферральсоли, акрисоли или ферральные ареносоли. После сведения леса они исключительно подвержены деградации посредством эрозии, исчезновения органического вещества и выщелачивания питательных веществ. Удобрения могут поддерживать плодородие и приведут к удовлетворительным урожаям, но не экономичны в настоящее время.

Зоны саванн или сухих лесов, промежуточные между высокими лесами и полупустынями, представляются более благоприятными, поскольку химически они менее бедные и характеризуются достаточными атмосферными осадками; это окрашенные и железистые лювисоли, вертисоли, планосоли, ареносоли и т.д. Однако строение лювисолей и ливневые дожди в этих зонах приводят к ускоренной эрозии, которая должна контролироваться на должном уровне. Вертисоли представляют трудности при механической обработке, планосоли плохо дренированы, ареносоли (Сенегал, Нигер, Чад) часто бедны питательными веществами и имеют низкую влагоемкость, в то время как очень бедные палеопочвы с железистыми панцирями, т.е. ферральсоли и акрисоли, часто сохраняются в этих районах. Экстенсивное пастбищное животноводство здесь будет решающим, но земледелие также может быть расширено в богатых долинах, часто с дополнительным орошением.

Зоны больших высот, окружающие рифты (Эфиопия, Лесото и др.), имеют, часто на вулканических породах, если они не эродированы, довольно благоприятные гумусированные почвы, такие, как андосоли, ферральсоли, нитосоли и другие; климат здесь также более умеренный.

Средиземноморские зоны (Северная Африка, Южная Африка) в целом более благоприятны для земледелия, а их почвы богаче; это лювисоли, окрашенные камбисоли, карбонатные и богатые камбисоли, каштаноземы и т.д.; однако эрозия здесь существенная и часто приводит к формированию литосолей.

Районы с горным рельефом не многочисленны в Африке. Они часто совпадают с распространением наиболее богатых почв, т.е. андосолей, богатых нитосолей, богатых камбисолей, но слишком трудны для рекламации.

Обширные пространства плохо дренированных почв встречаются во внутренних бассейнах Нигера, Сидда в Судане и Конго, но многие внутренние долины во влажных экваториальных и тропических зонах также часто обнаруживают условия плохого дренажа. Они могут быть использованы для производства риса и как пастбища, но представляют существенные трудности для других культур.

Тем не менее, до сих пор остаются как обрабатываемые, так и необрабатываемые земли, продуктивность которых может быть увеличена. Если экономические условия изменятся, а рост населения будет существенным, весьма возможно, что некоторые почвы, которые сейчас считаются неблагоприятными, будут пригодными для земледелия в будущем при соответствующей технологии, включая применение удобрений во влажных зонах и орошение в полузасушливых.

Приложения

В приложениях для некоторых основных почвенных единиц даны примеры почвенных характеристик, включая данные о положении профиля, окружающей среде, описания морфологии и результаты анализов.

RESUMEN

En este volumen se describe la sección de Africa del Mapa Mundial de Suelos FAO-Unesco a escala 1 : 5 000 000.

En 1964, la Comisión de Cooperación Técnica en el Africa al sur del Sahara (Commission de coopération technique en Afrique au sud du Sahara - CCTA) preparó y publicó un mapa de Africa a escala 1 : 5 000 000 y una memoria explicativa.

Sin embargo, otros estudios recientes y la necesidad de correlacionar todos los mapas existentes utilizando una leyenda uniforme obligó a la FAO a rehacer por completo el mapa de la CCTA con arreglo a los principios del Mapa Mundial de Suelos.

Los mapas

Las tres hojas con mapas que comprenden el mapa de suelos de Africa se han trazado sobre la base de los mapas topográficos de la serie a escala 1 : 5 000 000 de la American Geographical Society. Las unidades del mapa son asociaciones de unidades de suelos divididas en clases texturales y de inclinación. Se indican en el mapa por medio de símbolos, letras y cifras. Los suelos dominantes se muestran por colores, mientras que las diferentes fases se indican con sobreimpresiones.

Un pequeño mapa intercalado en un recuadro indica las tres clases de fiabilidad de la información sobre suelos.

En el Volumen I de la serie pueden encontrarse definiciones detalladas de las unidades de suelos y descripciones completas de todos los términos utilizados.

El texto

En el primer capítulo se describe el desarrollo del proyecto en Africa y se dan algunas notas sobre los usos posibles del mapa. En el segundo se da cuenta de la cooperación de organismos y del gran número de personas que han colaborado en los mapas y en el texto, y en el tercero se da un resumen del material contenido en el Volumen I sobre los mapas y la leyenda. Los capítulos 4, 5 y 6 tratan de las condiciones del medio, suelos y aprovechamiento de tierras.

Condiciones del medio

El Capítulo 4 trata de los factores ambientales que revisten importancia en el desarrollo de los suelos: clima, vegetación, fisiografía, geología y litología.

El *clima* se discute sobre la base de 12 amplias regiones climáticas. El mapa climático que sirve de complemento al mapa de suelos debería consultarse para la transferencia de información sobre cultivos de una parte del mundo a otra (Figura 1).

La *vegetación* se divide en nueve amplias zonas de vegetación, distinguiéndose 38 subregiones según la fisionomía y estructura de la cubierta vegetal. Las subregiones se bosquejan en un mapa a pequeña escala (Figura 2).

La *fisiografía* se estudia en función de 18 regiones, cada una de las cuales se divide en diversas subregiones. Las distintas regiones y subregiones se muestran en un mapa a pequeña escala (Figura 3).

La *geología* y *litología* se examinan juntas con arreglo a 30 regiones. Dos mapas a pequeña escala señalan las regiones geológicas y la litología de Africa (figuras 4 y 5 respectivamente).

Los suelos y el uso de la tierra

El Capítulo 5 esboza los suelos del continente con arreglo a 53 amplias regiones de suelos y contiene un amplio cuadro de asociaciones de suelos. El Capítulo 6 trata de los suelos en profundidad, examinando la distribución, el clima, la cubierta vegetal, el aprovechamiento de las tierras y la aptitud de los suelos para la agricultura.

En el cuadro de asociaciones de suelos se enumeran todas las unidades del mapa por orden alfabético de los símbolos. Otras columnas muestran los suelos asociados, inclusiones, fases, superficie de las unidades en miles de hectáreas, símbolos climáticos, países en

que se presentan, símbolos de vegetación y litología o materiales de partida.

La distribución de los suelos principales se examina sobre la base de 53 amplias regiones de suelos que se delinean en un mapa a pequeña escala (Figura 6).

El uso actual de la tierra y la aptitud para la agricultura se examinan en primer lugar en términos generales con un mapa a pequeña escala de la distribución de la población (Figura 7) y una exposición de los diferentes sistemas de labranza adoptados en Africa. Los suelos principales se examinan después por separado en función de su utilización actual y su aptitud para la labranza tanto tradicional como moderna.

Solamente una zona reducida de Africa se halla al presente sometida a cultivo. Quedan todavía por explotar inmensas regiones, algunas de las cuales probablemente nunca lo serán debido a los grandes espacios ocupados por los desiertos. La tierra sometida a cultivo se explota generalmente según métodos tradicionales y los rendimientos son sólo ligeramente superiores a los de una economía de subsistencia. La producción agrícola puede incrementarse sensiblemente si se aprovechan los recursos de tierras no explotados y se hace un mejor uso de las tierras ya cultivadas incrementando el rendimiento sin que ello cause la degradación del suelo.

Conclusiones

La agricultura en Africa queda afectada por diversas limitaciones. Vastas regiones en el Sahara en Somalia y en los desiertos de Namib y Kalahari sufren de carencia de agua. Aun cuando se utilizan los recursos hídricos subterráneos y se ha recurrido a la destilación de aguas marinas, las zonas regadas serán siempre pequeñas en relación con la superficie total de las tierras, especialmente debido a que los suelos en estas regiones con frecuencia son pedregosos, arenosos o salinos para la agricultura. Los suelos tales como los yermosoles, xerosoles, regosoles, vertisoles y fluvisoles con frecuencia tienen un elevado contenido de sustancias químicas, pero la falta de nitrógeno es un factor limitador.

Algunas zonas extensas cubiertas de bosques higrofíticos densos presentan un clima favorable, pero sus suelos, por ejemplo, los ferralsoles, acrisoles y arenosoles ferrálicos tienen una baja fertilidad natural. Después de la desforestación son extremadamente susceptibles a la degradación por obra de la erosión, desaparición de la materia orgánica y lixiviación de los elementos fertilizantes. Los abonos pueden mantener la fertilidad y producir rendimientos satisfactorios, pero al presente no resultan económicos.

Las sabanas y el bosque xerofítico que se encuentran entre el bosque alto y las zonas semidesérticas parecen ser más apropiados debido a sus suelos, por ejemplo, los luvisoles crómicos y férricos, los vertisoles, los planosoles y los arenosoles poseen una composición química más rica y reciben lluvias suficientes. Sin embargo la morfología de los luvisoles y la intensa precipitación en estas zonas facilitan una rápida erosión que debe combatirse constantemente. Los vertisoles son difíciles de cultivar con máquinas, los planosoles están insuficientemente avenados y los arenosoles en Senegal, Níger y Chad con frecuencia carecen de elementos nutritivos y de capacidad de absorción del agua y presentan capas ferruginosas de paleosol muy pobres (ferralsoles y acrisoles). Una solución es la ganadería extensiva, si bien el cultivo puede ser factible en los valles ricos que reciben un riego suplementario.

Las tierras altas como las de Etiopía y Lesotho con frecuencia presentan un basamento de roca volcánica y, si no están erosionados, poseen suelos húmicos favorables, como los andosoles, ferralsoles y nitosoles. El clima es también más templado.

Las zonas mediterráneas [1] del norte y sur de Africa poseen suelos ricos (luvisoles, cambisoles crómicos, cambisoles cálcicos y éutricos y kastanozems) y en general son más aptos para el cultivo, pero la erosión es grave y con frecuencia produce litosoles.

Las tierras escarpadas no abundan en Africa. Con frecuencia coinciden con los suelos más ricos (andosoles, nitosoles éutricos y cambisoles éutricos), pero son difíciles de rehabilitar.

En las cuencas del Níger y del Congo y en la región Sudd del Sudán existen dilatadas zonas con escaso avenamiento, y con frecuencia también en muchos valles de las zonas húmedas y tropicales. Pueden utilizarse para el cultivo del arroz y de pastos, pero son difíciles de manejar para otros cultivos.

El rendimiento de los suelos del continente tanto cultivados como sin cultivar puede aumentarse. Si las condiciones económicas cambian y la población aumenta, es probable que algunos suelos que al presente se consideran no aptos se sometan a cultivo en el futuro con una ordenación adecuada, incluida la aplicación de fertilizantes en las zonas húmedas y del riego en las zonas semiáridas.

Apéndice

En el apéndice se dan datos sobre emplazamiento y perfiles, incluso descripciones y análisis de perfiles para algunas de las principales unidades de suelos.

[1] El término « mediterráneo » se refiere al tipo climático.

1. INTRODUCTION

History of the project

The most notable early soil maps of Africa are those prepared by C.F. Marbut in 1923[1] and Z.Y. Shokalskaya in 1944.[2] Drafted to scales of approximately 1 : 30 000 000, these general maps relied too strongly on soil distribution hypotheses based on climatic, lithological or phytogeographical factors. Very few soil maps based on actual field surveys existed before the 1950s.

The preparation of a new general soil map of Africa based on regional surveys was included in the programme of the CCTA's Inter-African Pedological Service (Service pédologique inter-africain - SPI) at the inaugural meeting of its Administrative Council at Yangambi in 1953. The 2nd Inter-African Soil Conference, held in Léopoldville in 1954, recommended that the SPI coordinate the preparation of the map. At its second meeting, held in 1955, the SPI Administrative Council recommended that a 1 : 5 000 000 map for soil conservation and use be drafted in close collaboration with the four regional committees for southern, eastern, central and western Africa. This initiative led to the preparation of new maps covering whole countries and territories. Meetings held at Brazzaville in 1958, Kampala in April 1959 and Pretoria in May 1959 produced a uniform legend which constituted a compromise between the Belgian, French, British, Portuguese and South African classifications. Five successive drafts of the map were prepared, the last being submitted to the CCTA meeting held in Léopoldville in 1963. The final map of the continent, published in 1963, was the first of its kind to be prepared as the result of an international agreement, and made it possible to establish the relationship between the pedogenesis and development of the major soil units. However, the criteria used to distinguish these soil units reflect the effects of climate and the average variations of the topography and substratum rather than present and potential land use. Although the uniform legend of this map has not been extended to other regions in the same latitudes as had been hoped, it has nevertheless served as a reference legend for later maps.

Thus, when the 7th Congress of the International Society of Soil Science convened in 1960 at Madison, Wisconsin, U.S.A. and recommended the publication of soil maps of the major regions of the world, Africa already enjoyed a long lead over the other continents. The project was entrusted to two international agencies: FAO and Unesco.[3] In June 1961 a committee of prominent soil scientists representing various parts of the world was convened by FAO and Unesco to study the methodological, scientific and various other problems related to the preparation of a Soil Map of the World.[4] In subsequent meetings these experts established the new international legend based on criteria which were appreciably different from those used in the legend for the CCTA map of Africa. As they prepared a correlation, they often found it necessary to consult the original documents, as a one-to-one correspondence between the terms of the two legends proved impossible. When the definitions of the soil units are compared, each unit of one can be made to correspond to several units of the other legend, and vice versa. A reliable classification in the international legend of the FAO/Unesco Soil Map of the World is possible only on the basis of the descriptions and physico-chemical analyses of profiles.

Another difference between the CCTA and FAO/Unesco legends is the fact that complex soil associations (dominant soils, associated soils and inclusions) are included in the international legend while the CCTA legend indicates dominant soils and only exceptionally an association of two soils, making it necessary to recur to the original or supplementary documents.

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[1] *The vegetation and soils of Africa*, New York, American Geographical Society.

[2] A new soil map of Africa, *Pochvovodenye*, (9): 424.

[3] The background of the project as a whole is covered in greater detail in Volume I.

[4] The participants in this meeting were:
Consultants: G. Aubert (France), M. Camargo (Brazil), J. D'Hoore (Belgium), E. Lobova (U.S.S.R.), S.P. Raychudahuri (India), G.D. Smith (U.S.A.), C.G. Stephens (Australia), R. Tavernier (Belgium), Norman H. Taylor (New Zealand), I.V. Tiurin (U.S.S.R.), F.A. van Baren (Netherlands);
Unesco Secretariat: V.A. Kovda and M. Batisse;
FAO Secretariat: D. Luis Bramão, R. Dudal and F. George.

Many detail maps and maps covering countries and territories appeared between the publication of the CCTA map in 1963 and the completion of the first draft Soil Map of Africa with an international legend in 1968, and had to be incorporated into the original design. The first draft was presented to the 9th International Congress of Soil Science held at Adelaide in 1968. A second draft was prepared between 1968 and 1971 to incorporate the new maps and adapt their symbols to the international legend, and to include intervening changes in the legend and the definitions of certain units. The publication deadline for this volume of the Soil Map of the World has determined that the second draft be considered definitive, despite the fact that it has not been examined by all interested parties. Any comments received will be taken into account in a subsequent edition.

An *International Atlas of West Africa* prepared by the Organization of African Unity (OAU) with the sponsorship of the Ford Foundation began to appear in 1968. A 1 : 5 000 000 soil map of the western part of tropical Africa was to be prepared for the atlas by the Institut fondamental d'Afrique noire (IFAN) and the Office of Overseas Scientific and Technical Research (Office de la recherche scientifique et technique outre-mer - ORSTOM). As the OAU map had the same scale as the FAO/Unesco Soil Map of Africa and the same main source of information for western Africa (ORSTOM), and both maps were to be published at about the same time, FAO, IFAN and ORSTOM collaborated in the preparation of a unified soil map for that part of the continent. The limits of the soil associations are the same on both maps, the only difference being in the legend, since the FAO/Unesco map uses the international classification while the OAU legend is based on the French soil classification system.

Objectives

Transfer of knowledge and experience from one region of the earth to another can be successful only when allowance is made for similarities and differences in the geographical, soil and climatic conditions of the regions or countries involved. Furthermore, the economic feasibility of different management techniques under specific socio-economic conditions needs to be assessed before they can be recommended for adoption. In order to do so, reliable information on the nature and distribution of the major soils of the world is of fundamental importance. However, the preparation of regional and continental soil maps requires a uniform legend and nomenclature and the correlation of existing soil classification systems. One of the principal objectives of the FAO/Unesco Soil Map of the World project was to foster a spirit of cooperation among soil scientists all over the world which would lead to agreement on an international soil correlation system.

It is hoped that this project will promote better understanding among soil scientists, planners and farmers, provide useful coordination of national and international soil studies and stimulate applied research.

Value and limitations of the map

The Soil Map of Africa is meant to provide a basis and framework for regional and national surveys on smaller scales. It may assist in selecting methods for reclamation, crop production, fertilizer application and general use of soils. Until now all attempts to make overall plans or forecasts for agriculture have been hampered by lack of uniformity in the terminology, nomenclature and classification of soils, and by lack of a comprehensive picture of the world's soil resources.

Through a systematic interpretation of the Soil Map of the World it will be possible to make an appraisal of the distribution and the production potential of the major soils on a continental basis and to delineate broad priority areas deserving further study. This inventory of soil resources will bring to light the limitations and potentialities of the different regions for increased agricultural production.

In addition, a continental soil map such as the Soil Map of Africa can be a valuable teaching aid for the training of geographers, soil scientists, agronomists and all those who are involved in the study of the environment.

Although the publication of the map and text marks a significant step forward, it is necessary to point out its inherent limitations. The accuracy and detail of the information which can be shown are obviously limited by the small scale of the map and by the fact that soil data for some areas are scarce because of inadequate field correlation or lack of observations. On the other hand, differences in field and laboratory study methods present difficulties in the preparation of continental maps. These limitations also apply to the interpretative data, which can only be as accurate as the information on which they are based.

Despite these shortcomings, this Soil Map of Africa is the most recent and detailed inventory of soil resources based on international cooperation. Its limitations emphasize the need for intensified soil correlation and for obtaining a better knowledge of the nature and distribution of soils in those parts of the continent where information is lacking or incomplete.

2. ACKNOWLEDGEMENTS

The preparation of the Soil Map of Africa could only be accomplished with the cooperation of government institutions and the many soil scientists who provided basic material and took an active part in the meetings, study tours and discussions which led to the various drafts of the map and text.

Those who gave particular help to the project are listed below. Sincere appreciation is also expressed here to all those whom it has not been possible to single out but whose publications have been a source of information for the project.

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Guinea-Bissau	A.J. da Silva Teixeira
Ivory Coast	P. de Boissezon
Lesotho	B. West [1]
Liberia	R. Fanfant [1]
Libya	R.W. Price [1]
Madagascar	P. Roederer
Malawi	A. Young
Mali	G. Pieri
Mauritania	R. Boulet, J. Vieillefon
Morocco	P. Billaux, A. Ruellan

[1] FAO staff.

Mozambique	D.H. Godinho Gouveia
Namibia	H. Scholz
Niger	R. Boulet, M. Gavaud
Nigeria	H. Folster, G. Higgins,[1] K. Klinkenberg, G. Murdoch, A.J. Smyth,[1] W.G. Sombroek [1]
Reunion Island	J. Riquier
Rhodesia	J.G. Thompson
Rwanda	A. Pécrot,[1] A. van Wambeke [1]
Senegal	J. Vieillefon
Sierra Leone	R. Allbrook, J.C. Dijkerman
South Africa	R.F. Loxton, J.F.V. Philips
Sudan	G.H. Robinson [1]
Swaziland	G. Murdoch
Tanzania	R.M. Baker [1]
Territory of the Afars and the Issas	J. Boulaine
Togo	A. Le Cocq
Tunisia	J.P. Cointepas
Upper Volta	R. Boulet, R. Fauck, B. Kaloga J.C. Leprun
Zaire	C. Sys
Zambia	H. Brammer,[1] R. Webster

Preparation of the map

The first draft presented at Adelaide in 1968 was prepared in Rome by J. Riquier in close cooperation with institutes, soil specialists and FAO officers. The second draft and the final map were made by A. Pécrot and J. Riquier. However, it would not have been possible to prepare this map without the help of many others whose names are mentioned in the map legend and in the list of contributors.

Drafting and colouring of these maps were carried out by D. Mazzei, assisted by Miss M. Zolotariof-Ricci. The areas of the map units were measured by Miss M. Zanetti.

[1] FAO staff.

Grateful acknowledgement is made of the permission given by the American Geographical Society of New York to use its 1 : 5 000 000 world map as a basis for the preparation of the Soil Map of the World.

Preparation of the explanatory text

The explanatory text of the map was written by J. Riquier, seconded to FAO by the French Government. J.H.V. van Baren contributed the section on geomorphology, and P.L.J. de Jongh the one on geology and lithology. The chapter on land use and soil suitability was written by C. Sys.

Soil correlation

Responsibility for international correlation, preparation of the international legend and definition of soil units was entrusted to R. Dudal of FAO.

A first correlation between the different soil maps of African territories was prepared by J. D'Hoore at the time of the drafting of the CCTA map with the assistance of the international experts working on the map.

Correlation of the legends of the CCTA map and the various national and regional maps with the new FAO/Unesco international legend was carried out by A. Pécrot and J. Riquier at the FAO project centre in Rome and in the field during specially organized tours of Algeria, Morocco, Senegal, Ivory Coast, Nigeria and Ghana. For some regions, correlation was effected by the map correlators on the basis of their work in those regions (e.g. Zaire, A. Pécrot and C. Sys; Congo, Madagascar, Reunion Island and Comoro Islands, J. Riquier) or on the basis of previous trips by the authors to South Africa, Sudan, Kenya, Upper Volta and Niger.

Financial support

The costs of preparing and printing the Soil Map of Africa were shared jointly by FAO and Unesco. Acknowledgement is also made to the Government of the Netherlands, which made the services of J.H.V. van Baren and P.L.J. de Jongh available to the project.

3. THE MAP

Topographic base

The Soil Map of Africa was prepared on the basis of the 1 : 5 000 000 topographic map series of the American Geographical Society. The map is in three sheets, and the map sections have been slightly altered to facilitate fitting together with the rest of the world map and to leave enough space for the legend. The Miller oblated stereographic projection was used to prevent distortion of the original areas.[1]

Map units and cartographic representation

A map unit consists of a soil unit or of an association of soil units. The textural class is indicated for the dominant soil unit while the slope class reflects the topography in which the soil association occurs. Furthermore, the associations may be phased according to the presence of indurated layers or hard rock at shallow depth, stoniness, salinity and alkalinity. The soil units, classes and phases are defined in Volume I.

Each soil association is composed of a dominant soil and associated soils, the latter estimated to cover at least 20 percent of the delimited area. Soils which cover less than 20 percent of the area are added as inclusions.

Symbols

Map unit symbols explain the soil associations as follows: The first two letters (a capital letter for the group and a small letter for the subgroup) indicate the *dominant soil* in the association. The next figure denotes the *association.* The descriptive legend on the back of the map gives the associated soils and the inclusions. Next comes a dash, after which the figure 1, 2 or 3 denotes respectively the coarse, medium or fine *textural class* of the dominant soil. The small letters a, b and c indicate the *slope classes:* a denotes a slope of 0 to 8 percent (level to gently undulating relief), b, a slope of 8 to 30 percent (rolling to hilly), and c, a slope of more than 30 percent (strongly dissected to mountainous relief).

Example: Af13-1a — Ferric Acrisols, coarse textured, with Plinthic Acrisols and Lithosols, level to gently undulating.

Texture and slope do not appear on the map if information is lacking.

Two texture groups are denoted by two numbers and two types of topography by two letters:

Example: Af 17-1/2ab — Ferric Acrisols, coarse and medium textured, with Gleyic Luvisols and Gleysol and Lithosol inclusions, level to hilly.

Associations in which Lithosols are dominant are marked according to convention and to distinguish them from the other associations by the Lithosol symbol I combined with one or two associated soil units. In this case, there are no inclusions:

Example: I-Ql-Re — Lithosols, Luvic Arenosols and Eutric Regosols.

Map Colours

The soil associations have been coloured according to the dominant soil unit except for associations dominated by Lithosols, in which grey stripes (the Lithosol colour) alternate with stripes of the colour of the associated soil. If there is no associated soil, the grey Lithosol colour appears uniformly over a striped background.

Phases

Eight phases are indicated on the Soil Map of Africa. These phases — stony, petric, lithic, petrocalcic, saline, sodic, petrogypsic and petroferric — are indicated by overprints.

Solonchaks are not shown as saline phases, nor Solonetz as sodic phases, since these soils are saline and sodic respectively by definition.

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[1] A bipolar oblique conformal projection is erroneously mentioned on the map sheets.

TABLE 1. – SOIL UNITS FOR AFRICA[1]

J	FLUVISOLS
Je	Eutric Fluvisols
Jc	Calcaric Fluvisols
Jd	Dystric Fluvisols
Jt	Thionic Fluvisols
G	GLEYSOLS
Ge	Eutric Gleysols
Gc	Calcaric Gleysols
Gd	Dystric Gleysols
Gm	Mollic Gleysols
Gh	Humic Gleysols
Gp	Plinthic Gleysols
R	REGOSOLS
Re	Eutric Regosols
Rc	Calcaric Regosols
Rd	Dystric Regosols
I	LITHOSOLS
Q	ARENOSOLS
Qc	Cambic Arenosols
Ql	Luvic Arenosols
Qf	Ferralic Arenosols
Qa	Albic Arenosols
E	RENDZINAS
U	RANKERS
T	ANDOSOLS
To	Ochric Andosols
Tm	Mollic Andosols
Th	Humic Andosols
Tv	Vitric Andosols
V	VERTISOLS
Vp	Pellic Vertisols
Vc	Chromic Vertisols
Z	SOLONCHAKS
Zo	Orthic Solonchaks
Zm	Mollic Solonchaks
Zt	Takyric Solonchaks
Zg	Gleyic Solonchaks
S	SOLONETZ
So	Orthic Solonetz
Sm	Mollic Solonetz
Sg	Gleyic Solonetz
Y	YERMOSOLS
Yh	Haplic Yermosols
Yk	Calcic Yermosols
Yy	Gypsic Yermosols
Yl	Luvic Yermosols
Yt	Takyric Yermosols
X	XEROSOLS
Xh	Haplic Xerosols
Xk	Calcic Xerosols
Xy	Gypsic Xerosols
Xl	Luvic Xerosols
K	KASTANOZEMS
Kh	Haplic Kastanozems
Kk	Calcic Kastanozems
Kl	Luvic Kastanozems
H	PHAEOZEMS
Hh	Haplic Phaeozems
Hl	Luvic Phaeozems
B	CAMBISOLS
Be	Eutric Cambisols
Bd	Dystric Cambisols
Bh	Humic Cambisols
Bg	Gleyic Cambisols
Bk	Calcic Cambisols
Bc	Chromic Cambisols
Bv	Vertic Cambisols
Bf	Ferralic Cambisols
L	LUVISOLS
Lo	Orthic Luvisols
Lc	Chromic Luvisols
Lk	Calcic Luvisols
Lv	Vertic Luvisols
Lf	Ferric Luvisols
La	Albic Luvisols
Lp	Plinthic Luvisols
Lg	Gleyic Luvisols
P	PODZOLS
Ph	Humic Podzols
Pp	Placic Podzols
Pg	Gleyic Podzols
W	PLANOSOLS
We	Eutric Planosols
Wd	Dystric Planosols
Wm	Mollic Planosols
Ws	Solodic Planosols
A	ACRISOLS
Ao	Orthic Acrisols
Af	Ferric Acrisols
Ah	Humic Acrisols
Ap	Plinthic Acrisols
Ag	Gleyic Acrisols
N	NITOSOLS
Ne	Eutric Nitosols
Nd	Dystric Nitosols
Nh	Humic Nitosols
F	FERRALSOLS
Fo	Orthic Ferralsols
Fx	Xanthic Ferralsols
Fr	Rhodic Ferralsols
Fh	Humic Ferralsols
Fa	Acric Ferralsols
Fp	Plinthic Ferralsols
O	HISTOSOLS
Oe	Eutric Histosols
Od	Dystric Histosols

[1] This table follows the order of presentation of soil units in Volume I.

MISCELLANEOUS LAND UNITS

Miscellaneous land units are used to indicate land areas where there is no soil, or where parent materials outcrop or are overlain by glaciers, snow caps or salt flats.

Where the extent of the land unit is large enough to be shown separately, the sign is printed over a blank background. When the land unit occurs in combination with a soil or soil association the sign is printed over the colour of the dominant soil.

Sources of information

A small map showing the sources of information and the degree of their reliability appears as an inset on the soil map. A separation is made between the areas compiled from systematic soil surveys (class I), soil reconnaissance (class II), and general information with some local field observations (class III).

About 7 percent of the continent is now covered by large- or medium-scale survey maps based on sufficient ground control to be placed in reliability class I. Among these maps there are unavoidable variations in accuracy due to such factors as scale, methodology and purpose of preparation. Difficulties in correlating the FAO/Unesco legend with some local legends may also reduce the reliability of the information. Further uncertainty is introduced by the differing concepts used in determining the dominant soil and the importance of the associated soils.

About 38 percent of Africa is covered by reconnaissance maps showing soil distribution only in terms of environment, climate, vegetation, parent rock or geomorphology, which at times leads to somewhat bold extrapolations.

The third class of reliability, covering about 55 percent of the continent, refers to virtually unexplored areas where only occasional field observations have been made. These are thinly populated or semiinaccessible regions. It is to be hoped that aerial photographs and other information that may become available through remote sensing from aircraft or satellites may eventually complete the coverage.

The main documents used to compile the Soil Map of Africa are recorded here by country of origin.

ALGERIA

A 1 : 200 000 map of Algeria without the Sahara published by J.H. Durand in 1954 served as a basis for the CCTA Soil Map of Africa. T.G. Boyadgiev of FAO recently used the FAO/Unesco legend to draft a new map of Algeria on the basis of his own research and DEMRH[2] documents made available to him by M. Thamini, Chief of the DEMRH Soils Section. This map has been used for the Algerian part of the Soil Map of Africa.

The work of J. Boulaine in the Chélif plain is also a highly interesting source of pedogenetic information.

ANGOLA

Many studies have been undertaken in Angola since 1950 for the Junta de Investigações do Ultramar by J.V. Botelho da Costa, A.L. Azevedo and R. Pinto Ricardo. Many regional maps and physico-chemical soil studies have been published. The main source of information used for the Cabinda district was a map and report published by the Junta de Investigações do Ultramar. A 1 : 3 000 000 map of Angola with the international legend was prepared for the FAO/Unesco project by E.P. Cardoso Franco.

BENIN

General mapping of this country to a scale of 1 : 200 000 is in progress, but for the moment the only available map covering the whole country is the 1 : 1 000 000 soil map by B. Volkoff and P. Willaime.

BOTSWANA

Much surveying has been done in eastern Botswana and particularly in the northeastern part of the country where the development potential is greater. M.G. Bawden and A.R. Stobbs prepared a soil resources map from which it was possible to draft a soil map.

BURUNDI

Many local as well as vegetation and land-use maps have been prepared, but the general map of this country used for the Soil Map of Africa was that published by A. van Wambeke in a general report on the soils of Rwanda and Burundi.

CAMEROON

For western Cameroon there is only a general soil map based on the FAO report *The soils and ecology of west Cameroon.*

In eastern Cameroon ORSTOM has published many local maps at a scale of 1 : 100 000. A general synthesis by D. Martin and P. Ségalen at the scale of 1 : 1 000 000 has been used to prepare the map of this country.

[2] Division des études de mise en valeur et recherches hydrauliques (formerly Service des études scientifiques - SES).

CENTRAL AFRICAN EMPIRE

Some regions have been mapped systematically by ORSTOM and SOGETHA. The only existing general map of the country (P. Quantin, 1965) was used as a basis for preparing the Soil Map of Africa. The latest data, especially information on the northwestern region, have been incorporated in this map.

CHAD

The extensive soil survey work undertaken in this country is reflected in the many 1 : 200 000 maps prepared by ORSTOM. The legend of the 1 : 1 000 000 general soil map published by J. Pias in 1969 has been correlated with the FAO/Unesco legend.

COMORO ISLANDS

A small-scale soil map of Anjouan Island was made in 1953. Recent studies have been made by the Institut de recherches tropicales (IRAT) and the Bureau du développement de la production agricole (BDPA), but there are no general maps covering the islands as a whole.

CONGO

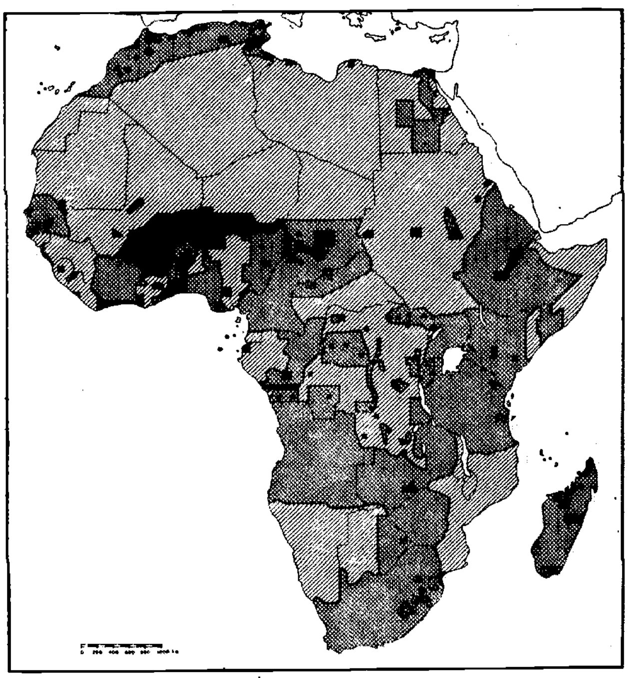
ORSTOM has done a special study of the southern part of the country with emphasis on the Niari valley, which was also covered in an FAO project. The 1 : 2 000 000 general map of the country by P. de Boissezon, G. Martin and F. Gras published in the *Atlas of the Congo* provided groundwork for the FAO/Unesco project.

EGYPT

A map which is very detailed but nevertheless difficult to interpret pedologically has been prepared of all the surroundings of the Nile and its delta. A general map of Egypt using the international legend has been proposed by M. Elgabaly *et al.* Interesting local studies have been made, particularly by A.M. Ghaith.

ETHIOPIA

The first general mapping was attempted by J. D'Hoore in the CCTA Soil Map of Africa. Since then local studies have been carried out, particularly



SOURCES OF INFORMATION

Systematic soil surveys | Soil reconnaissance | General information with local soil observations

in the Awash valley. The World Soil Geography Unit of the United States Soil Conservation Service provided the FAO/Unesco project with an unpublished survey prepared from aerial photographs and bibliographical references. The excellent report by H.F. Murphy on soil fertility in Ethiopia was also useful despite its lack of a map.

Gabon

ORSTOM has studied the soils in the regions with the greatest development potential. A provisional sketch of the soils of Gabon was specially prepared for the FAO/Unesco project by D. Martin.

Gambia

Only land-use maps are available for this country.

Ghana

The soil studies begun by C.F. Charter and continued by H. Brammer, P. Ahn, T. Day and other FAO officers provided valuable background information for the provisional 1 : 1 000 000 soil map of Ghana by H. Obeng *et al.*

Guinea

R. Maignien prepared for CCTA a general map of Guinea which was later revised by A. Kawalec of FAO. Very few local maps are available.

Guinea-Bissau

A provisional 1: 5 000 000 map was prepared specially for the FAO/Unesco Soil Map of Africa by A.J. da Silva Teixeira.

Ivory Coast

Use was made of soil documents at scales of 1 : 200 000 and 1 : 500 000 published by ORSTOM, a soil survey of the southwestern region by the Development and Resources Corporation, and a soil study of the Ferkessedougou region by SOGETHA. The main document used was the 1 : 500 000 map by A. Perraud and P. de la Souchère, which was simplified and correlated with the FAO/Unesco legend.

Kenya

The first studies were based mainly on a provisional 1 : 2 000 000 map of eastern Africa published by G. Milne in 1936. The many irrigation studies carried out from 1960 to 1970 produced large-scale maps covering only a small area. At present the only usable map for the whole country is the 1 : 3 000 000 soil map by G.H. Gethin-Jones and R.M. Scott which was published in the *Atlas of Kenya* in 1959.

Lesotho

The Land Resources Division of the Directorate of Overseas Surveys (DOS) published a study of land resources with two map sheets at a scale of 1 : 250 000 which were used as the basis for FAO/Unesco mapping work after correlation of the two legends.

Liberia

Very few soil maps are available in Liberia despite a number of studies done by the Liberia College of Agriculture. R. Fanfant of FAO prepared a provisional map of the country to replace the reconnaissance map prepared by W.E. Reed (USDA) in 1951.

Libya

There is no soil map of Libya apart from a soil study of northern Cyrenaica by P. Hubert and an FAO report on the soils of Tripolitania, Cyrenaica and various oases. A provisional map by P. Gibbs (USAID) extrapolated from the geological map by A. Desio was used for the FAO/Unesco map.

MADAGASCAR

Systematic mapping at a scale of 1 : 200 000 was done by ORSTOM and numerous maps were published. A 1 : 1 000 000 map in three sheets was published by J. Riquier. The document used to prepare the Soil Map of Africa is a simplified and revised version of the 1 : 1 000 000 map by P. Roederer and F. Bourgeat published in the *Atlas of Madagascar*. Many local soil and land-use studies have been done by IRAT.

MALAWI

A. Young and P. Brown wrote three reports on the physical environment of Malawi in which climate, relief, vegetation, soils and agriculture are studied very clearly and precisely. Soil maps and descriptions of soil series extracted from these reports were taken as a basis for the present map.

MAURITANIA

Among the few soil studies done in the desert regions of this country are those made for an ecological survey on the breeding ground of locusts. R. Boulet and J. Vieillefon of ORSTOM prepared a provisional 1 : 5 000 000 soil map of Mauritania based on a number of surveys and an interpretation of the Bureau de recherches géologiques et minières (BRGM) geological map for the desert regions.

MAURITIUS

The basic document used by the FAO/Unesco project was the 1 : 100 000 soil map and explanatory text by S.M. Feillafe and D.H. Parish.

MOROCCO

Among the many soil studies performed are those by G. Bryssine, G. Grillot and R. Jaminet. An overall map of the country was prepared by W. Cavallar in 1946. The latest information on the soils of Morocco appears in the provisional 1 : 4 000 000 soil map which was drafted with the international legend for the FAO/Unesco project by P. Billaux and A. Ruellan.

MOZAMBIQUE

On the basis of local studies and a general map published in 1948, D.H. Godinho Gouveia prepared a map of Mozambique with the international legend for the FAO/Unesco project.

NAMIBIA

Because of its desertic nature, this region is little known. The provisional map of Namibia used for the FAO/Unesco project was prepared with the collaboration of H. Scholz and supplemented by oral information from R.F. Loxton.

NIGER

The southern part of this country is well known through the work of ORSTOM, SOGETHA and Hunting Technical Services, which have produced several maps to scales of 1 : 100 000 and 1 : 500 000. As in Mauritania, the desert region has been interpreted by R. Boulet according to the BRGM geological map and various surveys.

NIGERIA

The existing general soil maps of Nigeria have been largely outdated by recent studies done by the DOS Land Resources Division and FAO which have contributed knowledge of soils in fairly large areas. K. Klinkenberg helped prepare a synthesis of the new findings for the Soil Map of Africa.

REUNION ISLAND

A reconnaissance map of the island was prepared in 1960. Since then more detailed local maps have been produced in potential development areas, but the scale of the FAO/Unesco map was not large enough to include all of the new studies.

RHODESIA

The best study of the soils of Rhodesia is that by J.G. Thompson of the Rhodesian Ministry of Agriculture. His map to a scale of approximately 1:1 000 000 was invaluable to the FAO/Unesco project.

RWANDA

The Institut national pour l'étude agronomique du Congo (INEAC) and FAO made a number of local maps in collaboration with the Institut des sciences agronomiques du Rwanda (ISAR). The country as a whole was covered in A. van Wambeke's general soil map of Rwanda and Burundi.

SÃO TOMÉ AND PRINCIPE

These two islands have been studied in detail, mainly in order to determine their agricultural suitability. The information concerned is too detailed for the scale of the Soil Map of Africa.

Senegal

Several 1: 200 000 maps and local studies were done by ORSTOM and IRAT. A first general synthesis was done by R. Maignien for the CCTA map, and another more recently by J. Vieillefon for the FAO/Unesco map.

Sierra Leone

A first map of this country was prepared by R. Allbrook of the Department of Agriculture and later incorporated by R.T. Odell and J.C. Dijkerman of the University of Njala in a general work *Properties, classification and use of tropical soils with special reference to those in Sierra Leone*. Although designed as a physiographical map, the soil descriptions furnished by the accompanying text can be used to prepare a soil map. The soil work by J.C. Dijkerman, S. Sivarajasingham, J. Stark and A.R. Stobbs also provided background information.

Somalia

Soil data on northern Somalia were taken from an article on vegetation by C.F. Hemming and from oral information supplied by H. Le Houérou. The southern coast has been fairly thoroughly studied by FAO, but the rest of the country is still mostly unexplored.

South Africa

The principal sources of information are C.R. van der Merwe's 1 : 5 000 000 soil map and book *Soil groups and subgroups of South Africa*, the soil descriptions and analyses of which were fairly easy to correlate with the international legend. Larger scale maps of the region of Pretoria and Johannesburg by R.F. Loxton and a complete study of the Tugela river basin by J.J. van der Eyk, C.N. Macvicar and J.M. de Villiers have made it possible to specify the limits of map units in some regions and facilitate their correlation.

Spanish Sahara

No soil map has been traced; however, a topographical map and a vegetation map accompanied by an ecological report have allowed some extrapolation to be made for soils known from studies made in neighbouring countries.

Sudan

Although soil studies have been made in the Gezira, Kordofan and Jebel Marra regions, the general mapping of Sudan is still based mainly on a map by G.A. Worrall published in the periodical *Sols africains*. An excellent soil study by J. Buursink of the central region was recently published, though without a map.

Swaziland

The soil mapping done by G. Murdoch in the 1960s has been of considerable use to the FAO/Unesco project.

Tanzania

A 1: 2 000 000 soil map of Tanzania was published by the East Africa Agriculture and Forestry Research Organization in 1961. Another map was prepared in 1970 by R.M. Baker *et al.* to a scale of 1: 1 000 000. Despite the fact that this map determined only physiographical regions, its limits have nevertheless been used to interpret the soil associations found in each region.

Territory of the Afars and the Issas

A first draft soil map was made by geologist H. Besairie for the CCTA map. It was later modified slightly to incorporate unpublished information supplied by J. Boulaine.

Togo

The 1: 500 000 soil map and accompanying explanatory text by M. Lamouroux were the main source of information. FAO's soil and water use study of Togo also furnished minor details relevant to the mapping of the coastal and savanna regions.

Tunisia

The Ministry of Agriculture's special soils and water use division has undertaken detailed soil mapping and dry and irrigated agricultural feasibility studies in a large part of central Tunisia. A 1: 1 000 000 soil map of the country published by the Ministry of Agriculture in 1971 was simplified for inclusion in the Soil Map of Africa.

Uganda

The Department of Agriculture has surveyed and mapped soils at a scale of 1: 250 000, thus providing reliable documentation.

Upper Volta

The 1: 500 000 map of Upper Volta prepared by Orstom soil scientists was simplified and used as groundwork for the Soil Map of Africa. The study of the Ouagadougou region and accompanying 1 : 200 000 map done by Sogetha were also useful.

Zaire

Ineac has published several soil and vegetation maps at scales of 1: 50 000 and 1: 100 000. The Ineac map at 1: 5 000 000 scale by C. Sys summarizes the work carried out by Belgian soil scientists up to 1960, and was used as a basis for the Ccta map.

Zambia

The first soil map of Zambia appeared in the general map of eastern African territories published by the Federal Department of Trigonometrical and Topographical Surveys. After independence, the Ministry of Lands and Mines published a 1 : 1 500 000 soil map which has been used as a basic document for the Fao/Unesco project. The modifications of the western part of the ministry's soil map were made on the basis of the findings of an ecological study by the Dos Land Resources Division.

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4. ENVIRONMENTAL CONDITIONS

This chapter briefly outlines four aspects of the environment that are important in the development of soils: climate, vegetation, geomorphology, and lithology. The following outlines indicate the location and nature of the major regions in which important variants of climate, vegetation, landscape and rock types occur. Small-scale maps illustrating these environmental factors appear at the back of this volume.

CLIMATE

Climate is one of the factors governing the distribution of soils throughout the world. Unevaporated rain leaches soils and heat triggers chemical processes, hastening the decomposition of minerals. Until recently it was the normal practice to distinguish zonal soils, which are distributed throughout the world according to a climatic zonality, from azonal soils, which are subject to other factors such as lithology and drainage. Although climate directly influences soils, it may also act indirectly by modifying vegetation, which furnishes varying quantities of organic matter to the soil and is involved in the cation cycle between soil and subsoil. The influence of climate on plants must be taken into account when soil use is considered. Cultivated plants all have their own requirements and the success of a crop depends on the climate as well as the soil.

Climatic zonality is determined by the successive positions of the earth in relation to the sun throughout the year which give rise to a general pattern of atmospheric circulation. However, local factors such as topography, ocean currents and continental mass alter the general circulation pattern and bring about local variations which produce a specific climate in a particular region. The distribution of these major climatic regions is detailed in the last part of this section. Figure 1 presents the climatic regions of Africa according to the system of J. Papadakis, which is based on critical temperatures of certain cultivated plants and the water balance of the soils. This climatic map is intended to be used mainly for agricultural purposes.

Climatic factors

The pattern of air circulation over the continent is determined by the earth's rotation and the temperature difference between the tropical and polar regions.

As it does not extend as far south as South America, Africa is the world's hottest continent; the average annual temperature exceeds 10°C. The hottest part receives the most solar radiation and lies between the two tropics as a result of the seasonal displacement of the thermal equator or intertropical convergence zone (ITZ).

At a specific time during the season, the air within this region becomes highly heated and rises to condense at high altitude over the zone of maximum rainfall. These air currents of varying dryness move at great height toward the tropical high-pressure anticyclone zones and then drop vertically, become compressed, warm up and lose the rest of their moisture over the desert zones of the Sahara and the Kalahari. The currents then move horizontally toward the ascending intertropical convergence zone, thus closing the cycle. Deflected by the earth's rotation, they then become trade winds which blow from northeast to southwest in the northern hemisphere and from southeast to northwest in the southern hemisphere. They are stronger during the equinoxes when the thermal equator corresponds to the true equator, producing a perfect symmetry of the air masses in both hemispheres. During the summer in one hemisphere, the intertropical convergence zone moves to the corresponding tropic, while the high-pressure area of the opposite hemisphere tends to cross the equator and attain the low pressure of the intertropical convergence zone. A swirling cyclonic circulation occurs around the low-pressure areas. The intertropical convergence zone passes over the same region twice a year; there are two rainy seasons in the countries lying on both sides of the equator.

High relief forces winds to rise and therefore to cool and condense; the windward sides of mountains thus receive more precipitation than the leeward sides, as in Madagascar and Reunion Island.

As the annual temperature variations over the land are more rapid and extensive than those over the sea, the monsoon winds blow from the sea to the continent in the summer and vice versa in the winter. The monsoon and trade winds may strengthen or check each other. The point where they converge receives more precipitation than surrounding areas.

During the northern hemisphere summer, the southeast trade winds and then the southwest monsoon take moisture from the Indian Ocean and bring rainfall to eastern Africa. An equivalent air current from the Atlantic affects the west coast of Africa and penetrates fairly far inland. The monsoon meets the "harmattan," a dry northeast trade wind, and the convergence of these two currents forms the intertropical convergence zone previously discussed, producing a rainy storm front. In the winter, however, the harmattan blows from the Sahara southward, creating a winter dry season.

The immensity of the arid regions north of the equator as compared with the smaller size of the deserts in the southern hemisphere appears to be due to the fact that the part of the continent north of the equator is more extensive and its climate is therefore more continental.

The presence of the large island of Madagascar, which serves to block the trade winds, perhaps also explains why eastern Africa is relatively drier than western Africa. Eastern Africa is, however, also affected by the large land mass of Asia.

Climatic regions

1. Mediterranean region

This region is indicated by the figure (6)[1] on the Papadakis climatic map. Rain falls only in the winter (400 to 700 mm) and the summer is very hot and dry. The summer climate of the Atlantic coast of Morocco is due to the influence of the cold sea current from the Canary Islands.

The plateaus of the "chotts" rise to an altitude of about 1 000 metres, have cold winters and receive less rainfall (150 to 200 mm). These conditions have produced a treeless steppe. The decrease in precipitation is due to a lower latitude and to the coastal ranges which block the cold, moist winds from the north. The Atlas chain receives much more rainfall, but is also colder.

[1] All the numbers in parenthesis in this subsection correspond to the Papadakis classification system used in the climatic map (Figure 1) and key.

In Egypt and Libya the Mediterranean climate is reduced to a narrow coastal strip by the lower latitude and by the advancing desert, which here is not contained by the Atlas mountain system, as is the Maghreb.

2. Saharan region

The Sahara has a desert climate (3); four fifths of its surface receive precipitation of less than 20 mm a year, often in the form of fine rain. The Mauritanian Sahara (3.1) receives more. The wadis do not flow every year. As noted previously, this situation is due to the subtropical anticyclone. Violent winds are frequent and cold sea currents produce fog and an ocean desert climate (3.3) on the coast of Mauritania, the Spanish Sahara and Morocco. In the northern part there is frost in the winter. In the summer temperatures exceed 43°C. Because of their altitude, the Ahaggar and Tibesti ranges have a semidesert climate, i.e. a rainfall of about 100 mm and more moderate temperatures with regular frosts in the winter.

3. Western Africa

South of approximately the 15th parallel are east-west climatic regions which become increasingly humid toward the Gulf of Guinea.

The first semiarid tropical region (1.5 and 1.9) corresponds to the Sahelo-Sudanese climate of Aubreville. The average annual temperature averages between 26° and 31°C and precipitation is between 400 and 1 000 mm. The rainy season is short to very short (two to four months) and the dry season, when the harmattan blows, is extremely severe.

The second region (1.4) corresponds approximately to the Sudano-Guinean climate of Aubreville. The tropical temperatures are lower (24° to 28°C) and rainfall heavier (950 to 1 750 mm). The dry season lasts four to five months and the rainy season five to seven months. Precipitation occurs mainly in the summer.

The third zone (1.1) is of the humid equatorial and tropical type (Guinean zone of Aubreville). The rainfall curve often shows two maxima and two minima, always exceeds 1 000 mm a year and may reach 2 000 mm in Liberia. The dry season is very short, temperatures range from 25° to 27°C and the fluctuation of the temperature is very modest in comparison with the first two zones.

The abnormal drier climate of the coasts of Togo and Ghana (1.3) and the "Baoulé 'V'" formed by

KEY TO THE CLIMATIC MAP OF AFRICA

	Climate	Temperature regimes [1]	Humidity regimes [1]	Main locations
	TROPICAL			
1.1	Humid semihot equatorial	Eq	HU Hu MO humidity index > 1	Congo basin, Gabon, Ivory Coast basin, Niger delta, east and northwest coasts of Madagascar
1.2	Humid semihot tropical	Tr	Hu MO humidity index > 1	Lower Congo, southeast coast of Madagascar, Zambezi delta
1.3	Dry semihot tropical	Eq Tr	humidity index 0.44 to 1.00	Coastal Mozambique, Tanzania and Angola; west coast of Madagascar
1.4	Hot tropical	EQ TR	MO Mo	Northern Guinea, Ivory Coast and Ghana; southern Mali, Benin, central Nigeria, the Central African Empire, southeastern Congo, interior of Mozambique, western Madagascar, upper Lualaba basin
1.5	Semiarid tropical	EQ Eq TR Tr	mo	Northern Senegal, Mali, southern Niger, Chad and Sudan, Somali coast, Lake Rudolf region, coastal Angola, southern Madagascar
1.7	Humid tierra templada	Tt tt	Hu Mo	All highlands in northern Angola, southern Zaire, Cameroon, southern Guinea, Ethiopia, Mozambique and Tanzania, scarps of the high plateaus of Madagascar
1.8	Dry tierra templada	Tt tt	Mo mo	Tanzania, Kenya, Uganda, region east of the Ethiopian high plateaus
1.9	Cool winter hot tropical	tR	HU Hu MO Mo mo	Northeastern Nigeria, eastern Chad and northern Central African Empire; southern scarps of the high plateaus of Madagascar
	TIERRA FRIA (possibility of frost)			
2.1	Semitropical tierra fría	TF, Ct in winter	Hu MO Mo mo	Much of the plateau area in Angola and central western Africa, eastern Malawi
2.2	Low tierra fría	TF, Ci or Av in winter	Hu MO Mo mo	All high plateaus of Madagascar, northern South Africa, Rhodesia and Shaba region in Zaire
2.3	Medium tierra fría	Tf	Hu MO Mo mo	Highlands of Ethiopia, Madagascar, South Africa, Kenya; northern Malawi
2.4	High tierra fría	tf	Hu MO Mo mo	Lesotho
	DESERT			
3.1	Hot tropical desert	EQ TP tr	da de do	Northeastern Sudan, Somalia, northeastern Kenya, coastal Mauritania, southeastern and northeastern Ethiopia
3.2	Hot subtropical desert	Ts SU	da de do	Sahara, Kalahari, western Africa, Libyan desert, northern Sudan
3.3	Semihot and cool tropical desert	Eq Tr tr	da de do	Coastal Mauritania, Spanish Sahara, southwestern Angola and northern Namibia
3.4	Cool subtropical desert	Su MA Mm	da de di do	Coastal Namibia, the Karroo region in South Africa, and the Gulf of Sidra in Libya

[1] These temperature and humidity types are defined in the Key to symbols in Table 2.

KEY TO THE CLIMATIC MAP OF AFRICA *(concluded)*

	Climate	Temperature regimes [1]	Humidity regimes [1]	Main locations
3.5	Tropical highland desert	TF Tf tf	da do	Somali-Ethiopian border, central Namibia, two regions in central South Africa
3.8	Pampean desert	PA	da de di do	Northern Karroo region in South Africa
	SUBTROPICAL			
4.2	Monsoon subtropical	SU Su	Mo mo	Southeastern Rhodesia, northern Botswana and Namibia, southern Angola
4.3	Hot semitropical	Ts, G in summer	MO Mo mo	Zambezi basin between Senanga and the Kariba dam, Darfur and Kordofan in Sudan
4.4	Semihot semitropical	Ts, g in summer	Hu mo	East coast of South Africa and the region north of Swaziland
	PAMPEAN			
5.4	Marine pampean	MA	St	Southern coast of South Africa
5.6	Monsoon peripampean	PA	mo	High Veld in South Africa
5.7	Semiarid peripampean	Su	si	Between the Suurberge and Winterberge mountains in South Africa
	MEDITERRANEAN			
6.1	Subtropical Mediterranean	Su su	ME Me	Lowlands of southwestern South Africa, great plains of Morocco, coastal strip of Algeria and Tunisia, Tripolitania and Cyrenaica in Libya
6.2	Marine Mediterranean	MA Mm	ME Me	Cape area in South Africa, Safi region in Morocco
6.5	Temperate Mediterranean	TE	ME Me	Rif region in Morocco
6.7	Continental Mediterranean	CO Co co	ME Me	High Atlas in Morocco, Algerian high plateaus
6.8	Subtropical semiarid Mediterranean	SU Su Tr tr MA	me	Souss plain in Morocco, Sousse region in Tunisia, Tripolitania in Libya, coastal plain of Egypt, southern coastal plain of South Africa
6.9	Continental semiarid Mediterranean	CO Co co TE Te te	me	Desert fringe of the High Atlas, Algerian high plateaus, Tebessa mountains in Tunisia and Hodna mountains in Algeria.

[1] These temperature and humidity types are defined in the Key to symbols in Table 2.

an incursion of climate (1.4) in Ivory Coast are reflected in the vegetation and soil distribution.

4. HORN OF AFRICA

The Somali-Ethiopian region is characterized both by very dry desert climates with a yearly precipitation of less than 100 mm (Danakil plain - 3.1 and 3.5) and semidesert climates with 250 to 500 mm (Somalia - 1.5). However, the Ethiopian highlands, with altitudes of 3 000 to 5 000 metres, receive plentiful rainfall in the summer: a maximum of 1 200 to 1 300 mm (1.7) on the western scarp of the high plateau and less on the plateau itself (2.3). The eastern scarp of the plateau receives 500 to 1 000 mm (1.8). The temperature is much lower on the plateau (2.3) than in the neighbouring plains (1.5 and 1.7).

TABLE 2. – CLIMATIC CHARACTERISTICS OF PLACES REPRESENTING THE CLIMATIC REGIONS OF THE MAP

Map Symbol	Climate	Place	Winter type	Summer type	Temperature regime	Humidity regime	Annual rainfall	Annual evapotranspiration [1]	Leaching rainfall in humid season [2]	Drought stress in dry season [3]	Humid season [4]	Dry season [5]
							Millimetres					
1.1	1.12	Yangambi, Zaire	Ec	g	Eq	Hu	1 710	1 130	580	0	3–12	0
1.2	1.23	Brazzaville, Congo	Tp	g	Tr	MO	1 450	1 360	500	410	10–4	7–9
1.3	1.31	Porto Amelia, Mozambique	Ec	g	Eq	MO	800	1 430	170	800	1–4	6–11
1.4	1.48	Kaduna, Nigeria	Tp	G	TR	MO	1 250	2 050	600	1 400	6–9	11–4
1.5	1.53	Ouagadougou, Upper Volta	Tp	G	TR	mo	930	2 550	300	1 920	7–9	11–5
1.7	1.72	Kampala, Uganda	Tp	c	Tt	Hu	1 150	1 030	240	120	3-6 8-12	0
1.8	1.82	Dodoma, Tanzania	Tp	c	Tt	Mo	570	1 520	50	1 000	1–3	5–11
1.9	1.91	Kano, Nigeria	tP	G	tR	mo	860	2 470	350	1 960	7–9	11–5
2.1	2.13	Broken Hill, Zambia	Ct	c	TF	MO	920	1 360	470	910	12–3	5–10
2.2	2.25	Tananarive, Madagascar	Ci	c	TF	MO	1 340	1 020	730	410	11–3	6–9
2.3	2.32	Addis Ababa, Ethiopia	Ci	M	Tf	MO	1 220	1 240	600	620	6–9	11–2
2.4	2.43	Barkly East, South Africa	Ti	t	tf	Mo	670	1 070	400	800	3	6–9
3.1	3.12	Djibouti, Territory of the Afars and the Issas	Ec	G	EQ	do	120	1 660	0	1 540	0	4–3
3.2	3.23	Tamanrasset, Algeria	Ci	G	SU	da	30	2 310	0	2 280	0	9–8
3.3	3.33	Villa Cisneros, Spanish Sahara	Tp	c	Tr	do	70	920	0	850	0	10–9
3.4	3.41	Walvis Bay, Namibia	Ci	M	MA	da	20	660	0	640	0	4–3
3.5	3.53	Postmasburg, South Africa	Ci	c	TF	do	300	1 610	0	1 310	0	4–3
3.8	3.82	Cahrnia, South Africa	Av	M	PA	de	200	1 470	0	1 270	0	7–6
4.2	4.22	Maun, Botswana	Ci	G	SU	mo	470	2 010	0	1 540	0	4–12
4.3	4.31	El Fasher, Sudan	Ct	G	Ts	mo	300	3 210	0	2 910	0	9–6
4.4	4.45	Durban, South Africa	Ct	g	Ts	Hu	1 000	810	350	160	9–4	0
5.4	5.43	George, South Africa	Ci	M	MA	St	810	790	120	100	9-12 2-3	0
5.6	5.62	Bethulie, South Africa	Av	M	PA	mo	440	1 450	0	1 010	0	4–3
5.7	5.77	Somerset East, South Africa	Ci	g	Su	si	630	1 330	0	700	0	4–9
6.1	6.19	Rabat, Morocco	Ci	g	Su	Me	490	880	90	480	11–3	7–9
6.2	6.23	Cape Town, South Africa	Ci	M	MA	Me	500	820	130	450	5–8	12–3
6.5	6.51	Chauen, Morocco	av	M	TE	Me	1 160	730	770	340	10–7	7–9
6.7	6.74	Setif, Algeria	av	g	CO	Me	460	1 180	70	790	11–2	6–10
6.8	6.81	Kairouan, Tunisia	Ci	G	SU	me	280	1 600	0	1 320	0	2–12
6.9	6.93	Djelfa, Algeria	av	M	TE	me	300	1 260	10	970	12–1	4–10

See notes at end of tables.

Key to symbols in Table 2

I. Winter types

Symbol	Agricultural suitability	Average of the absolute minima of coldest month	Average of daily minima of coldest month	Average of daily maxima of coldest month
		Degrees Centigrade		
Ec	Warm enough for equatorial crops (rubber, coconut)	> 7°	> 18°	
Tp	Colder but frostless, too warm for cryophilous plants (wheat)	> 7°	13 — 18°	> 21°
tP	Idem, but wheat not entirely excluded	> 7°	8 — 13°	> 21°
Ct	Frost a possibility, but mild enough for citrus, marginal for cryophilous plants	— 2.5 to + 7°	> 8°	> 21°
Ci	Idem, but cool enough for cryophilous plants	— 2.5 to + 7°		10 — 21°
Av	Colder, but mild enough for winter oats	— 10 to — 2.5°	> — 4°	> 10°
av	Idem, but winter days are cooler	> — 10°		5 — 10°

II. Summer types

Symbol	Agricultural suitability	Duration of frostless season	Average of the mean daily maxima of warmest months n=number of months	Average of daily maxima of warmest month	Average of daily minima of warmest month
		Months	*Degrees Centigrade*		
G	Warm enough for cotton, summer days very hot	> 4.5	> 25° n = 6	> 33.5°	
g	Idem, but summer days less hot	> 4.5	> 25° n = 6	< 33.5°	> 20°
c	Warm enough for maize and cotton, nights cool but frostless, good for coffee growing	12	> 21° n = 6	< 33.5°	< 20°
O	Colder, but warm enough for rice	> 4	21-25° n = 6		
M	Colder, but warm enough for maize	> 4.5	> 21° n = 6		
T	Colder, but warm enough for wheat	> 4.5	< 21° n = 6 or > 17° n = 4		
t	Colder, but warm enough for wheat, short frostless season	2.5 — 4.5	> 17° n = 4		

III. Temperature regimes

Symbol	Temperature regime	Winter type	Summer type
EQ	Hot equatorial	Ec	G
Eq	Semihot equatorial	Ec	g
TR	Hot tropical	Tp	G
Tr	Semihot tropical	Tp	g
tR	Cool winter hot tropical	tP	G, g
Tt	Tierra templada	Tp, tP, tp	c
TF	Low tierra fría	Ct or colder	g
Tf	Medium tierra fría	Ci or colder	O, M
tf	High tierra fría	Ci or colder	T, t
Ts	Semitropical	Ct	G, g
SU	Hot subtropical	Ci, Av	G
Su	Semihot subtropical	Ci	g
MA	Warm marine	Ci	O, M
TE	Warm temperate	av, Av	M
PA	Pampean	Av	M
CO	Warm continental	Av or colder	g, G

IV. Humidity regimes

Symbol	Humidity regime	Definition
Hu	Humid	No dry month.[4] Humidity index[5] > 1. Ln[2] > 20% of potential evapotranspiration.[1] One or more months are not humid.[4]
ME Me me	Mediterranean	Neither humid nor desert, winter rain > summer rain. If summer is G, July should be dry. Latitude > 20°, otherwise the regime is monsoon.
Me	Dry Mediterranean	Ln[2] < 20% of annual evapotranspiration. Humidity index 0.22 to 0.88. In a month or more with daily maxima averaging above 15°C, water stored in the soil fully covers evapotranspiration.
me	Semiarid Mediterranean	Too dry for Me.
MO Mo mo	Monsoon	Neither humid nor desert. Humidity index[5] for July-August greater than for April-May. July or August is humid if two winter months are humid. July or August is not dry if two winter months are not dry. Otherwise the regime is steppe or semiarid isohygrous.
MO	Moist monsoon	Ln[2] > 20% of annual evapotranspiration and/or a humidity index[5] > 0.88.
Mo	Dry monsoon	Ln[2] < 20%. Humidity index[5] between 0.44 and 0.88.
mo	Semiarid monsoon	Humidity index[5] < 0.44.
da de do	Desert	All months with an average maximum temperature > 15°C are dry. The humidity index[5] is < 0.22.
da	Absolute desert	All months for which the average of the maxima is above 15°C have a humidity index[5] below 0.25. The annual humidity index is < 0.09.
de	Mediterranean desert	Not dry enough for da. Winter rains are heavier than summer rains.
do	Monsoon desert	Not dry enough for da. July-August are less dry than April-May.
si	Semiarid isohygrous	Too dry for the steppe regime, too humid for desert; neither Mediterranean nor monsoon regime.

[1] Potential evapotranspiration is computed month by month on the basis of the maximum daily air saturation deficit by the Papadakis formula: $E = 0.5625\ (e_{ma} - e_{mi-2})$, where E is in cm. and e in millibars.
[2] Leaching rainfall (Ln) is rainfall minus potential evapotranspiration during the humid season.
[3] Drought stress is the opposite of leaching rainfall; it is the potential evapotranspiration minus rainfall during the nonhumid period of the season.
[4] A month is *humid* when rainfall exceeds evapotranspiration, it is *dry* when rainfall plus the water stored in the soil covers less than half of the potential evapotranspiration, and *intermediate* when it is neither dry nor humid.
[5] The annual or monthly humidity index is obtained by dividing the rainfall by the potential evapotranspiration.

5. Sudanese region

The zonality of western Africa is somewhat disturbed by the Jebel Marra mountains and the large swampy depression of the Sudd. The fairly sharp relief causes cooler winters (1.9 and 4.3). On the other hand, the Sahelo-Sudanese climate reaches further south along the White Nile depression following the 1 000 mm isohyet southward. Northern Sudan is arid. The Red Sea coast and the coastal hills receive about 100 mm of rain in the winter (3.1).

6. Eastern Africa

The climate is extremely varied owing to the marked relief. On the whole it is much drier than the rest of the continent lying within the same latitude. The desert climate (3.1) reaches as far as the equator in northern Kenya. Only the high regions, e.g. the Kenyan highlands, volcanoes and crests on either side of the Great Rift valley (1.7) are relatively well watered, receiving 1 200 to 1 500 mm of precipitation. On the other hand, the Rift valley (1.3) and the plateau south of Lake Victoria (1.8) are rather dry. The heights to the east of Lake Victoria are cooler (2.3), with dryness increasing toward the coast (1.3 and 1.5) because of lower relief and, perhaps, the influence of a cold sea current. However, the coast of Tanzania in front of Zanzibar Island has an abnormally high rainfall of approximately 2 000 mm (1.1).

7. Central Congo basin

This basin has a humid (precipitation over 1 500 mm) and hot equatorial climate (1.1 and 1.2) with two rainfall maxima. There is no distinct dry season around the equator, but there are two dry seasons at higher latitudes. The average temperature is around 25°C and the daily ranges increase with distance from the equator (11° to 20°C). The highlands have a climate with cooler nights (1.7).

8. High plateaus of southern Africa

These regions cover southern Angola, Zambia, Rhodesia and part of South Africa. The predominant climate is (2). Because of the altitude, which often exceeds 1 000 metres, average temperatures are appreciably lower. The average July minima is below 0°C. Winter seasons are dry and long. Some lower regions are subtropical and therefore hotter (4).

9. Plains of Mozambique

These plains have a low rainfall ranging from 200 to 600 mm and a cool winter (1.9), but the coastal strip is better watered (1.3). The northern plains are appreciably more humid (1.2), as are the scarps of the plateaus mentioned above.

10. Namib and Kalahari deserts

These deserts were formed as a result of the persistence of the subtropical anticyclone and the influence of the cold Benguela current (3.3, 3.4, 3.2, 2.1 and 2.2). The effects of both these factors diminish toward the interior. The Kalahari is less dry than the Sahara, having an average summer rainfall of over 150 mm which reaches a maxima of 500 mm in the northern and eastern parts. Although the Namib receives little rainfall, it has a fairly high air humidity (3.4).

11. Coastal strip of South Africa

A Mediterranean climate (6) prevails at the foot of the Great Escarpment. Temperatures are lower during the summer than in northern Africa. Rainfall and temperature increase toward the east, forming a semitropical climate (4.4). Pampean climates (5) with hot summers and some frosts occur between these two climates.

12. Madagascar

The east coast and a small area in the northwest (Sambirano) have an equatorial-type climate (1.1 and 1.2). Rainfall ranges from 1 500 to 3 500 mm; the dry season is extremely short as the coast blocks the trade winds. The high plateaus have milder temperatures (2.1 and 2.2). The hot west coast has a distinct rainy season which often lasts less than six months (1.3 and 1.4). The southwestern part of the island, which is sheltered from the trade winds, has a semiarid climate (1.5) and a rainfall of under 500 mm.

VEGETATION

The broad vegetation regions

The natural plant cover of Africa may be divided into nine main ecological regions. These regions are distinguished on the basis of the physiognomy and structure of the vegetation, and not the floristic species composition. They may be subdivided into 38 subregions, as shown on the vegetation map (Figure 2), which is based on a map drafted by J. Schmithüsen [2] and the AETFAT/Unesco *Carte de la végétation de l'Afrique au sud du Tropique du Cancer.*[3]

Following is a list of the main ecological regions and subregions.[4]

1. Tropical wet evergreen forest
   - a. Tropical lowland rain forest
   - b. Regularly inundated tropical forest
   - c. Tropical swamp forest
   - d. Tropical montane rain forest

2. Tropical deciduous and semideciduous forests
   - a. Tropical semideciduous rain forest
   - b. Tropical semideciduous montane forest
   - c. Large-leaved rain-green dry forest (Myombo)
   - d. Small-leaved rain-green dry forest with umbrella trees

3. Tropical inundated coastal formations
   - a. Mangroves

4. Savanna
   - a. Large-leaved semideciduous tree savanna
   - b. Open rain-green thorntree savanna
   - c. Moist savanna
   - d. Inundated savanna
   - e. Dry savanna
   - f. Highland dry savanna
   - g. Thornbush savanna
   - h. Reed swamps

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[2] Professor Schmithüsen is a lecturer at the Institute of Geography of the University of Saarland in Saarbrücken.

[3] Other publications used to compile this chapter are the FAO/Unesco *Vegetation map of the Mediterranean region,* P. Birot's *Les régions naturelles du globe,* and the *Notice de la carte de Madagascar* published by the French Institute in Pondichery.

[4] This list constitutes the legend of the vegetation map (Figure 2). The crosses indicate the most important oases.

5. Mediterranean macchia and forests
   a. Hard-leaved shrub bushes (macchia)
   b. Partly evergreen thorny shrubs
6. Temperate and Mediterranean woods and forests
   a. Coniferous montane forest
   b. Mediterranean laurel forest
   c. Open hard-leaved forest
   d. Evergreen oak and pine forest
   e. Coniferous dry forest
7. Steppe
   a. Subtropical highland grass steppe
   b. Temperate dry short-grass steppe
   c. Tussock steppe
8. Semidesert formations
   a. Thorntrees and succulents
   b. Very open shrubby succulents
   c. Tropical and subtropical semidesert low vegetation
   d. Succulent semidesert
   e. Halophyte semidesert
9. Desert formations
   a. Subtropical desert with cushion plants
   b. Desert with isolated bushes
   c. Sand desert
   d. Tropical montane desert
   e. Halophyte desert
   f. Oasis vegetation

1. Tropical wet evergreen forest

The northern limit of this forest coincides approximately with latitude 4°N where the proportion of large deciduous trees increases fairly rapidly, especially in Guinea, Liberia and Ivory Coast. South of this latitude the limit of the forest is difficult to determine because of climatic variations. For example, the lower Congo region receives an annual precipitation of 1 400 to 1 500 mm and has at least four dry months, climatic conditions which tend to favour a forest-savanna formation. In Zaire and Congo, the very sandy soils of the Bateke plateaus do not retain enough water to enable the forest to compensate the short dry season. However, along the Mayombe mountains the forest extends into Angola because of the deep soils and the mist and clouds overhanging the area. The Kivu ridge (the highlands bordering the western side of the western Rift valley) blocks the Atlantic monsoon during the summer and limits the intertropical convergence zone in January and February. Beyond the ridge the number of dry months increases very rapidly and the forest disappears. On the high mountains along the eastern and western Rift valleys (the Kivu ridge, Mounts Kilimanjaro and Kenya, and the Mitumba and Kipengere ranges), dry-season mists sustain a montane evergreen forest.

1a. *Tropical lowland rain forest*

This tropical forest is never completely leafless. It consists of several strata, including an upper stratum of large trees which may be 40 to 60 metres high. It is very heterogeneous and among its numerous species are *Brachystegia laurentii*, *Gilbertiodendron dewevrei*, *Diogoa zenkeri*, *Scorodophloeus*, *Oxystigma oxyphyllum* and *Celtis soyauxii*. The underwood includes *Alchornea floribunda*, *Geophila obvallata* and *Scaphopetalum thonneri*. However, the forest is not always virgin and there are numerous secondary and degraded forests of fast-growing light-wood species such as *Ricinodendron heudelotii*, *Albizzia ealaensis*, *Irvingia grandifolia* and especially the umbrella tree (*Musanga cecropioides*).

On the east coast of Madagascar the rain forest consists of three strata. The upper stratum is composed of trees 25 to 30 metres high which frequently have laurel-type foliage and are intermixed with creepers (Apocynaceae, Menispermaceae, liana bamboos). The trees include *Diospyros*, *Echinocarpus*, *Ochrocarpus*, *Tambourissa*, *Dalbergia*, *Dilobeia*, *Weinmannia*, *Symphonia*, *Dombeya*, *Eugenia*, and some palms (*Dracaena* and *Ravenala*). The middle stratum is composed of trees with mesophilous-type foliage of greater size than that of the large trees. This stratum contains Rubiaceae, Euphorbiaceae, Ochnaceae, Erythroxylaceae and Flacourtiaceae. The lower stratum is heavily broken up and the ground surface covered with a thick dead layer of rotting leaves, trunks and branches. This stratum consists of tree ferns (*Cyathea*), dwarf palms (*Dypsis*), grasses with creeping and radicating stems and relatively broad and flexible leaves (*Oplismenus*), Acanthaceae, and others. Second-growth "savokas" occupy land where cultivation has been abandoned. Unlike virgin forest, which is of great floristic richness, they form nearly pure and practically impenetrable stands of *Ochlandra capitata, Arundo madagascariensis, Psiadia altissima, Philippia, Solanum auriculatum, Haronga madagascariensis* and *Ravenala.*

These forests keep the soil almost permanently moist, shelter an intense biological life, maintain a rather constant temperature and suffer practically no erosion. Nevertheless, they live a virtually closed life cycle in which the decomposing dead matter nourishes the living matter. This equilibrium is precarious and could be upset by deforestation and cultivation.

1b. *Regularly inundated tropical forest*

The forest vegetation of the islands or river valleys begins with *Mimosa pigra*. It is often invaded by

Alchornea cordifolia, *Bridelia ripicola*, *Ficus mucuso*, *Lannea welwitschii*, *Oxystigma buchholzii* and wild oil palm (*Elaeis guineensis*). The dominant stage is composed of *Lannea welwitschii*, *Oxystigma buchholzii*, *Spondianthus preussii*, with underwood of *Leptonychia batangensis*.

1c. *Tropical swamp forest*

Despite an asphyxiating soil, the immense swampy area of the confluence of the Congo and the Ubangi carries a tree cover in which the trunks have prop roots. Some of the trees are of rather spare appearance (raffia palm), while others are more exuberant and composed of other specialized genera of fresh water swamp forest. Characteristic species are *Uapaca heudelotii*, *Albizzia laurentii*, *Coffea congensis*, *Entandrophragma palustre*, *Sersalia palustre*, *Symphonia globulifera*, *Myrianthus scandens* and *Elaeis guineensis*. The open water is often invaded by *Eichhornia crassipes* and fragments of *Utricularieto nymphacetum* and *Lemneto pistretum*. The occurrence of grasslands of *Echinochloa stagnina* and *E. pyramidalis*, *Leersia hexandra*, *Phragmites mauritianus* and *Cyperus papyrus* is determined by the thickness of the peat and the depth of the water.

1d. *Tropical montane rain forest*

This forest generally occurs at altitudes of over 1 300 metres. It differs from tropical lowland rain forest in its lower tree height, abundance of epiphytic bryophytes and floristic composition. Characteristic species of Ethiopia are *Olea*, *Ocotea*, *Juniperus*, *Podocarpus*, *Schefflera* and *Pittosporum*. In South Africa the climate is temperate to subtropical, but the forest is floristically similar to the evergreen montane forest of the intertropical regions; both forests therefore are designated by the same symbol on the vegetation map. Characteristic species are *Podocarpus* (reaching heights of up to 50 metres), *Widdringtonia* and a 10- to 20-metre-high lower stratum of shiny-leaved laurel-type trees with numerous lianas and epiphytes (*Olea*, *Ocotea* and many other genera). This montane storey in Madagascar was described by H. Perrier de la Bathie as "forest overgrown by lichens." It is, however, composed of a 10- to 20-metre-high stand of highly ramified sclerophyllous trees occurring with a shrubby undergrowth. Species represented in this forest are *Podocarpus*, *Aphloia*, *Symphonia*, *Myrica*, Bambuseae, Compositae (*Vernonia*, *Senecio*, *Psiadia*), Rubiaceae, Lauraceae and Erinaceae (*Philippia* and *Agauria*). All bear epiphytes, among which the *Usnea* (mosses and orchids) abound.

2. Tropical deciduous and semideciduous forests

This region includes: 1) the edge of the dense tropical rain forest where deciduous species and tall-grass savannas become increasingly frequent; 2) deciduous forest proper in an already dry climate.

2a. *Tropical semideciduous rain forest*

Rain forest species are intermixed with deciduous species. Semideciduous rain forest grows especially along rivers and in groves on hills and plateaus. The climate differs little from that of rain forest and it seems that the presence of savanna is due to degradation or to various ecological conditions, especially the insufficient water-holding capacity of sandy soils. These tall-grass savannas are composed of *Pennisetum purpureum*, *Loudetia arundinacea* and *Imperata cylindrica*, together with a number of fire-tolerant shrubs such as *Hymenocardia acida*. These grass steppes are frequently burned off by farmers and hunters.

2b. *Tropical semideciduous montane forest*

This rather heterogeneous formation is composed of the same type of evergreen species found in tropical montane rain forests, e.g. *Podocarpus* and *Olea*, as well as woodland associations of trees and shrubs such as *Hagenia abyssinica*, *Lasiosiphon glaucus*, *Erica*, *Philippia*, *Protea*, *Hypericum*, tree ferns (*Cyathea dregei*), and bamboos such as *Arundinaria alpina*.

Climate varies rapidly with altitude, as do the species. Tree species (*Senecio* and *Lobelia*) and shrubby species (*Alchemilla* and *Helichrysum*) occur at the higher levels. Also found in this formation are grasslands of *Themeda triandra*, *Pennisetum clandestinum*, *P. schimperi* and *Loudetia simplex*, and, at higher altitudes, *Festuca abyssinica*, *Agrostis isopholis* and *Pentaschistis mannii*.

2c. *Large-leaved rain-green dry forest* (*Myombo*)

A large region of southern Africa south of the Congo basin is or was covered by woodland known as Myombo forest. The trees in the upper storey belong to the *Isoberlinia* and *Brachystegia* genera, which retain their leaves during part of the dry season. The lower storey is composed of *Uapaca*, which lose only some of their broad leaves. *Brachystegia* and *Julbernardia* are dominant, but *Monotes*, *Terminalia*, *Combretum* and *Acacia* occur at the limit between the Myombo and the valley grasslands. This formation subsists on a low rainfall, since evaporation is less intense than north of the equator owing to the greater altitude (800 to 2 000 metres) and the continental trade winds, which are less violent and regular than the harmattan.

In the drier regions, especially on Kalahari sand, there are distinctive species such as *Marquesia acuminata*, *Cryptosepalum pseudotaxus* and *Guibourtia coleosperma*, as well as a few dense dry forests of *Baikiaea*. Even treeless steppes are found on the plateaus.

In Madagascar dry deciduous forests comprise the *Dalbergia-Commiphora-Hildegardia* series, but show numerous variations determined by the type of terrain. *Tamarindus indica*, *Euphorbia*, *Chlorophora greveana* and *Flacourtia ramontchii* are found on sandy soil; a 12- to 15-metre-high forest of *Protorhus humberti*, *Albizzia polyphylla* and *A. greveana*, *Sideroxylon collinum* and some *Adansonia*, *Diospyros* and *Acacia* occurs on calcareous plateaus; and alluvia carry a high (25 to 30 metre) forest of *Canarium multiflorum*, *Khaya madagascariensis*, *Eugenia sakalavarum*, *Terminalia*, *Ficus sakalavarum*, *Albizzia* and two large palms (*Medemia nobilis* and *Borassus madagascariensis*).

2d. *Small-leaved rain-green dry forest with umbrella trees*

This area represents a transition from woodland to *Acacia* wooded steppe in a warmer, drier climate (less than 750 mm) than that of the preceding formation. *Acacia* predominates, and associations of *Combretum* and *Terminalia* and *Adansonia digitata* and *Sclerocarya* also occur.

The valleys are dominated by a tall-grass alluvial savanna with *Acacia polyacantha* and *A. sieberiania*, and especially woodlands of *Colophospermum mopane*, which has fire-tolerant bark and can subsist on poorly drained soils. These forests normally reach heights of 15 metres or more, but may be low and stunted in regions subject to frost.

3. Tropical inundated coastal formations

3a. *Mangroves*

Extensive mangrove forests are found on loamy saline soils exposed directly to the tides in the coastal area from the Senegal river on the Mauritania-Senegal border to the Longa river in Angola, and especially in the Niger delta and the islands of the Gulf of Guinea. The stands have *Rhizophora racemosa*, *R. harrisonii* and *R. mangle* dominants. *Avicennia nitida* sometimes occurs behind areas of *Rhizophora*.

The mangroves of Madagascar and the east coast of Africa have a strong Asian affinity and comprise *Rhizophora mucronata* (mangrove with prop roots), *Bruguiera gymnorhyza* (semi-circular roots), *Avicennia officinalis* (long narrow pneumatophores) and *Sonneratia alba* (shorter and thicker pneumatophores). The tannin barks of the *Rhizophora* and *Bruguiera* are exploited on a large scale. These species regenerate easily if the natural alternation of the tides is not disturbed.

4. Savanna

The density of these stands varies greatly but is generally open, leaving the grass cover visible. The savanna extends on either side of the forest into regions of marked dry season and often merges imperceptibly with semidesert steppe where the grassy ground cover is exposed.

4a. *Large-leaved semideciduous tree savanna*

This type of savanna is fairly humid, and stages range from woodland to grassy savanna. Tree cover density varies greatly with edaphic conditions and the nature and extent of human activity. Grass height varies from 80 cm to 3 or 4 metres; the trees tend to be of the *Daniellia oliveri*, *Lophira lanceolata* and *Combretum*, *Anogeissus*, *Khaya* and *Pterocarpus* genera. The grasses are mainly of the *Hyparrhenia* genus.

In Angola, *Hyparrhenia bracteata*, *H. rufa*, and *H. dissoluta*, *Panicum maximum* and *Chloris* occur with an open savanna of *Brachystegia*, *Isoberlinia* and *Combretum*.

In Zaire, Gabon and Chad, the *Hyparrhenia* occur in association with *Hymenocardia acida*, *Annona arenaria* and *Bridelia ferruginea* on a clay soil.

In Ivory Coast, Guinea, Guinea-Bissau and Senegal, *Hyparrhenia chrysargyrea*, *H. cyanescens*, *H. diplandra*, *H. rufa*, *Panicum afzelii* and *Sporobolus patulus* occur with a wooded savanna derived from dense evergreen forest degraded by cultivation and fire.

In Madagascar this formation is represented mainly by the "savoka," a second-growth formation of *Solanum auriculatum*, *Haronga madagascariensis*, *Ravenala*, *Dombeya* and bamboos, and by *Helichrysum*, *Philippia*, *Agauria* and *Pteridium* brush. The *Imperata* savanna of abandoned clearings gives way to a *Hyparrhenia rufa* savanna. An *Aristida* pseudosteppe occurs on the most eroded soils.

4b. *Open rain-green thorntree savanna*

The vegetation in this category covers large areas between the desert and subdesert types on the one hand and the more humid wooded types on the other. The largest area lies between Ethiopia and Sudan and Ethiopia and Somalia, and particularly in Somalia.

The trees, mainly *Acacia* and *Commiphora*, form open or closed woodlands or thickets (thornbush) or may be scattered. They are deciduous, fine-leaved and thorny.

The grasses, usually less than 1 metre high, include such species as *Chrysopogon aucheri*, *Aristida stipoides*, *Cenchrus ciliaris* and *Sporobolus variegatus*. Nearer the dry regions there is a transition to *Acacia* steppe. In wide valleys with flat clay soils there is much *Acacia* savanna with tall grass, e.g. *Beckeropsis* and *Hyparrhenia*.

4c. *Moist savanna*

In Africa this formation is often found in association with large-leaved semideciduous tree savanna (4a). Although *Isoberlinia doka* and *Isoberlinia dalzielli* woodlands intermixed with clumps of *Uapaca togoensis* characterize this type, these species are often replaced on eroded slopes by *Monotes kerstingii* and in poorly drained clay depressions by *Terminalia macroptera* and *laxiflora*. Tall-grass savannas, sometimes with *Borassus* palms, occur in wide valleys.

In Madagascar the savanna is an extremely degraded low *Uapaca* sclerophyllous forest which often retains underwood species such as *Dicoma incana*, *Stereospermum euphorioïdes*, *Acridocarpus excelsus*, *Philippia*, *Psiada* and *Helichrysum*, but generally develops into *Hyparrhenia* and *Aristida* pseudosteppe with scattered shrubs and very few trees.

4d. *Inundated savanna*

This type of savanna occupies the vast plain of Sudan where the Blue Nile and its affluents permanently inundate large areas of low-lying ground. There is a wooded savanna of *Anogeissus leiocarpus* and *Combretum hartmannianum* and *Acacia mellifera* thicket in the drier parts. *Acacia seyal* and *Balanites aegyptiaca* savanna occur in the central part. The grasses, which are very tall and predominantly annual, are *Sorghum purpureo-sericeum*, *Hyparrhenia pseudocymbaria* and *Cymbopogon nervatus*. *Brachiaria obtusiflora* grows on Pellic Vertisols. *Andropogon gayanus*, *Hyparrhenia rufa* and *Ischaemum afrum* grow in the moister areas. *Vetiveria nigritana* and *Sporobolus pyramidalis* occur in seasonal marshes (" toich ") and *Cyperus papyrus*, *Phragmites*, *Vossia* and *Echinochloa* in permanent marshes (" sudd ").

4e. *Dry savanna*

Acacia predominates in this wooded savanna, but many broad-leaved trees (*Combretum* and *Terminalia*) occur in association with *Adansonia digitata*, *Sclerocarya*, *Celtis*, *Ziziphus* and *Gymosporia*.

North of the equator the grasses comprise mainly *Andropogon gayanus*, various *Hyparrhenia* and *Pennisetum*, and some *Cymbopogon*, *Loudetia* and *Ctenium*. South of the equator, especially in South Africa, medium to tall grasses predominate, especially *Hyparrhenia hirta*, *Themeda triandra*, *Heteropogon contortus* and *Trachypogon spicatus*. *Setaria*, *Sehima* and *Ischaemum* occur on Vertisols.

The savannas of western Madagascar mainly comprise tall grasses (Andropogoneae) which often reach heights of more than 2 metres and are denser than those in the central area. Trees and shrubs are lacking on fertile soils where grassy formations are more robust and fires consequently more destructive. On poorer, drier and sandier soils the savanna is dotted with palms such as *Medemia nobilis* and *Hyphaene shatan*, and with fire-tolerant trees and shrubs such as *Sclerocarya caffra*, *Acridocarpus excelsus*, *Stereospermum* and *Dicoma incana*. *Strychnos spinosa*, *Grewia triflora* and *Terminalia seyrigii* occur on the less burnt parts.

4f. *Highland dry savanna*

This category includes communities of tall grasses about 1 metre high at altitudes of between 1 800 and 2 500 metres, and shorter grasses at altitudes above 2 500 metres. The most common grass species are *Themeda triandra*, *Loudetia simplex* and *Andropogon distachyus* and, at higher elevations, *Festuca abyssinica*, *Pentaschistis mannii* and *Agrostis isopholis*. They are often associated with evergreen or *Acacia* thickets.

In Ethiopia intensive cultivation has caused dense forest and woodland to be replaced by this type of vegetation, giving the countryside a varied appearance, e.g. grassland or savanna with scattered trees, and woodland with cultivated fields. The most common species are *Pennisetum schimperi* and *P. clandestinum*, *Hyparrhenia hirta*, *Exotheca abyssinica*, *Heteropogon contortus* and *Andropogon abyssinicus*. *Setaria sphacelata* and *S. acuta*, *Sporobolus agrostoides*, *Eleusina floccifolia* and *Cenchrus ciliaris* occur with woodland formations. The few tree species encountered comprise acacias, giant euphorbia and, at higher elevations, olive and juniper trees.

When grassland has been degraded by grazing, a grassy cover of *Aristida* sp., *Digitaria* sp., *Heteropogon contortus* and *Andropogon* occurs.

4g. *Thornbush savanna*

This type of vegetation forms an intermediate zone between the moister wooded types and the subdesert types. Grasses are generally less than a metre high and include *Chrysopogon aucheri*, *Aristida stipoides*, *Cenchrus ciliaris* and *Sporobolus variegatus*. Trees and shrubs are generally *Acacia* and *Commiphora*. In the valleys there are taller grasses such as *Hyparrhenia* and *Beckeropsis*.

In Botswana on Kalahari sand, grasses such as *Eragrostis lehmanniana*, *Aristida* and *Digitaria* (with

Aristida amabilis and *Danthonia glauca* on the crests of dunes) are associated with *Acacia haematoxylon*, *A. unicata* and *A. giraffae*. Shrubby species such as *Bauhinia*, *Commiphora grewia* and *Lonchocarpus* occur in the moister parts. Grazing rapidly destroys the grass cover and frees the sand, which begins to move.

In Sudan, Chad and Mali, *Cenchrus biflorus* and *Eragrostis tremula* dominants occur with *Acacia seyal* bushes and, in moist places, thickets of *Combretum*, *Dalbergia*, *Albizzia*, *Sclerocarya* and *Terminalia*. *Schoenefeldia*, *Andropogon* and *Sporobolus* grasses are usually found on clay soils.

In Tanzania, predominantly *Themeda triandra* grasses occur with remnants of forest or scattered *Acacia drepanolobium*.

In Madagascar thornbush savanna is degraded into steppe with *Cenchrus ciliaris*, *Eragrostis*, *Panicum voeltzkowii*, and *Digitaria psammophila*.

4h. *Reed swamps*

These swamps are periodically or permanently inundated. The vegetation in them or their surroundings varies enormously with the depth of the water, the peat content, and the period of submersion.

The commonest species, which often form pure stands, are *Cyperus papyrus*, *Typha*, *Juncus* and *Scirpus*. The most characteristic hygrophilous grasses are *Echinochloa pyramidalis*, *Vetiveria nigritana*, *Oryza barthii*, *Phragmites*, *Leersia hexandra*, *Saccharum spontaneum* and *Panicum repens*. In temporary swamps the vegetation consists of *Hyparrhenia rufa*, *Chloris gayana*, *Ischaemum afrum* and *Setaria palustris*. It is common to see cattle enter the water up to their bellies to graze on floating species such as *Echinochloa pyramidalis* and *Stagnina* or *Vossia cuspidata*.

The shallow peat marshes of eastern Madagascar also contain *Nephrodium unitum* ferns, *Pandanus*, raffia palms, and giant Araceae (*Typhonodorum lindleyanum*).

5. Mediterranean macchia and forests

This Mediterranean-type sclerophyllous vegetation is composed of generally small and heath-like evergreen shrubs with hard leathery leaves. Many of them contain oil or resin. Trees are rare and grassland occurs only sporadically.

5a. *Hard-leaved shrub bushes (macchia)*

This vegetation type occurs in the South African Cape region, and in Morocco, Algeria and Tunisia. In South Africa shrubs are of the *Protea*, *Leucadendron*, *Erica*, *Aspalathus* and *Rhus* genera, and tree species are *Widdringtonia cupressoides*, *W. juniperoides* and *Sideroxylon inerme*. In northern Africa a dominant associated stage of *Olea europaea* and *Pistacia lentiscus* is often associated with *Chamaerops humilis* in the warmer regions. Degradation of these formations produces asphodel wastelands.

5b. *Partly evergreen thorny shrubs*

In Morocco this type of vegetation consists primarily of steppes of jujube trees (*Ziziphus lotus*), *Withania frutescens*, *Lycyum*, *Atriplex halimus* and a belt of *Acacia gommifera*.

In Algeria artemisia steppes (*Artemisia*, *Atriplex*, *Stipa tortilis* and *Lygeum*) occur. In Tunisia this vegetation type is represented by highly degraded alfa steppes (*Stipa*, *Lygeum spartum*, *Passerina hirsuta* and *Halophyllum articulatum*) and by secondary *Ziziphus* steppes developed by man. They occupy low plains suitable for olive cultivation.

6. Temperate and Mediterranean woods and forests

The Mediterranean evergreen forest cannot withstand severe frosts, but the xerophilous leaves of the trees manage to survive the extremely dry summers by closing their stomates. The holly oak is more tolerant of cold than the cork oak and Aleppo pine. Where annual precipitation falls below about 350 mm and the number of wet months is less than five, continuous shrub cover disappears.

6a. *Coniferous montane forest*

In Morocco the natural vegetation of the High Atlas is *Pinus halepensis* forest with some *Pinus pinaster* which may occur with *Cupressus atlantica* woodland, but more often with an underwood of holly oak (*Quercus ilex*). This vegetation is adapted to cold and drought. In degraded areas *Juniperus* becomes dominant.

In Tunisia *Pinus halepensis* woods are representative of this storey, but are often degraded into wastelands and macchia of rosemary, *Juniperus oxycedrus* and alfa.

6b. *Mediterranean laurel forest*

This forest of South Africa west of Port Elizabeth displays floristic affinities with the evergreen forests of the intertropical mountainous regions. The tallest trees are *Podocarpus*, but the dominant vegetation formation is composed of *Olea*, *Ocotea* and *Widdringtonia*.

6c. *Open hard-leaved forest*

Originally a forest of thuja (*Tetraclinis articulata*) and *Juniperus phoenicia*, this vegetation has degraded into thuja and juniper wastelands and macchia.

6d. *Evergreen oak and pine forest*

In Morocco this forest consists of *Quercus ilex* and *Quercus coccifera* (the latter in the Rif and south of Taza), but *Quercus suber* dominates around Rabat. A belt of *Fraxinus dimorpha* often occurs at higher elevations between these forests of holly oak and kermes oak and the Aleppo pine storey (6a).

These oak forests cover much of Algeria and are often degraded into macchia, with the exception of the moister areas around Annaba and Skikda, where cork oaks abound.

6e. *Coniferous dry forest*

A forest of thuja (*Tetraclinis articulata*) and *Juniperus phoenicia* occurs on the lower slopes of the Atlas east of Marrakech and in the regions of Mostaganem, Nemours, Sidi bel Abbès and Ouarsenis in Algeria. This forest has more or less degraded into wasteland and macchia.

7. STEPPE

The thin woody stand is very open or even nonexistent. Grass cover is also open and sometimes short-lived.

7a. *Subtropical highland grass steppe*

This steppe occurs between 1 100 and about 3 000 metres altitude and receives precipitation ranging from 400 to 1 500 mm. Frosts and drought prevent the growth of shrubby vegetation on a climax grassland of *Themeda triandra*, *Eragrostis*, *Heteropogon contortus*, *Festuca* and *Tristachya hispida*. *Eragrostis* tends to dominate when the cover is not efficiently exploited by grazing. These species form a fairly short close sward which becomes denser on Vertisols.

7b. *Temperate dry short-grass steppe*

This steppe consists of *Eragrostis*, *Aristida*, *Urochloa*, *Panicum*, and of *Vetiveria nigritana* in poorly drained areas. Grass cover of this type is associated with a few wooded areas of *Colophospermum mopane* and *Adansonia digitata*. These annual grasses dry up and disappear almost completely during the dry season. There are also *Aristida* steppes with *Welwitschia mirabilis*.

7c. *Tussock steppe*

This steppe consists of High Veld tussock grass. The soils are thin on fairly pronounced and often overgrazed slopes, while the climate tends to be cold owing to the altitude. Short alpine grasses such as *Festuca rubra*, *F. caprina* and *F. costata* and *Danthonnia disticha* are dominant, and are unsuitable for continuous pasturing. *Themeda triandra* is a minor component of this association. However, grasses such as *Koeleria cristata*, *Poa binata*, *Pentaschistis*, *Agrostis* and *Bromus* provide satisfactory pasturage.

8. SEMIDESERT FORMATIONS

8a. *Thorntrees and succulents*

In southern Madagascar the climate is dry, the soil is generally thin and rocky or excessively sandy, and rainfall varies from year to year. Of the dominant endemic Didiereaceae, the commonest genera are *Didierea* and *Alluaudia*. Other species encountered are the tree euphorbia with pulpy, thorny branches, a few scattered *Adansonia*, *Dicoma* and *Ficus* trees, thickets of *Acacia*, *Commiphora*, *Grewia*, *Solanum* and *Jatropha*, and lianas. The trees, shrubs and lianas have few or no leaves. Thorny plants are strongly represented, as are pulpy plants such as *Aloe*, *Kalanchoe*, *Euphorbia* and *Senecio*. Grasses are rare.

In Ethiopia and Somalia the subdesert steppe is composed of widely spaced low perennial plants; annuals including grasses (e.g. *Aristida*) flourish for several weeks following the rains. Species of *Acacia* and *Commiphora* occur, but are small and widely spaced. *Salvadora* and *Leptadenia* are also characteristic.

8b. *Very open shrubby succulents*

The genus *Mesembryanthemum* is represented by several species of low succulent plants rarely more than 40 cm high. Ericoid shrubs and taller succulent plants such as the aloes and euphorbia also occur. The distribution of *Ehrharta*, *Aristida*, *Eragrostis* and *Urochloa* grasses varies according to altitude, temperature and humidity of mists.

8c. *Tropical and subtropical semidesert low vegetation*

This is a true steppe with very widely spaced grasses. The commonest of the many genera of shrubs and shrublets of the Karroo are *Pentzia*, *Chrysocoma*, *Euryops* and, on saline soils, *Salsola*, *Suaeda* and *Atriplex*. North of the Orange river the commonest shrub is *Rhigozum trichotomum*. From Walvis Bay to Moçâmedes the extraordinary *Welwitschia bainesii* often occurs in association with *Zygophyllum stapfii*.

South of the Sahara and the Libyan desert *Acacia* and *Commiphora* occur as in type 4g vegetation, but are smaller and more widely spaced. *Salvadora* and *Leptadenia* are also characteristic, often appearing in association with *Ziziphus*, *Balanites*, *Bauhinia*, *Grewia*, *Faidherbia albida* and occasionally *Hyphaene thebaica*.

Aristida forms a very sparse grass cover, e.g. *Cenchrus setigerus* on sandy soils and *Cymbopogon proximus* on overgrazed ground.

8d. *Succulent semidesert*

In Cyrenaica, Libya, the plant cover consists of *Artemisia herba-alba* and *Arthrophytum scoparium* steppe. Acacias occur in the wadis. Further inland there is a degraded facies of *Arthrophytum* steppe with *Hyphaene* (" argoun "), and *Aristida pungens* on dunes. Here, too, acacias grow in the wadis.

In Algeria this type is represented by the high plateau steppe of alfa (*Stipa tenacissima*) on clay soils, *Artemisia herba-alba* and *A. eygeum* on the sandy areas, and *Aristida pungens* with Salsolaceae on alkaline soils. However, there are also some nearly pure patches of alfa.

8e. *Halophyte semidesert*

A large area of this vegetation type occurs in the Danakil depression in Ethiopia and near Lake Al el Bad. The halophytes are fairly scattered.

9. DESERT FORMATIONS

Vegetation is very rare and lies along the wadis or between the dunes where run-off penetrates over a vast area and collects at certain points. In loamy areas moisture is stored at the surface for a few weeks after the rains, allowing rapid development of small short-lived plants.

9a. *Subtropical desert with cushion plants*

The hamadas have a highly degraded facies of *Acacia* and *Panicum* steppe. The hamada of the Dra is covered by a subdesert steppe of *Acacia raddiana*, *Panicum turgidum*, *Euphorbia echinus* and *Argania sideroxylon* and, a little further east, *Anabasis aretioides*.

9b. *Desert with isolated bushes*

Occasional short-lived vegetation (" acheb ") and associated *Acacia* and *Panicum* occur in the wadis and *Aristida* grows on rock debris. *Acacia*, *Panicum* and a Chenopodiaceae succulent (*Haloxylon salicornicum*) occur sporadically in the drainage channels of the better " regs." *Tamarix* ("ethel") and a few *Balanites* with formidable 10 cm-long thorns also occur in dried-up wadis.

9c. *Sand desert*

Extensive areas of dunes in the Erg of Ténéré, the Idehan Murzuq and the Erg Chech have neither permanent nor ephemeral vegetation. In the interdunal areas of the most favourable regions *Aristida pungens* (" drinn ") occurs with *Calligonum* and *Cornulaca*, a Salsolaceae (" retem ") and clumps of a Chenopodiaceae (" had ").

9d. *Tropical montane desert*

Mountain slopes are bare rock or are covered with soilless rock debris. All vegetation occurs in quite dense clumps in the valleys with a fairly dense and verdant grass cover which lasts a few weeks a year. In the Ahaggar there are a few tree and bush leftovers from a former Mediterranean vegetation, e.g. wild olive (*Olea lapperini*) and rose laurel. In the Tibesti, Sahelian bushes and shrubs such as *Balanites aegyptiaca* and *Salvadora persica* occur. High-altitude plateaus have a thin layer of loam with *Artemisia* steppes and grass tussocks. At a lower altitude there is a montane facies of desert steppe with a sparse cover of *Acacia flava* and *Panicum turgidum* occurring on sandstone hamadas.

9e. *Halophyte desert*

Halophytes occupy salt flats (" sebkhas ") bordering the desert, the largest of which are the Qattarah depression in Egypt and the Oum el-Drouss depression in Mauritania. The parts of these depressions which are not too saline and remain sufficiently humid sustain *Atriplex* and Salsolaceae vegetation (*Salsola foetida*, *S. sieberi*), and *Zygophyllum album*.

9f. *Oasis vegetation*

This vegetation is composed mainly of date palms, but also of other plants introduced by man and sustained by irrigation.

GEOMORPHOLOGY

Africa is the second largest continent after Asia. With the exception of the Atlas mountain system in the northwest and the Cape ranges in the south, the continent is unique in that it consists of an unbroken crystalline basement complex which is exposed over large areas. Sedimentary rocks deposited on the basement complex are for the most part unaltered. Aeolian deposits in the Sahara and the Kalahari cover the older rocks over large surfaces.

The surface of the continent was first nearly levelled by ongoing erosion, and then uplifted several thousand metres. During the upheaval great north-south-trending fractures opened up on the eastern side of the continent. These rift valleys extend from the Red Sea through Lake Malawi (Lake Nyasa), and appear locally elsewhere. Volcanic activity was associated with this faulting, particularly in the Great Rift valley, and in the Cameroon mountain ranges.

In the uplifted surface broad shallow depressions such as the basins of the upper Niger, Lake Chad and the Congo gave rise to large inland lakes, of which only small remnants have remained.

There are many level to gently undulating plateaus and plains at different levels which correspond to different erosion cycles and are usually bordered by narrow coastal plains, except between the Atlas mountain system and the sea. A distinct feature is the break between one erosion surface and another. In southern Africa this break often takes the form of a distinct escarpment, such as the Great Escarpment bordering the interior plateau. Rift valleys are deeply incised in the Ethiopian plateaus and the eastern African plateaus, from which rise great volcanic cones. On the surface of the African plateau are large shallow depressions, some forming internal drainage basins (e.g. the Chad basin). The Sahara consists of vast expanses of rock waste, bare rock and partly mobile sand. Mountain systems occur only in the northwest (the Atlas mountains) and in the south (the Cape ranges).

The following regions are outlined in the geomorphological map (Figure 3):

A. Atlas mountain system
B. Saharan region
C. Chad basin
D. Upper Nile and Blue Nile basin
E. Lower Nile valley and delta
F. Sinai Peninsula
G. Western African plateaus and plains
H. Ethiopian highlands
I. Eastern African plateaus
J. Eastern African marginal regions
K. Zambian-Rhodesian uplands
L. Southern African plateaus
M. Southern African marginal regions
N. Equatorial Africa
O. Congo basin
P. Coastal lowlands
Q. Central highlands of Madagascar
R. Marginal regions and coastal plains of Madagascar

A. Atlas mountain system

The Atlas extends for over 3 000 km from northern Morocco to Tunisia. A series of mountain-building forces produced a sequence of generally parallel relief features which trend west-southwest to east-northeast and run roughly parallel to the Mediterranean coast. The mountain ranges are separated by plateaus or at times by narrow basins. The area covered by coastal lowlands is relatively small.

The Atlas system is best developed in Morocco, where Mount Toubkal reaches an altitude of 4 165 metres in the High (Great) Atlas, a mountain range with many snow-capped peaks. In Algeria altitudes do not exceed 2 500 metres, and in Tunisia, 1 500 metres. The rugged to hilly Rif Atlas (A1), comprising the oldest of the fold mountains, stretches from southeast of Tangiers to the Moulouya river valley. The higher areas near the Atlas comprise plateaus and plains. The central plateau (A3) has an average altitude of 1 100-1 300 metres and some peaks of 1 500-1 600 metres. The lower Phosphate plateau lies to the southwest. Further south, the Middle Atlas (A4) diverges from the High Atlas in a northeasterly direction, attaining an average altitude of over 1 200 metres in central Morocco. It mainly consists of a plateau bordered by mountain chains on the south and east along the Oued el-Abid and the Moulouya river. Between the Rif and the central plateau are the Rharb lowland and the Sebou-Taza hills (A5).

In southern Morocco the Souss alluvial plain (A6), a triangular structural depression separating the High Atlas and Anti-Atlas ranges, extends 130 km inland from Agadir. This nearly flat plain is crossed by the Souss river, the water of which is used for irrigation.

The Anti-Atlas (A7), an elevated part of the African shield, has a tabular surface at about 1 500 metres, but its highest peak is nearly 3 900 metres above sea level. It is joined to the High Atlas by the volcanic formations of the Jebel Siroua (3 304 m).

The High Atlas (A8), which attains altitudes of over 4 000 metres in the west, extends east-northeast from the Atlantic coast near Agadir. In Algeria it becomes the Saharan Atlas, where altitudes rarely surpass 2 000 metres. Toward the east the Middle and High Atlas merge with the Oran meseta (A2), a rather monotonous plateau from where the Moulouya river flows to the Mediterranean. In Algeria the meseta merges with two subparallel mountain ranges: the Tell Atlas (A9), which in the north continues the line of the Rif Atlas, and the Saharan Atlas in the south. These ranges enclose the high plateaus where "chotts" (shallow, muddy, frequently semipermanent salt lakes) are characteristic features. The Tell Atlas is a large tabular plateau with some mountainous massifs incised by deep valleys. It drops steeply to the sea in places. A separate coastal range, the Maritime Atlas (A12), is in some places separated from the Tell Atlas by deep valleys such as the Chélif. The high plateaus (A10), an undulating semiarid steppe region with an elevation of 750 to 1 000 metres, diminish in height from east to west. The subdued relief has formed many shallow depressions with chotts, the largest being the Chott Chergui, which is more than 150 km long. The Saharan Atlas (A11) is somewhat broken and falls into a number of distinct groups such as the Monts des Ksour, the Djebel Amour, and the Monts des Ouled Naïl. The eastern Algerian ranges (A13), including the Aurès mountains with Algeria's highest peak, the 2 328-metre-high Djebel Chélia, are structurally a part of the Saharan Atlas. In eastern Algeria the Tell Atlas and the Saharan Atlas approach each other, almost eliminating the high plateaus.

The Atlas ranges extend into Tunisia as the Northern Tell, the High Tell and the Low Tell, their tightly packed ridges and valleys passing out to sea to form Cape Blanc and Cape Bon. The Medjerda river (A14), which drains the eastern Algerian uplands, flows between the two ranges through the plain of Tunis and forms a marshy delta in the Gulf of Tunis.

The steppe-like Sahel plain borders the coast and continues into northwestern Libya. Between the Sahel and the mountains is the Tunisian steppe (A15), an intermediate platform with high hills and plateaus and a steppe vegetation.

Also included in the Atlas region are the Canary Islands (A16), a group of seven islands and six uninhabited islets situated 100 km from the Saharan coast. All are of volcanic origin and consist mainly of basaltic lavas. Most of the islands are the peaks of mountains which rise precipitously from the ocean floor, the highest being the 3 707-metre-high Pico del Teide on Tenerife. Only the eastern islands of Lanzarote and Fuerteventura are less high and precipitous, reaching an elevation of nearly 730 metres on the latter island.

B. Saharan region

The Sahara, the world's largest desert, covers nearly a quarter of the African continent. It occupies an area extending for nearly 5 000 km from east to west, and a maximum of 1 600 km from north to south. The central Sahara is dominated by an elevated region with an average altitude of over 500 metres and several massifs more than 1 000 metres high. The elevations to the east and west are rarely higher than 500 metres.

Only one eighth of the region is occupied by sand; the rest consists of rock and gravel surfaces. The weathering processes have given rise to three main types of surface:

— The "erg," or sandy desert of shifting dunes, has barchans and various types of sand ridges which form according to the direction of the prevailing winds. The two largest ergs, the Great Western Erg and the Great Eastern Erg, form the least-known parts of the Sahara.

— The "hamada," or rocky desert, is a wasteland of boulders and rocky platforms, such as the area around the Ahaggar and Tibesti mountains.

— The "reg" or "arag" desert is intermediate between erg and hamada, consisting of pebble and coarse sand surfaces which sometimes cover vast areas, as in the Tanezrouft. These materials represent the detritus from rock outcrops produced largely by solar weathering.

The crystalline Eglab plateau (B3) in Algeria rises only 500 metres above the monotony of sand and gravel and separates two sedimentary basins with peripheral escarpments: the Tindouf basin occupied by the Erg Iguidi (B1) to the north and west and the Taoudenni basin with the Erg Chech (B2) to the south and east. Southeast of the latter erg are the gravel wastes of the plain of Tanezrouft (B4).

The central Sahara is dominated by the Ahaggar massif (B5), with a rugged landscape caused by erosion of volcanic and crystalline rocks by a largely fossil river system, which flows once or a few times a year with heavy rainfall. The southern extensions of the Ahaggar are the very flat Adrar des Iforas (B6), and the Aïr (Abzine) (B7), which is less flat owing to some volcanic cones. The central massif formed by the Ahaggar, Adrar des Iforas and Aïr massifs is partly bordered by the Tassili plateaus comprising the Ahenet, Mouydir and Tassili n'Ajjer (B9) in the north, and the Tassili des Ahaggar (B8) between the Adrar des Iforas and Aïr in the south. The Tassili n'Ajjer forms a bridge to the Tademait plateau (B10), separating the Great Western Erg (B11) and Great Eastern Erg (B12), both extensive sand plains.

East of the massif and the Tassilis lies the Tibesti (B13) in northern Chad. It is dominated by several volcanoes, the highest of which are the Tousside (3 265 metres) and the Emi Koussi (3 415 metres).

In northwestern Libya the Saharan plateau begins where the coastal steppeland is bordered by the scarp of the Tripolitanian Jebel (B14). Inland are strong plateaus such as the Hamada al-Hamra (B15) (red stony desert), the hills of Jabal al-Soda (516) (black hills) and extensive sand deserts.

In the Fezzan basin (B17), south of Tripolitania, the general elevation diminishes and extensive basins and depressions are enclosed by rocky ridges with loose sand in the lower parts. The Idehan Murzuq is of special importance.

Cyrenaica comprises the plateau and hills of Jabal al-Akhdar (B18) (green mountains), a series of ridges and more open terraces along the narrow and discontinuous coastal lowlands, and the higher Al-Marj plateau (B19), broad and rolling in the west and more dissected in the east.

Southeast of the Fezzan basin are the Tibesti and the sandstone plateau of Ennedi (B20), the separation between the extensive Chad basin (Ténéré) in the south and the Fezzan and Cufra basins (B21) in the north.

The great Libyan desert (B22), the eastern extension of the Sahara, covers large areas of Libya, Egypt and Sudan. It is mostly a massive plateau of sedimentary rocks resting upon the Nubian sandstone and basement. The northeastern corner of this stony, sandy desert is the Western desert (22a) of Egypt, which occupies nearly three quarters of the country's surface. The highest altitudes are attained where the borders of Libya, Egypt and Sudan converge. The Jilf al-Kabir (22b), Jebel Kissu (22c) and several other plateaus reach altitudes of 1 000 to 2 000 metres. This sandstone tableland slopes gently northward to basins formed by the erosion of softer strata. The largest is the Qattarah depression (B23) in northwestern Egypt, the floor of which is over 130 metres below sea level and contains salt lakes and marshes.

In Libya sand covers the entire surface of southern Cyrenaica, forming the Sand Sea of Calanscio (22d).

The Eastern desert (B24), extending from the Nile valley to the Gulf of Suez and the Red Sea, is part of the Red Sea highland region which extends as far south as Ethiopia, flanked on the northeast and west by dissected limestone and sandstone plateaus.

The Libyan desert extends into Sudan to where the steppe vegetation appears at about 16°N north of Khartoum. East of the Nile and partially within its great bend is the Nubian desert (22e).

South of the Libyan desert and northwest of the upper Nile basin a gently undulating, shallowly dissected plain covers a large part of Darfur and Kordofan provinces in Sudan. It is broken by a few isolated hill masses such as the Jebel Marra (B25) and the Nuba mountains (B26).

C. Chad basin

This great depression in which lies Lake Chad is the largest inland drainage basin of the sub-Saharan region. While the altitude of most of Chad is about 300 metres, the lake lies at about 200 metres. North of the lake a number of even lower depressions occur, the largest being the Bodele (C1), with an altitude of 170 metres.

The permanent drainage of the basin comes mainly from the Ubangi-Chari plateau in the south via the Chari and Logone river systems. The lake varies in size from season to season and from year to year according to the rainfall in the south. It is shallow and the aspect of the northern part varies with the season.

D. Upper Nile and Blue Nile basin

Formed by the White Nile and Blue Nile with their numerous tributaries, this basin is enclosed by high plateaus except in the north, where the boundary is formed by outliers of the Nubian desert near Khartoum. Only the boundary with the Ethiopian highlands is abrupt. There is mostly a Sudanese-type savanna vegetation, while in the north toward the Ironstone plateau some forests occur.

This flat, largely remote region consists of a downwarped clay plain which generally lies below 500 metres altitude. It is crossed by rivers which frequently overflow their banks and deposit sediments. There are a number of inselbergs, remnants of a former surface.

The part of the basin south of 10°N becomes a swamp (Sudd region - D1) in the rainy season, but permanent swamps are confined to the areas bordering the main rivers.

The Gezira region (D2) between the Blue Nile and White Nile rivers south of Khartoum was originally a flat steppe area but is now mostly under irrigation, mainly for cotton.

E. Lower Nile valley and delta

The relatively narrow, flat-bottomed Nile valley is cut deeply into the Nubian sandstone as far as Aswan. The valley broadens near Isna, and opens into the Nile delta near Cairo. Numerous wadis enter the Nile where it borders the Eastern desert. The valley is about 10 km wide until it reaches the delta.

The delta, an ancient Mediterranean gulf filled in with silt largely from the Ethiopian highlands, begins at Cairo. It is crossed by the two main tributaries of the Nile, the Rosetta branch and the Damietta branch, and numerous smaller streams. About half the delta is occupied by lakes and marshes. Along the coast shallow, brackish lagoons and salt marshes are separated from the sea by low mud banks.

F. Sinai Peninsula

The northern two thirds of the peninsula consist of an extremely dissected limestone plateau which descends gently northward from the Al-Tih mountains (1 500 metres) toward the broad coastal plain.

The country is more open in the north, where there are shallow wadis near the coastal strip. The partly dune-covered, sandy coastal region contains the salt water lagoon of Lake Bardawil.

The Sinai massif in the south is separated from the plateau by a gravel-covered central area. The mountains, which attain an altitude of more than 2 600 metres in Jebel Katrinah, are a mass of peaks, deep gorges and ravines.

G. Western African plateaus and plains

The landscape consists of extensive plateaus and plains interrupted by some higher small plateaus and residual inselbergs. The different surfaces are usually separated by scarps or narrow zones of broken country.

In the eastern part of the region the high plains of Hausaland border the Chad basin. Beyond the plains is the 1 200- to 1 400-metre-high Jos plateau (G1), which is bordered by steep escarpments up to 600 metres high on the west and south. In addition to widespread granite residuals there are volcanic cones and lava flows.

Further east lies the Biu plateau (G2), a basalt area with a number of volcanic cones, a few of which exceed 900 metres. East of this plateau lie the Mandara mountains (G3), an isolated part of the Cameroon mountain ranges.

The Fouta Djallon (G4) consists of a remarkably level plateau with an average altitude of about 1 000 metres and some parts over 1 500 metres. It is extremely dissected by the angular drainage pattern. To the west and north the plateau consists of a series of fault steps, but to the east the slopes are much gentler with wider steps.

The Guinean highlands (G5) attain 1 752 metres altitude in Mount Nimba and 1 947 metres in the Loma mountains. In contrast to the Fouta Djallon, there are few level surfaces and the hills are rounded.

Bordering the Volta basin in the east, the north-northeast- to south-southwest-trending Togo-Atakora ranges (G6) rise to over 1 000 metres in Mount Agou and form the boundary with the Mono valley in Togo. These ranges form a series of parallel ridges which are sometimes broken into blocks. Between the ridges are deep, narrow, steep-sided valleys with scarps of over 300 metres. This area presents the remnants of an eroded plateau.

Southwestern Ghana is occupied by the Ashanti uplands (G7), consisting of highly dissected plain residuals and ranges of hills separated by wide, flat-bottomed valleys.

The lowlands of Senegal, Gambia and Guinea-Bissau are formed by low sandy plains broken only by the wide, shallow valleys of the Senegal, Gambia and Casamance rivers and their numerous tributaries. Many other usually dry valleys, e.g. those of the Sine and Ferlo rivers, cross this flat region.

The western plains of Senegal are slightly undulating, lie at an altitude of less than 40 metres, and usually have sandy soils. This region is well known for its groundnut cultivation. In the coastal regions there are marshes and lakes, some of which are saline. The mouths of many rivers are bordered by mangrove swamps.

To the north of the Guinean highlands lies the broad upper Niger basin (G8), a great plain mostly lying below 500 metres which is bordered by upland areas except to the northeast. The basin is very flat, but a few residuals up to 180 metres high break the surface. Upon leaving this plain, the Niger river enters the Segou basin, which stretches as far as Lake Debo. This area is known as the " inland Niger delta " (G9). In the upper part of the basin the rivers flow in incised river beds, but below Segou banks are overtopped during floods, and below Macina a braided distribution system has developed. This area is the " live " delta or " pondo." Older tributaries, now abandoned, occur on the left bank to form the " dead " delta.

The Benue river valley (G10), probably of tectonic origin, is much broader than the Niger valley. The Benue drains a part of the high plains of Hausaland including the Jos plateau, and a large part of the mountain ranges in Cameroon and eastern Nigeria.

The lower Niger valley (G12) narrows when crossing the plains of northern Borgu, near Jebba, and near the confluence of the Niger with the Benue. Otherwise the valley is broad and open and contains numerous swamps and pools.

The Niger delta (G12) is a wide mudflat with mangroves and swamps. The river has many mouths and a continuous line of creeks and lagoons extends as far as Benin.

The Volta river basin (G11) is bordered in most places in the north, west and south by a high sandstone plateau edge and outward-facing escarpments. Its altitude ranges from 100 to 200 metres except on its upturned edges, of which the Mampong scarp in the south is the most striking, rising to nearly 500 metres above the adjoining terrain.

Also included in the western African region are the volcanic islands of Cape Verde, which lie about 700 km off the African coast. Mount Fogo, which stands over 2 800 metres high, erupted in the mid-1950s after nearly 300 years of inactivity. Mounts Santo Antão and São Tiago reach 1 979 metres and 1 392 metres respectively.

H. Ethiopian highlands

This usually rugged upland, with an average altitude of about 2 500 metres, is split into two unequal parts by the eastern Rift valley and in places is bounded by spectacular escarpments, especially near the Red Sea plains and the Rift valley. On the west the highlands are bordered by terraces and broken foothills leading to the Sudanese plains, while in Harer province they drop steeply to the southeast. Elevations in the north range from 2 400 to 2 700 metres, with high peaks reaching 4 300 to 4 600 metres. In the south elevations are less than 3 700 metres. The highlands consist of hills, mountains, peaks and cliffs separated by canyons which are sometimes of great depth, and include a series of " ambas " (flat-topped tablelands usually protected by resistant strata).

Most of the main western highlands (H1) have plateau basalts which are also found in the more eroded remnants of the Harer massif. Elsewhere crystalline rocks occur.

The eastern highlands and plateaus (H2) include the Bale massif, Ethiopia's most impressive highland with a mean altitude of 3 000 metres and some elevations of more than 4 300 metres.

The Rift valley (H3) is also a distinct physiographical feature of Ethiopia. It divides the highlands and forms the Awash valley and its southern extension with the lakes toward Lake Rudolf in Kenya.

To the north the Rift valley opens on to the Danakil plain (H4). The Kobar sink (4a), an elongated tectonic depression in the north of the plain, is as much as 120 metres below sea level. The Danakil mountain chain (4b) lies between the depression and the Red Sea.

I. Eastern African plateaus

The major physical elements in eastern Africa are vast, near-level plateaus. These are bordered by the Rift valleys, along which there are volcanoes. The plains contain some steep-sided inselbergs. In this rather complex region a few subdivisions can be recognized.

The axis of the system is the eastern Rift valley (I1), lying roughly between Lake Rudolf and Lake Malawi. It forms part of the Great Rift valley.

The high mountains flanking the eastern Rift consist of volcanoes and lava flows such as Mount Kenya (I2) (5 194 m), the Aberdare range (3 994 m), Mount Kilimanjaro (I3) (5 963 m) and Mount Meru (4 566 m).

The eastern mountain system is more complex in southern Tanzania than in Kenya. Between Lake Malawi and Mount Kilimanjaro and enclosing the Masai steppe belonging to the marginal region are the southern highlands (I4), the Rubeho mountains (I5), the Unguru mountains (I6), and the Uluguru mountains (I7) in the south, and the Pare-Usumbara ranges (I8) branching off from Mount Kilimanjaro in the north.

Between the eastern and western Rift valleys lies a region with an average altitude of 1 100 to 1 200 metres. In the north and south it is occupied by extensive, gently undulating plains with a few inselbergs: the Karamoja plain (I9) and the central plateau (I11) respectively. The centre is formed by the Lake Victoria basin (I12). The lake is less than 100 metres deep, but lies at an altitude of over 1 100 metres above sea level.

Flanking the Karamoja plain to the east are the Chemorongi, Suk and Cherangami mountain ranges in northwestern Kenya (I10), Mount Elgon (I13) (4 821 m) and, to the northeast of Lake Victoria, the Kisii highlands (I11a).

The western Rift valley (I14) and highlands terminate the plateau in the west. The landscape of high, broken country is about the same as its eastern counterpart and several peaks, e.g. the non-volcanic Ruwenzori (I14a) (5 119 m) and the Nufumbiro chain (I14b) of active volcanoes crossing the Rift from Zaire to Rwanda and Burundi, surpass 4 000 metres.

The trough-like depression of Lake Tanganyika attains a depth of more than 1 400 metres and is the world's second-deepest lake. Its surface, at 779 metres altitude, lies more than 150 metres below the surrounding country, which is deeply incised by the streams flowing to the lake.

Further south the Rift valleys converge in the southern highlands (I4) and form the area around Lake Malawi. This narrow lake, more than 550 km long, is bordered by discontinuous plains at 450-600 metres and by highlands on either side. The chief elevations in the area are isolated flat-topped plateaus such as the Shire highlands (I4e). North of the lake lies the extensive Kipengere range (I4a), which attains an altitude of 2 961 metres. It is bordered by the Livingstone mountains (I4b) along the lake, which reach an elevation of 2 700 metres. The Nyika plateau (I4c) rises to over 2 600 metres to the northwest of the lake; the Vipya highlands (I4d) to the south are less high.

J. Eastern African marginal regions

This series of low plateaus and hills, ranging in elevation from less than 100 to over 700 metres and in some places reaching over 2 500 metres, rises from the coastal plains toward the Ethiopian highlands.

The Masai steppe (J1) in northeastern Tanzania is almost ringed by higher land and may be considered an outlier of this region. It has a gently undulating topography which in some places is broken by residual hills.

In the north the Harer massif slopes toward the southeast to merge with the Somali plateau, an arid, broken, eroded desert area extending into the desert plain of northeastern Kenya. This plain, which lies at an altitude of about 600 metres, is interrupted by inselbergs and isolated massifs such as the Marsabit region (J2), and usually has a thornbush vegetation.

Southeastern Kenya (Nyika) is somewhat better-watered, especially in the Teita hills (J3). It is dissected by a number of relatively small rivers. Between eastern Kenya and the Rift zone the Matthews range (J4) and the Kitui hills (J5) are areas of strongly to slightly dissected ranges and hills. The Matthews range is nearly 3 100 metres high; the Kitui hills are much lower.

The Niassa plateau (J6) in the dissected northern Mozambique plateau is almost entirely formed by basement rocks consisting mostly of gneiss and schist with intrusive granite which has weathered into rounded hills and mountains. In Mozambique the Shire-Zambezi valleys and the Manica plateau form the southern limit of this region.

K. Zambian-Rhodesian uplands

These uplands are a continuation of the southern African plateau region. The extremely flat planation surfaces lying at 1 200 to 1 700 metres altitude are cut by the Zambezi and Luangwa river valleys. River valleys in the uplands are usually shallow and a few areas are poorly drained. Shallow swamps and lakes such as Lake Bangweulu and the Kafue flats in Zambia cover large areas. To the west this region disappears under Kalahari sands and other deposits.

In the Zambian uplands (K1) the main surface in the Copperbelt (1a) is at about 1 250 metres. In the Muchinga mountains (1b) west of the Luangwa river valley the hills on the plateau occur as chains with a more rugged relief.

Southeast of the Luangwa trough the Luangwa-Malawi uplands (K2) border the Rift zone.

The Rhodesian uplands (K3) are about 1 500 metres high in the east, and where they end in the Great Escarpment the Melsetter-Umtali and Invanga mountain ranges (3a) reach an elevation of 2 600 metres.

The floors of the Zambezi and Luangwa river valleys (K4) may be as much as 1 000 metres below the adjacent plateaus. Sections of the valley floors are fairly flat and in places terminate at the foot of imposing escarpments.

Lake Kariba, formed by the construction of the Kariba Dam on the Zambezi river, is one of the largest man-made lakes in the world.

L. Southern African plateaus

The plateau character of this part of the continent is typified by the interior plateau, which is depressed in the centre and bounded by the Great Escarpment overlooking the bordering marginal regions and coastal plains.

The Great Escarpment, one of the most important physical features in Africa, runs in an almost unbroken line from the Zambezi in Rhodesia around the southern edge of the continent and northward until it crosses the Cunene river and continues through Angola. Its edge lies between 50 and 250 km inland, and the escarpment is variable in structure, height, abruptness and steepness of slope. In South Africa parts of it are known as the Drakensberg, Stormberg, Sneeuberg and Nieuwveldberge ranges, and other local names.

The interior plateau consists in principle of the central Kalahari basin, which is surrounded by a belt of peripheral highlands broadest in the east and narrowest in the west.

The physiography of southern Africa is comparatively well known through the works of Wellington, King, and others. According to Wellington (1955) the terms High Veld, Middle Veld and Low Veld are used in the altitudinal sense. High Veld denotes land of moderately even surface above 1 200 metres altitude, Low Veld means land lying below 600 metres, and Middle Veld land between 600 and 1 200 metres high. In Rhodesia these altitudes are about 1 350 and 900 metres. In general the terms coincide with vegetation belts.

The High Veld (L1) covers the eastern interior plateau of the southern Transvaal and Orange Free State, and is bounded on the east and south by the Great Escarpment and in the north by the central Transvaal Bushveld, or plateau basin. The Kaap plateau (1a), regarded as a subregion of the High Veld, is sharply bounded on the east by the Campbell Rand and the Middle Veld and merges to the west with the Kalahari. The Basuto highlands (1b), which might also be considered a part of the High Veld, consist of a wide summit plateau which forms one of the most rugged and certainly the highest region in southern Africa with altitudes between 2 500 and 3 500 metres.

The Transvaal Bushveld (L2), also known as the Bushveld igneous complex, lies north of the High Veld in a great bend of the Limpopo river valley. The general altitude ranges from 1 000 to 1 200 metres, falling to 600 metres in some places and reaching over 2 000 metres in the mountainous east.

Bordering the Pietersburg plain and the Soutpansberg to the north is the Limpopo river valley (L3), a depressed wide, even plain with inselbergs between the Transvaal Bushveld and Zambian-Rhodesian uplands subregions.

To the west, the boundary of the Middle Veld (L4) with the High Veld at the 1 200-metre contour line is gradual nearly everywhere except in the area bordering the Kaap plateau at the Campbell Rand, where it is abrupt.

South of the Orange river is the vast plain of Namaqualand where exposed granite and gneiss provided the sand which was distributed to Bushmanland. To the north, three prominent massifs rise abruptly from the plain. South and southeast of Keetmanshoop is the Karas mountain range (4a), which reaches a maximum altitude of 2 200 metres in Mount Schroffenberg.

The northern extension of the Middle Veld formed by the southwestern African highlands (L5) continues to the plateaus surrounding the Congo basin. It is formed by the highland region between the Great Escarpment in the west and the Kalahari basin in the east. In the north the boundary is formed by the Bié plateau (5a). South of the Bié plateau, the Chela-Otavi highlands (5b) reach a maximium elevation of 2 200 metres in the Serra da Chela. Along the eastern edge of the chain lies the narrow Humpata plateau, a flat limestone area. Between the Otavi highlands and the Khomas highlands further south is the Damaraland plain (5c), a generally even plateau broken only by isolated mountains such as the Great Omatako and Mount Etjo. The Khomas highlands (5d) near Windhoek consist of an extremely rugged area at an elevation of 1 900 metres with peaks reaching nearly 2 500 metres in the Molkteblick. South of these highlands are the Namaqua highlands (5e) bordering the Cape Middle Veld at the 1 200-metre contour line on the southeast, the Kalahari on the east and the Great Escarpment on the west.

The Kalahari desert (L6), forming the central part of the interior plateau, is probably the largest continuous sand surface in the world. Only here and there is the sand broken by rock or boulder surfaces. The desert lacks surface water; vegetation-wise it is mostly steppe and savanna in the south, but some forest occurs in the north. In the very dry southwestern area, where wind transport of sand is generally absent, continuous, roughly parallel ridges have a northwest-to-north orientation. The precise origin of the desert sands is unknown, but they probably originated from Karroo or Stormberg sandstone sediments transported by ancient rivers and distributed over the basin floor by the wind in dry periods.

The northern part of the Kalahari contains parts of the Okavango and Linyanti (Cuando) river valleys, which form extensive marshes and papyrus swamps in some places. In northeastern Botswana the Okavango river forms an extensive delta with swamps and reeds (6a), the northwestern part of which is perennially flooded.

In a northwesterly outlier of the Kalahari basin flat sand plains slope toward the Etosha pan (6b), a partly saline sandy clay plain.

M. Southern African marginal regions

These regions border the interior plateau below the Great Escarpment. They are usually wide, rolling uplands which are separated one from another by more or less steep scarps and descend step-like to the coastal regions. A folded zone occurs in the south.

The eastern uplands or plateau slopes (M1) below the Great Escarpment almost reach the sea in some places and are bordered in the south by the Winterberge-Amatola escarpment. In the northeast the Low Veld forms a narrow transition zone to the Mozambique coastal region.

The southern Cape region (M2) bordering the Great Escarpment and the Winterberge-Amatola escarpment contains basins and ranges. The largest area is occupied by the Karroo headwater basins.

The Great Karroo, a series of basins between the Great Escarpment and the folded ranges, has a general altitude varying from 300 to 800 metres, but reaches 1 200 metres near the Escarpment. It consists of the western Karroo, the headwater basin of the Doorn river and its tributaries lying between the folded mountains and the Roggeveld escarpment, and the larger eastern Karroo between the Nieuwveldberge-Sneeuberg escarpment and the Witteberge-Swartberge-Suurberge mountain chains. The surface of the desertic western Karroo usually consists of slightly decomposed shales and sandstone, and aeolian sands occur in places.

The Cape ranges south and west of the Karroo are mainly formed by Table Mountain sandstone with subsidiary ridges of Witteberg quartzite.

The area between the Great Escarpment and the coastal lowlands in the western part of southern Africa is much smaller than in the east, especially in the southern part. These western uplands (M3) or plateau slopes mainly comprise a coastal desert zone: the Namib and its northern extensions which extend for over 2 000 km. In the south the desert is narrow and often occupies the whole area below the Escarpment. It is broadest south of Walvis Bay, where it reaches a width of over 150 km. This arid region is divided into the "trough Namib" in the south, where harder ridges withstood wind erosion, and the "plain Namib" dominated by debris surfaces. Inselbergs occur frequently near the Great Escarpment. Bordering the Kackoveld is the "dune Namib," an area of barchans and sand ridges.

The Kaokoveld (M4), lying between the interior of Namibia and the northern Namib desert, is a terrace about 150 km wide consisting of a usually rugged terrain formed by erosion of table-topped mountains under an arid climate. Occasional torrential rains flood the valleys between the ridges.

In southern Africa the coastal lowlands, bordered by a remarkably straight shoreline in most places, are of less importance. Much of the coastal plain area is occupied by uplifted terraces lying at about 180 metres altitude in Natal, but rising to 300 to 350 metres in Pondoland (eastern Cape Province). Many of the river mouths are blocked by sand bars.

N. Equatorial Africa

This region includes a variety of mostly dissected plateaus and some minor mountainous areas which completely surround the Congo basin. In most places the boundaries with the other regions are not precise. Nearly the whole region drains into the Congo basin.

To the east of the Congo basin the highlands bordering the western Rift valley locally attain elevations of more than 3 000 metres. The northern Mitumba mountains (N1) descend westward to the basin and are crossed by many Lualaba (Congo) tributaries. The eastern plateau in Zaire also forms part of this area.

In the northeast the watershed with the Nile is not well defined. The region consists of undulating plateaus lying at 1 000 to 1 200 metres altitude. The Bongo mountains (N2), which reach an altitude of 1 400 metres, form a watershed between the Nile, Chad and Congo basins. To the west the Chad drainage passes within 100 km of the Ubangi river in the Ubangi-Chari plateau (N3), which has a minimum altitude of only 600 metres.

Further west, the dissected, undulating plateau in the eastern half of Cameroon has an elevation ranging from 600 to 800 metres and rises gently to the Yade plateau (N4), which attains an altitude of 1 200 metres in the northwest. West of the Yade plateau the altitude rises to about 1 500 metres in the Cameroon mountain range (N5), a series of high crystalline and volcanic plateaus. Mount Cameroon, an impressive, still-active volcano (4 070 m) near the Gulf of Guinea, stands separately from the main range.

The border with the rather narrow coastal plain along the Atlantic is formed by the Gabon-Cameroon plateaus with altitudes ranging from 600 to 1 000 metres. The plateaus continue farther south as the Chaillu mountains with Mount Iboundji in central Gabon. In northern Gabon the edges of the plateaus are known as the Crystal mountains (N6) and in Congo as the Mayombé mountains (N7), a succession of sharp ridges with elevations of about 500 to 800 metres.

The Bangou-Mokaba highlands (N8) are deeply dissected by the Congo and its tributaries. It is through these mountains that the Congo river cuts its way from the Congo basin to the Atlantic Ocean.

The volcanic islands of Cape Verde (Fernando Póo, São Tomé, Principe and Annobón) are geologically a part of the Cameroon mountain range. Fernando Póo is a collection of extinct volcanoes rising from the ocean depths to heights of 3 000 metres above sea level. The peak of Santa Isabel on Fernando Póo reaches 2 850 metres.

O. Congo basin

This broad, flat basin constitutes a slight depression of the African continental platform. Its floor has an average altitude of 400 metres and rises to the uplands and plateaus forming the rim. The monotonous basin plains and terraced plateaus have some elevations, such as the hills around Zongo and Banzyville. The basin is filled with alluvial deposits from a number of large Congo tributaries such as the Ubangi, Lualaba and Kasai rivers. Small remnants of larger lakes and extensive swamp areas occur.

P. Coastal lowlands

The coastal lowlands range from very broad, level-to-undulating plains to very narrow dissected lowlands. In many places a scarp forms the limit between the plains and the interior. The plains may be broken by ridges, dunes, hills and depressions, and consist of light-to-heavy-textured material. They often contain lakes, swamps, or lagoons bordered on the seaward side by sand spits or barriers. Coral reefs may also occur. Rivers are usually bordered by mangrove swamps near their mouths. Coastal plains, which occur under very different climates, can support a vegetation ranging from evergreen forest to desert shrubs, and have sometimes no vegetation at all.

Besides the relatively narrow coastal lowlands and plains which have been discussed with the bordering physiographic regions, the following areas are distinguished separately:

- — eastern Africa from Somalia to Mozambique
- — the region from Angola to Cameroon
- — western Africa from Nigeria to Guinea-Bissau.

From Somalia to Mozambique: in Somalia the lowlands are bordered by the Ogaden plateau in Ethiopia and the dissected upland region gently rising to the Harer highlands. The coastal lowlands consist mostly of broad, level-to-undulating sand plains, coastal ridges, and active sand dunes which in southern Somalia are crossed by river flood plains with mangroves. In eastern Africa the coastal plain is between 15 and 60 km wide, and in places is fringed with coral reefs. Mangrove swamps cover extensive areas in estuarine regions. In Mozambique the coastal area is comparatively narrow in the north, but covers practically the whole width of the region south of the Save river. Rather extensive swamps and numerous lakes and lagoons occur, especially in the southern part of Mozambique and east of the Lebombo mountains, where the river gradients are small and inundations may follow the rains. Coastal sand dunes and mangroves also occur.

From Angola to Cameroon: North of 12°N the low coastal plain between Angola and Cameroon is mostly bordered by the mountains surrounding the Congo basin. Its width varies greatly and is especially large near Libreville where the Ogooué river enters the plain, and around Douala. The plain is crossed by numerous rivers bordered by mangrove forests along the estuaries, and there are also lagoons, lakes and swamps.

From Nigeria to Guinea-Bissau: Under the influence of the west-east longshore currents, huge sand bars have formed between the ocean and the lagoons. These shoals, which have joined the mainland at their further ends, occur from Nigeria to Cape Palmas at the border of Liberia and Ivory Coast. Breaches in the sand bars allow water from the lagoons and rivers to pass to the ocean. The shore of the mainland north of the lagoon strip is rocky in many places and forms a small cliff to the low coastal plateau.

The coastal plains southwest of the Fouta Djallon region in Guinea extend into narrow valleys in the highlands. No sand bars or lagoons have formed, but rather muddy creeks and estuaries ("rias") covered with mangroves and flanked by marshes.

Guinea-Bissau has low peninsulas and rias and numerous offshore islands, and the mainland is crossed by sluggish meandering rivers. Here also mangrove swamps cover relatively large areas.

Q. Central highlands of Madagascar

This region covering the central part of the island has a total area of about 590 000 km^2, a length of more than 1 500 km, and a north-southeast to south-southwest trend.

The African basement complex of igneous and metamorphic rocks forms the eastern two thirds of the island, including the central highlands. The highlands consist of a dissected plateau of more than 800 metres altitude with flat-topped interfluves and hill summits of 1 200 to 1 500 metres elevation. This landscape is comparable to that of the plateaus of the mainland. However, the basement complex in Madagascar has in some places been broken up into blocks along generally north-south-running faults. Most high mountains are of volcanic origin, while the rest of the highlands are essentially formed by the schists, migmatites and gneiss of the basement complex.

The mighty Tsaratanana massif in the north includes the highest peak of the island (2 886 m). The volcanic Ankaratra massif south of Tananarive (Q1) and Boby Peak in the Andringitra south of Fianarantsoa attain an altitude of about 2 650 metres.

On the east, the central highlands end in escarpments overlooking the coastal plain, which is rarely more than 30 km wide. Because of the proximity of the sea, rivers have deeply incised the bordering highlands.

The extensions of two escarpments enclose Lake Alaotra and the valley of the Mangoro river, which runs parallel to the coast for over 150 km (Q2).

R. Marginal regions and coastal plains of Madagascar

The north-northwest-aligned coastal plain in the northeastern part of the island continues along the deeply incised river valleys. South of the Bay of Antongil the plain's orientation changes to north-northeast, and it is bordered by a very straight coastline. The width of the plain varies from a few to about 30 km, and is occasionally twice as wide where river valleys border the coastal lowlands. Numerous relatively short, swift-flowing rivers reach the plain. Extensive marshes occur in the lowest parts, while coastal lagoons are widespread between Tamatave and Manakara. The nearly 700-km-long Pangalanes Canal connects the lagoons.

The plains of northwestern Madagascar are separated by the mountainous barrier of the Tsaratanana (R1) from those to the southwest.

Where the central highlands bound the low plateaus and plains to the west there are several escarpments, the most spectacular being that of Bongolava south of Morafenobe. The plateaus have a slight westward tilt. Large areas of the Bemaraha plateau are over 300 metres high, and other plateaus such as the Tampoketsa and Ikahavo exceed 600 metres.

Lower, very straight-sided plains sometimes occur between these relief elements, e.g. the Betsiriry plain (R2) between the escarpment of Bongolava and the Bemaraha plateau.

The flat plains along the west coast are wider than these along the east coast. In northwestern Madagascar the coast is indented, and numerous bays bordered by marshes and mangrove forests occur west of the low, flat Majunga plains.

GEOLOGY AND LITHOLOGY

The greater part of the African continent consists of a great continental shield bounded to the north by the Alpine-Atlas mountain system and to the south by the Hercynian Cape system.

The shield is similar in form and origin to the Brazilian and Laurentian shields. Ever since the end of the Precambrian this relatively rigid block has been fractured by vertical movements, but has suffered only slight folding. The basement complex forming the shield is of lower Precambrian (Archaean) age. It underlies the whole continent and outcrops over one third of the area.

There are many indications that the African shield was once part of the ancient continent of Gondwanaland, which also comprised South America, India, Antarctica and Australia. It is believed that during the Mesozoic era Gondwanaland gradually broke up into blocks, a process known as "continental drift." The separation of Madagascar from the continent also took place in this manner, and portions of the Gondwana surface are visible in the island's extensive peneplains.

After the displacement of Gondwanaland, horizontal and vertical movements continued to affect the continent. Apart from the folded Atlas and Cape mountain systems, these movements have all been of epeirogenic nature.

Unequal uplift and differential faulting have produced a series of great basins, separated by gently rising uplands or plateaus. The age of these basins varies considerably. In general, their formation began in the Palaeozoic. Exceptions are the Chad basin, formed by downwarping in the Quaternary, and Lake Victoria, which is associated with the evolution of the Great Rift valley, where the effects of faulting are demonstrated on a spectacular scale.

Though the structures may be of great age, possibly Precambrian, the most important movements took place during the Plio-Pleistocene period. The Rift valley system includes the Red Sea trough and extends north to Syria and south to Lake Malawi (Lake Nyasa). The width of the Great Rift valley in Africa is remarkably constant, averaging 40 to 50 km. Its sides often rise to heights of 2 000 metres, and between Lakes Albert and Edward the great horst of Mount Ruwenzori reaches 5 000 metres.

With the exception of the lava shields of Ethiopia, Mount Kenya, Mount Kilimanjaro and some active volcanoes west of Lake Victoria, no volcanism is evident along the southern part of the Rift valleys.

Folded mountain systems occur in the Cape ranges and the Atlas system. The main orogenesis of the former took place during the Triassic and upper Cretaceous, and the most important folding of the latter occurred in the mid-Tertiary.

One of the most characteristic elements of African geomorphology is the different planation surfaces. These peneplains represent the final stages of individual cycles of erosion and are often separated from each other by scarps. Six erosion cycles are recognized in Africa, resulting in "pre-Karroo," "intra-Karroo," "Gondwana," "post-Gondwana," "African" and "post-African" surfaces.

The African basement comprises a granitized, migmatized basement complex of lower Precambrian (Archaean) age which is heavily injected with intrusives. It is overlain by more characteristic non-fossiliferous sedimentary formations of middle Precambrian age which generally are metamorphosed and associated with intrusives. The upper and final Precambrian deposits are slightly metamorphic or non-metamorphic and generally contain fossils.

Following the Precambrian period there is usually a great gap in the geological record which represents the first of the many long intervals of erosion to which the continent has been subjected. Over the whole of southern Africa outcrops of lower Palaeozoic sediments are very restricted in extent and the Precambrian is overlain by Devonian strata. In northern Africa the record of lower Palaeozoic rocks is more complete. The Cambrian followed a glacial period which is indicated by the presence of tillite. The Cambrian, the Ordovician and the Silurian are represented by slightly metamorphic or non-metamorphic rocks. During the Carboniferous, northern Africa and parts of central Africa were inundated, and marine sediments were deposited.

In southern and central Africa the Karroo system was initiated under glacial conditions and lasted from the Carboniferous to the lower Jurassic. The Karroo sediments rest upon the older strata with marked disconformity and consist entirely of continental deposits derived from erosion and denudation of the Precambrian and lower Palaeozoic rocks, with the exception of some volcanics of the upper Karroo (Stormberg). Comparable in age and facies are the Nubian sandstone of Sudan, Egypt and Libya and the *continental intercalaire* of northern central Africa, where sediments accumulated in broad basins from the upper Carboniferous to the lower Cretaceous.

In northern Africa and parts of western Africa subsidence brought shallow flooding of extensive areas by Cretaceous and Eocene seas, and marine sediments were deposited over an extensive area. There are no marine deposits in central and southern Africa, with the exception of a narrow band along the coast, where local downwarping allowed thick deposits to accumulate. During the Tertiary the sea gradually withdrew from northern Africa and continental detritus of the upper Tertiary and the Quaternary accumulated in basins. All Tertiary formations of continental origin are called *continental terminal* in northern Africa, while south of the equator they form the Kalahari system.

The main geological regions are shown in Figure 4, and the lithological groups in Figure 5.

1. Atlas mountain system

Geology

The present landscape was mostly produced by Tertiary folding and uplift of sediments deposited over a long period in a geosyncline lying between the African and Tyrrhenian shields. A series of Palaeozoic rocks were deposited on the continental African shield, and at the end of the Carboniferous the Hercynian orogenesis folded these rocks in Morocco and western Algeria. Until the end of the Tertiary, various marine transgressions alternated with continental conditions. The Pyrenean orogenesis (Cretaceous-Eocene) was severe, resulting in the formation of the Rif Atlas and the beginning of the formation of the Tell Atlas.

During the Alpine orogenenis renewed folding and uplifting occurred as a result of the great pressure that built up between the Tyrrhenian and African shields.

The Anti-Atlas, which continues the chain of the Saharan Atlas toward the coast, shows some evidence of folding, but basically represents a disturbed and elevated portion of the Saharan shield.

The Canary Islands have been volcanic since the end of the Cretaceous. New volcanic activity took place in the Eocene and lasted until the Pleistocene.

Lithology

The Rif Atlas consists of Jurassic, Cretaceous and Tertiary flysch deposits. Jurassic limestone occurs in the Middle Atlas, and toward the west there are Carboniferous marine deposits which are metamorphosed and associated with basalt and granite. In the High Atlas the Precambrian granitic basement is exposed in several places, but is mostly overlain with Jurassic limestone and Cretaceous and Eocene flysch deposits.

The Tell Atlas forms a double chain: the littoral Tell and the inland Tell, which are separated by a Miocene basin. The littoral Tell was formed by Jurassic and Cretaceous calcareous sediments which are sometimes slightly metamorphosed, an Eocene flysch and an Oligocene alluvial and lagoonal facies. The inland Tell is a massive development of Triassic and Jurassic limestone which probably overlies gneiss. The Saharan Atlas is dominated by Cretaceous limestone and marl partly overlain with Neogene and Quaternary sandstone and sands.

The high plateaus are covered with Neogene clayey marls, which are mostly unconsolidated.

In the Anti-Atlas Precambrian rocks outcrop over extensive areas and consist of metamorphic rocks (schist, gneiss and amphibolite) often associated with granitic instrusions and volcanism. Cambrian rocks generally border the Precambrian and are composed of limestone, schist and sandstone with volcanic deposits which are generally metamorphosed. Ordovician schists predominate in the eastern part of the Anti-Atlas.

The Cretaceous volcanic deposits in the Canary Islands are doleritic basalts. During the Eocene there were effusions of basalt, rhyolite and trachyte. The later eruptions produced basalt.

2. Ougarta range and Tindouf syncline

Geology

The Ougarta range connects the Anti-Atlas and the Tassilis and separates the Western Erg from the Erg Chech. It consists of a number of northwest-southwest folds, most of which have been covered by sand. Late Pliocene (Villafranchian) deposits have fossilized the ridge and valley landforms of the Ougarta range, forming today's hamadas.

Lying between the Anti-Atlas and the Requibat ridge, the Tindouf syncline occupies the Dra plateau covered by a hamada of *continental terminal* and surrounded by Palaeozoic rocks.

Lithology

The Palaeozoic rocks forming the Ougarta range are predominantly Cambro-Ordovician quartzite, with some shale and Silurian schist. The hamadas surrounding and covering the range consist of Villafranchian limestone, calcareous marl, sandstone and travertine.

The Tindouf syncline is covered with *continental intercalaire* and *continental terminal* calcareous deposits.

The continental Carboniferous deposits surrounding the syncline are composed of clayey sandstone and limestone, while the marine Carboniferous and Devonian deposits consist of limestone with intercalations of sandstone and schist.

3. Rio de Oro basin and Senegal plain

Geology

The Río de Oro basin occurs along the coast south of the Anti-Atlas and west of the Requibat ridge. The basin floor consists of the Precambrian basement complex, the basin itself being filled with marine Cretaceous sediments left by the Cenomanian transgression. Toward the coast these sediments are overlain with lower Eocene marine sediments and *continental intercalaire* of upper Eocene and Miocene age.

Toward the south the basin merges with the Senegal plain, which is covered with *continental terminal.* At the inland limit a pediment of Cambrian and Ordovician rocks forms the surface, and along the coast a belt of Palaeocene marine sediments occurs near Dakar. They are partly overlain with Ypresian deposits which outcrop between Dakar and Thiès.

Lithology

The Cenomanian deposits in the Río de Oro basin consist mostly of calcareous sandstone and limestone. The lower Eocene marine sediments are phosphatic limestone.

The *continental terminal* deposits covering the greater part of this basin and the Senegal plain consist of sandstone, shale, marl, sand and clay.

The pediment toward the east consists of schist and sandstone, and the Palaeocene deposits are marble and nummulitic limestone. Deposits from the Ypresian transgression are shale, phosphatic limestone and marl.

4. Requibat ridge

Geology

The Requibat ridge consists of granitized, migmatized lower and middle Precambrian rocks with intrusions of syntectonic and post-tectonic granites and pegmatites, and a north-south fold trend. On the extreme western end of the ridge there is an upper Precambrian outcrop consisting of a non-metamorphic volcanic-sedimentary complex.

Most of the Requibat ridge is covered by the sands of the Erg Iguidi.

Lithology

The lower and middle Precambrian rocks consist of gneiss, micaschist, quartzite, cipolin and amphibolite. Granitization and migmatization have produced granite, granitic gneiss, migmatite, schist and leptite. The upper Precambrian rocks are sandstone, slate, limestone and acid effusives such as rhyolite.

5. Taoudenni basin

Geology

The Hercynian Taoudenni basin occupies more than half of the western Sahara. It is a 1 200-km-wide tectonic depression surrounded by the Precambrian rocks of Mauritania, Guinea, Ivory Coast, Upper Volta and the Requibat ridge. The eastern boundary is less precise because the Precambrian basement hidden beneath Cretaceous and Tertiary rocks does not outcrop and is covered by the sands of the Tanezrouft.

In the northern part of the basin a strip of Cambrian rocks bordering the Requibat ridge is overlain toward the south with Ordovician strata; both are only slightly metamorphic.

Carboniferous rocks are exposed over an extensive area southwest of the Erg Chech. The Mesozoic and Tertiary are represented by the *continental intercalaire* and *continental terminal* occupying the centre of the basin.

The northwestern limit of the southern Taoudenni basin is formed by the Precambrian rocks of Mauritania. Toward the east the plateaus of the Adrar des Iforas consist of Infracambrian and Cambrian formations overlain with Ordovician deposits (the Dhar sandstone series). South of the El-Djouf desert Cambrian metamorphics (the Nara series) and many sill and dyke outcrops are exposed over an extensive area. Further south, the non-metamorphic "Infracambrian" (between the Precambrian and Cambrian) formation is exposed as far as the southern limit of the Taoudenni basin. The Affollé plateau also consists of this formation. Between the Niger river in Mali and Upper Volta, Precambrian rocks form the southern limit of the basin. They are partly overlain with *continental terminal.*

The Fouta Djallon plateau lies at the southwestern limit of the Taoudenni basin and is composed of Precambrian metamorphics and basic intrusives forming many sills which seem to have originated from laccoliths.

Toward the coast the formation is overlain with a formation of Devonian rocks surrounded by Silurian and Ordovician strata.

Lithology

The Cambrian rocks of the northern part of the basin are composed of pelites, sandstone, shale and conglomerate. The Carboniferous rocks are carbonate sediments, i.e. limestone, sandstone in a calcic matrix, and gypsiferous clay. The *continental intercalaire* can be divided into two series: Jurassic (?) sandstone and a red clay with oolitic fragments, and lower Cretaceous sandstone, quartzite and silex. The upper Cretaceous deposits near the Aïr massif consist mainly of limestone, shale and calcareous sandstone. The *continental terminal* is a mixture of slightly consolidated sandstone, quartzite and chert.

The Precambrian rocks of Mauritania and the Fouta Djallon are crystalline schist, quartzite and greenstone (metamorphic lava). The Dhar series consist of sandstone with intercalations of quartzitic banks. The Nara series are calcareous schists, quartzite and pelites. The sills and dykes are composed of dolerite and diabase. The Infracambrian consists of sandstone and tillite deposits with minor intercalations of limestone. West of the Fouta Djallon plateau the Ordovician deposits are composed of very fine cross-bedded sandstone. Toward the centre of the plateau they are overlain with Silurian schist and quartzite, which in turn are partly overlain with Devonian schist and sandstone. The upper Niger basin in Mali is occupied by Quaternary and recent alluvial material.

6. Lower Sahara basin

Geology

The Atlas ranges are separated from the Ahaggar massif by the sedimentary basin of the lower Sahara, which is more than 600 km wide. The Precambrian basement complex forming the floor of the basin is found at a depth of 3 000 to 5 000 metres. The oldest deposit, which extends over a wide area, is the *continental intercalaire* varying in age from Cambrian (?) to lower Cretaceous. Middle Cretaceous marine deposits occur in a wide band north of the Tassilis, and are partly overlain with upper Cretaceous marine deposits left by the Cenomanian transgression, which are in turn succeeded by Palaeogene marine sediments.

The greater part of the Cretaceous and Tertiary marine deposits and the *continental intercalaire* is covered by the sands of the Western and Eastern Ergs.

Lithology

The *continental intercalaire* consists of sandstone with haematite, evaporite and some anhydrite. The lower Cretaceous deposits forming the upper part of this deposit are mainly clayey sandstone. The middle Cretaceous deposits are dolomite, slate and anhydrite. The upper Cretaceous is formed by limestone and anhydrite. The Palaeocene deposits are composed of nummulitic limestone.

7. Ahaggar massif and Tassilis

Geology

The Ahaggar massif forms a great inlier of crystalline rocks which has been exposed by erosion of the surrounding Palaeozoic strata that form the Tassilis.

The Ahaggar massif continues southward to the Adrar des Iforas in the southwest and the Aïr in the southeast. The lower Precambrian Suggarian system and the middle Precambrian Pharusian system also outcrop in this region. The Suggarian occurs in the Aïr, in the central part of the Ahaggar and in the Adrar des Iforas, the latter two being separated by a large trench of Pharusian outcrops. The Suggarian consists of the Arechchoum series and the younger Egéré series.

The Ahaggar massif is bordered in the northeast and south by a series of tilted plateaus known as the Tassilis. The central Tassilis are marine deposits and the outer Tassilis comprise Devonian continental deposits and Carboniferous marine strata.

Lithology

In the Ahaggar massif the Suggarian can be divided into the Arechchoum series (biotite and amphibolite, gneiss, micaschist, quartzite and cipolin) and the Egéré series (banded gneiss, micaschist and amphibolite and more quartzite and cipolin).

The Pharusian comprises conglomerate, sandstone, arkose, and some limestone. Micaschist, leptite, amphibolite and gneiss are also abundant, and are usually associated with migmatite zones composed of greenstone and granite. The Cambro-Ordovician centre of the Tassilis consists of sandstone and sandy marl. The Silurian rocks are mostly clayey schist. In the outer Tassilis there are Devonian sandstone and Carboniferous shale, sandstone and limestone.

8. Iullemeden basin

Geology

The Iullemeden basin is a large northwest-southeast-trending synclinal basin which separates the Ahaggar massif and the Tassilis from the Precambrian massifs of western Africa. In this basin sedimentary rocks of Cretaceous to recent age overlie a pre-Cretaccous basement of crystalline rocks which forms the borders of the basin toward the south and the east.

Two geological zones may be distinguished in the Iullemeden basin. Toward the north the Ténéré desert and the Tegama plateau, between the Adrar des Iforas and the Aïr, consist of *continental intercalaire*.

South of this region is the Iullemeden basin proper. It is formed by Cretaceous and Tertiary plateaus overlying the *continental intercalaire*.

Lower Eocene sediments border the Cretaceous sediments toward the south and east. The southeastern part of the basin is covered with *continental terminal*.

Lithology

The *continental intercalaire* consists of Izegouandana arkose, Agadès sandstone, Irhazer claystone and the Tegama sandstone series. The Cretaceous and lower Eocene deposits consist of marble and very fine sandstone in a chalky matrix. The *continental terminal* is composed of deposits of poorly consolidated sandstone, ferruginous shale, laterite, mudstone, conglomerate and grits.

9. Fezzan basin

Geology

The Fezzan basin lying between the Ahaggar and Tibesti massifs can be divided into the Chati basin in the north, the Murzuq basin in the centre and the Djado basin in the south. The Fezzan is a large Palaeozoic basin partially covered by *continental intercalaire* and *continental terminal* and the sands of the Erg of Murzuq.

Lithology

The *continental intercalaire* in the Murzuq and Chati basins consists of Triassic sandstone, shale and dolomite, Jurassic sandstone and shale, and lower Cretaceous shale and oolitic limestone. The Cambrian and Ordovician formations consist of thick sandstone deposits. The Carboniferous strata in the Djado basin are marine and lacustrine limestone, shale and gypsum overlain with continental sandstone and shale. The Silurian and Devonian strata are composed of schist and sandstone. The deposits of *continental terminal* are non-calcareous, poorly consolidated sediments.

10. Tibesti, Borkou and Ennedi

Geology

The Tibesti, Borkou and Ennedi are plateaus of Palaeozoic strata which overlie a Precambrian basement. In the Tibesti these strata are overlain with volcanic strata.

East of the Tibesti mainly marine Devonian and Carboniferous rocks overlie the Cambro-Ordovician. West of the Tibesti Cambro-Ordovician horizontal marine strata outcrop over an extensive area, overlying with unconformity the folded Precambrian basement. To the south they are overlain with the Silurian rocks of the Borkou plateau. The highest part of the Tibesti is a volcanic massif formed during the Tertiary and Quaternary. The Ennedi plateau is composed of Devonian and Cambro-Ordovician strata which are of the same facies as those of the Tibesti.

Lithology

In the Tibesti the lower Precambrian consists of gneiss, migmatite, granite, leptite and micaschist. The middle Precambrian is composed of cipolin (crystalline limestone), schist and quartzite. The Cambro-Ordovician and Devonian rocks consist of a thick series of horizontal sandstone. The Silurian is not schistose as in the Tassilis, but has an argillic sandstone facies. The marine Carboniferous rocks are composed of gypsiferous sandstone, marble and limestone. The effusives of the volcanic massif of the Tibesti are for the greater part basic: basalt, dolerite and labradorite. The cones of the Emi Koussi and the Tousside are composed of rhyolite.

11. Continental deposits of northeastern Africa

Geology

The Precambrian basement in northern Africa is covered with deposits of *continental intercalaire* which include rocks varying in age from upper Carboniferous to lower Cretaceous. In Egypt the Nubian sandstone may be correlated with the *continental intercalaire*, and in general is represented by lower Cretaceous beds with silicified wood.

During the upper Cretaceous northern Africa subsided shallowly beneath the sea and marine deposits were left on the *continental intercalaire* in the north. To the east the long-accumulated piedmont deposits of Nubian sandstone were also partly inundated by the upper Cretaceous sea.

In the Libyan desert the Jabal al-Uwaynat is a small massif formed by the basement complex.

In general the *continental intercalaire* forms plains and plateaus in which inselbergs of granite occur. In the Libyan desert it makes flat hamada plateaus, while in the Nubian sandstone complex to the east the inliers of a pre-Nubian inselberg landscape increase in size. North of the upper Nile basin the continental deposits have been almost completely eroded and the basement complex is exposed in plateaus or isolated hills such as the Nuba mountains in Kordofan.

Lithology

The *continental intercalaire* is a shallow water deposit, but abundant aeolian grains imply wind transportation prior to and during deposition. It is composed of poorly-consolidated sand, conglomerate and shale.

The Nubian sandstones are false-bedded but are not dune-sands of aeolian origin. Occurring in association with ferruginous shales, they represent a shallow fresh water deposit consisting of yellow and brown bedded sandstone intercalated with mudstone, clay, marl and conglomerate, and scattered Cretaceous marine strata.

The basement complex in the south is composed of gneiss, quartzite and schist. Sandstone and trachyte also occur in the Jabal al-Uwaynat.

12. Marine deposits of northern Africa

Geology

During the upper Cretaceous subsidence allowed the sea to penetrate 1 000 km inland from the present coastline and leave thick calcareous deposits during the Cenomanian transgression.

The Cretaceous deposits are in turn succeeded by nummulitic limestone of Palaeocene to Oligocene age deposited when the sea invaded Egypt as far as Aswan during the Ypresian transgression.

Neogene deposits overlie the nummulitic limestone in the north. The older marine deposits which still outcrop are found in the Sinai Peninsula, where middle Triassic, Jurassic and Cretaceous rocks overlie the basement complex in the north.

Volcanic rocks found in the Jabal al-Soda and the Haruj al-Aswad date from the upper Oligocene to the Quaternary.

Half the region is occupied by the sands and hamadas of the Libyan desert.

Lithology

The lower Cretaceous marine deposits are marly and dolomitized limestone. The Eocene deposits consist of massive siliceous limestone interbedded with soft argillaceous marl and sandstone. The Neogene deposits are composed of compact limestone interbedded with layers of marl and gypsum. The volcanic rocks in Libya are basalt.

13. Chad basin

Geology

The Chad basin was formed by Quarternary downwarping. It is filled with mainly Quaternary *continental terminal* which in places is more than 1 000 metres thick. Although Tertiary deposits occur, most Quarternary deposits directly overlie the basement complex; Palaeozoic and Mesozoic strata have never been found. The basin is bordered by plateaus of Precambrian and Palaeozoic rocks. On the western edge of the basin, the Tegama and Koutous plateaus to the south of the Aïr massif contain some *continental intercalaire*.

Lithology

The Tegama and Koutous plateaus consist of Jurassic sandstone, shale and conglomerate, lower Cretaceous limestone and shale, and *continental terminal* composed of poorly consolidated sandstone, shale and marl. Pleistocene and recent alluvial and lacustrine deposits are found in the central part of the basin. The Erg of Kaouar in the north and the Kanem region east of the lake are covered with aeolian sands.

14. Western African basement complex

Geology

This part of the basement landscape is characterized by extensive, perfectly flat plains. In some areas there are depositional surfaces such as the coastal plains of Guinea, Sierra Leone and Liberia, and the deltaic deposits of the Niger river. In large areas erosion surfaces cut across a variety of basement rocks and structures. These peneplains can be divided into the Gondwana surfaces (Jos plateau of Nigeria, Man massif, Guinean highlands) which occur mainly at altitudes ranging from 900 to 1 400 metres; the African surfaces (plain of Hausaland and locally in the Atakora range and Guinean highlands) at 450-600 m, and the post-African surfaces (200-300 m). These surfaces are often interrupted by a number of higher small plateaus and residual inselbergs, including granitic domes and quartzitic ridges.

The Guinean highlands occur at the western edge of the western African basement complex and are composed of basement rocks.

At the southeastern limit of the Guinean highlands is the slightly undulating Man massif, which has an average altitude of 1 300 metres and is considered a Gondwana surface.

The Nimba mountains form a narrow ridge on the border between Liberia and Guinea and are of geomorphological interest because they show evidence of erosion surfaces at altitudes of 1 600, 1 300, 800 to 900 and 550 to 600 metres. The hardness of the quartzite composing the mountain chain has helped it to withstand erosion.

The larger part of the post-African surface lies to the west of the Volta basin, where it forms a peneplain occupying all of Ivory Coast and Upper Volta and parts of Ghana, Guinea, Liberia and Niger. The peneplain tilts slightly toward the south and consists of Precambrian formations which dissappear in the north beneath the Tufra-Cambrian plateaus of Bobo-Dioulasso.

The post-African surface is often overlain by a succession of residual plateaus and flat-topped hills formed by older erosion cycles. They normally consist of granite, gneiss, greenstone or schist and often are overlain with bauxite and ironpans. Toward the north the peneplain is dominated by granitic domes.

Half the surface of Ghana is covered by the Volta basin, an extensive plateau formed by an ancient sedimentary basin which was filled in with Voltaian sandstone and by the Buem series, both of Precambrian to Ordovician age.

The Benue river valley is a remarkably deep trough and the thickness of its Cretaceous sedimentary strata is estimated at 4 500 to 6 000 metres. It is possible that it is part of the great rift which separates South America from Africa. The trough is filled with *continental intercalaire* comprising the Bima sandstone which overlies the basement floor and also outcrops in the northern and western parts of the trough and in the Niger valley.

The Jos plateau owes its survival to its erosion-resistant granitic surface. The average altitude of the plateau increases toward the south from 1 200 to 1 400 metres. Where the surface rises there are isolated granitic residuals and hills formed by two phases of volcanic activity.

East of the Gongola valley lies the Biu plateau, an extensive basalt formation with numerous volcanic cones. Further east the Mandara mountains represent the northern part of the eastern highlands of Nigeria, isolated from the rest of the upland by the Benue trough. A narrow strip of Tertiary marine deposits found along much of the western African coast widens slightly in Nigeria, where sustained subsidence in the delta area allowed for the accumulation of a deposit nearly 1 000 metres thick.

Lithology

A granitic gneiss complex of lower Precambrian (Dahomeyan series) rocks is exposed in eastern Guinea, Sierra Leone, Liberia, Ivory Coast, western Ghana, Upper Volta and northwestern Nigeria.

In Sierra Leone this complex is known as the Kasila system and occurs with pegmatite, schist and ferruginous quartzite. The Man massif consists of a continuous granite-norite series (granite, leucogranite, quartz, biotite, apatite and norite). In western Ghana the lower Precambrian level comprises intensely folded orthogneiss, paragneiss, granite, quartzite and micaschist.

Northwestern Nigeria consists of the lower Precambrian Gwarian complex (granitic gneiss, micaschist and amphibolite) which is intensely metamorphosed and granitized and intruded with granitic batholiths.

The Middle Precambrian (Birrimian) outcrops in northern Guinea and Ivory Coast and in an extensive area west and east of the Volta basin. It is composed of schist, quartzite and greenstone and was folded and intruded during the Eburnian or Ivorian orogeny. In Ghana these outcrops cover extensive areas in the east and in the southwest near Accra and consist of schist, phyllite, grauwacke, sandstone and greenstone as well as intrusives. The Precambrian rocks forming the greater part of Benin are probably also of Birrimian age and are composed of gneiss, quartzite and micaschist. The upper Precambrian (Tarkwaian) is exposed in the Atakora range and consists of granite and quartzite.

The Voltaian series covering the Volta basin rest discordantly on the Tarkwaian, and comprise sandstone, shale, conglomerate, dolomitic limestone and schist. The Buem series are exposed in the eastern part of the basin and consist of sandstone, conglomerate and dolomite.

With the exception of the upper Voltaian series, Palaeozoic rocks do not outcrop over large areas in the western basement complex.

Mesozoic rocks are exposed in Nigeria, where lower and middle Cretaceous marine deposits in the Benue trough and Gongola valley consist of dolomitic limestone, sandstone and shale.

Toward the west and in the Niger trough there are outcrops of *continental intercalaire* composed of sandstone and shale with coal measures. Upper Cretaceous and Palaeogene clastic deposits are found in a narrow band from Enugu toward the Atakora range and are overlain toward the south with *continental terminal* of sandstone and shale. Palaeogene marine sandstone and shale also occur northwest of the Benue trough. Young alluvial deposits form the Niger delta.

15. Central African basement complex

Geology

This basement complex does not differ from the western basement complex and is mainly composed of highly metamorphic and granitized crystalline rocks. Slightly metamorphic, sedimentary, intrusive and volcanic rocks also occur.

The Cameroon-Adamawa highlands consist of basement rocks partly overlain by volcanic deposits.

Volcanism began in the upper Cretaceous, but the major eruptions took place in the Tertiary and have continued through the present.

A marginal band of sedimentaries near the coast merges inland with a hilly region of basement rocks broken up into horsts and fault troughs, which in turn merges with the less-faulted interior highlands.

The African surface occurs in the Ogooué-Livindo basin, which has a mean altitude of 500 to 550 metres. Inselbergs and buttes attain altitudes of more than 900 metres and are capped by a thick ironstone layer. To the west the northern Crystal mountains are formed by a granitic massif. The N'Djolé mountains toward the south consist of slightly metamorphic rocks. In the Central African Empire the post-Gondwana and African surfaces form a smooth plain on the basement complex. The basement complex of the Ouadda-Ndélé plateau north of the Ubangi river is overlain with *continental intercalaire*, which also occurs between Mouka and Ouadda south of the Bongo massif. In Sudan the central basement complex forms a rather monotonous, gently undulating plain which is shallowly dissected by a dendritic drainage system of Pleistocene age.

Lithology

The granitized part of the basement complex is believed to be of lower Precambrian age. It includes granite, gneiss and migmatite. The part which has not been affected by granitization consists of schist, quartzite, syenite and dolerite. In the Kivu ridge the middle Precambrian rocks comprise strongly metamorphosed gneiss, amphibolite, quartzite and micaschist as well as granitic intrusives. The upper Precambrian rocks around the Congo basin are slightly metamorphic sandstone, quartzite and schist. The northern edge of the Congo basin is formed by upper Precambrian non-metamorphic sandstone and shale. In the Central African Empire upper Precambrian rocks occur in a graben surrounded by the older basement complex. The volcanic rocks in the Cameroon-Adamawa highlands are basic effusives.

The Cretaceous-lower Tertiary rocks are generally basalt and andesite. The upper Tertiary rocks are mainly trachyte and phonolite and the recent ones basalts and pyroclastics.

The *continental intercalaire* in the Central African Empire consists of sandstone and conglomerate.

16. Sudd basin

Geology

An extensive area of the basement complex in southern Sudan is covered by continental deposits which occupy the Sudd basin. The basin, which in Pleistocene times may have had an internal drainage system, is filled with a thick series of *continental terminal*. Though now drained by the White Nile and its tributaries, it is still a sedimentation basin since precipitation is insufficient to produce sustained runoff over the gently sloping ground.

Lithology

The Umm Ruwabah formation in the Sudd basin has *continental terminal* consisting of unconsolidated clay and sand. The formation is partly overlain with the Kordofan sands, which form a surface deposit of fixed dunes.

17. Nubian shield (eastern African basement complex)

Geology

The Nubian shield forms the eastern extension of the African basement complex. It consists of Precambrian rocks which extend from Ethiopia and Sudan northward along the Red Sea coast as far as the Gulf of Suez and form the highest mountains in the southern Sinai Peninsula. Toward the west it is covered by continental deposits and toward the south it disappears under the volcanic rocks of the Ethiopian highlands.

The Precambrian rocks in the Sinai Peninsula and eastern Egypt are of Pharusian age. Toward the south they are overlain with the Dokhan series (middle Precambrian?) and the Hammanat series (upper Precambrian?). In Sudan the Pharusian outcrops sporadically, but is overlain with the Nafirdeib and Awat series, the latter of which may be correlated with the Hammanat series in Egypt. Nubian sandstone and *continental terminal* overlie the Precambrian basement rocks in the west, and in the south Jurassic marine deposits occur in Sudan near Asmara.

Lithology

The Pharusian rocks in Egypt and the Sinai Peninsula consist of orthogneiss, granite, diorite and syenite. The Dokhan series are composed of serpentinite, gabbro and different lavas and are overlain with the Hammanat series (conglomerate, schist and grauwacke as well as igneous rocks). In Sudan the Pharusian consists of a granitic gneiss complex with micaschist and dolerite dykes. The Nafirdeib series are composed of gneiss, quartzite, schist, crystalline limestone and andesite. The Awat series are conglomerates of argillaceous rocks overlain with andesite and rhyolite and intruded with granite.

The Jurassic marine deposits consist of marl, dolomite, limestone and some minor sandstone strata.

18. Ethiopian highlands

Geology

The greater part of the Ethiopian highlands was formed by lava from the fissures and volcanoes that appeared during the series of tectonic adjustments affecting this zone. Vast quantities of the older lavas (the Ashangi group) effused from fissures onto the Mesozoic surface or the basement complex.

The crystalline basement rocks of the Ethiopian highlands were uplifted toward the end of the Eocene, before the main Alpine orogeny. This upheaval, which is believed to predate the formation of the mountains of the west coast of Saudi Arabia, was accompanied by an effusion of magma and the outpouring of the fissure and central-type basalts of the Magdala group.

During the Alpine orogeny the rifts extending from Syria through Ethiopia to southeastern Africa were formed. The major upheaval, which accompanied the rift faulting on a large scale, was succeeded by the outpouring of the basalts of the Shield group (Eocene-Oligocene), producing lava sheets and many volcanoes. It is believed that the succeeding period of major faulting took place in the upper Pliocene and determined the subsidence of the Red Sea and the Rift valleys. It resulted in a phase of increasing fissure eruptions which continued into the Pleistocene (the Aden volcanic series). In the Ethiopian highlands these series occur only in the Great Rift valley and are much more extensive along the eastern Rift valley in Kenya and Tanzania.

The Ashangi, Magdala and Shield groups form the Trap series. They are horizontal and form a monotonous flat surface.

Along the upper course of the Blue Nile, the lavas have been eroded by regressive erosion, and Jurassic limestone outcrops cover an extensive area.

Lithology

The Ashangi group consists of fissure basalts with local Eocene silicic lavas. The Magdala group is composed of basalt, silicic lavas and pyroclastics. The Shield group consists of characteristically alkaline lavas with some calcic-alkaline types and includes phonolite, nephelinite, trachyte, rhyolite and basalt. The Aden volcanic series comprise basalt with some basaltic breccias and tuff.

19. Horn of Africa

Geology

The crustal movements of the Alpine orogeny began near the close of the Oligocene as the Red Sea basin was formed and the bordering mountains were uplifted. The Horn of Africa took shape during this period, when the Red Sea trough and the Gulf of Aden were formed, separating Africa from Arabia.

The older rocks which outcrop in the Horn of Africa are the metamorphics and intrusives of the basement complex, which is also found south of Berbera where it is overlain in places with the Aden volcanic series. In northeastern Kenya it is overlain with the Triassic Mansa Guda formation, which is part of the Karroo system.

The lower and middle Cretaceous deposits consist of the Lugh series and Marehan sandstone, and are composed of shallow marine and continental deposits produced by the erosion of terrestrial sands. The upper Cretaceous is represented by the terrestrial Jessoma formation. Tertiary deposits form the extensive plain in eastern Kenya and southern Somalia, where aeolian, alluvial, lagoonal, littoral and lacustrine deposits are found. Recent aeolian sands occur along the coast, especially north of Mogadishu.

Lithology

The basement complex consists of quartzite, schist, gneiss and granite. The Mansa Guda formation is composed of sandstone, quartzite and conglomerate. The Jurassic marine sediments are mainly limestone and marl. The upper horizons, being partly Cretaceous, consist of a gypsum formation. The Lugh series comprise hard siliceous sandstone and siltstone with horizons of gypsum and intercalations of clay and sand. The Marehan series are composed of a cross-bedded sandstone. The Jessoma sandstone varies from conglomerate to banded siltstone.

The lower Tertiary marine deposits are limestone and marl, with bands of clay and sand. The upper Tertiary and recent deposits are fine-grained marl and calcareous sand and clay.

20. Inter-Rift valley zone

Geology

The two fault systems bordering the inter-Rift valley zone are the western Rift, an arcuate fault system extending from Sudan to Lake Malawi, and the eastern Rift, which extends from Lake Rudolf to a point near Dodoma and as far as Mbeya.

The movements responsible for this faulting took place in different periods, and frequently along the same fault lines; however, the present landforms were not established until the Plio-Pleistocene period.

The faults bordering the *western Rift* zone tend to follow pre-existing Precambrian structures, and the rejuvenation of faulting which took place in at least two major phases has been established as post-Jurassic. Later phases of faulting have produced steep scarps flanking the edges of the lakes.

Faulting played an important part in the formation of Mount Ruwenzori, which may be considered a horst. Its position in the Rift valley axis and the striking absence of volcanism indicate that it was uplifted by vertical pressure or compression.

Between Rutshuru and Goma is a volcanic dam on the floor of the Rift which diverted the northward outflow of a former river system to form Lake Kivu.

Toward the south and divided by a zone of heavily faulted country there is a double trough traversing a high submerged peak. The Rift can be traced, though less clearly, from Lake Tanganyika toward the southeast, where it joins the eastern Rift valley at Lake Malawi.

Formed during the Miocene, the *eastern Rift* is believed to be younger than the western Rift. However, the Cartwright archaeological excavations near Nairobi have produced evidence that the main tectonic movement responsible for the valley's formation took place after the Miocene, and that the later movements which produced the present landscape occurred in the middle Pleistocene. In contrast with the western Rift, the eastern Rift was formed by intense volcanic activity. From Lake Rudolf in the north to Lake Manyara in the south, vast lava beds associated with innumerable volcanic cones extend to the east and west of the Rift valley.

The *inter-Rift valley zone* is for the most part composed of the Precambrian basement complex, which consists of the granitized basement complex, the Dodomian system, the basement system, the Nyanzian and Kavirondian systems, the Karagwe-Ankolean system and the Bukoban system. The granitized basement complex is found in the central plateau of Tanzania, where early rocks of the Dodomian and basement systems were present. The Dodomian system occurs only in central Tanzania, in a strip running from Urambo to Iringa. The basement system occupies northern Uganda and the southwestern border of Tanzania. The Nyanzian and Kavirondian systems occur in the area surrounding Lake Victoria, where they are associated with intrusives. Both systems have suffered slight metamorphism as a result of intense folding. The Karagwe-Ankolean system outcrops west of Lake Victoria and consists of a series of folded, slight-to-moderately metamorphosed sediments more than 1 000 m thick. The Bukoban system occurs in western Tanzania and separates the Karagwe-Ankolean system from the granitized part of the basement complex.

The Karroo system and Mesozoic and Tertiary sedimentaries do not occur extensively in the inter-Rift valley zone. The volcanic activity, which has been going on since Tertiary times, is mainly associated with faulting of the eastern Rift. On both sides of the Rift the layers of lava are sometimes more than 2 000 metres thick.

There is still some volcanic activity in the vicinity of Mount Rungwe north of Lake Malawi, where the two Rift zones coalesce. The western Rift valley is mainly filled with Quaternary sediments.

Lithology

The granitized basement complex is composed of orthogneiss, granite, migmatite, amphibolite and ultrabasic and basic rocks. The Dodomian system consists of coarsely metamorphosed rocks and associated migmatites and granites. Quartzite, schist, gneiss, amphibolite and hornblende gneiss are common. The basement system is composed of quartzite, crystalline limestone, amphibolite, pelitic schist, gneiss, charnockite and hornblende, as well as intrusives. The Nyanzian system comprises thick layers of acid and basic volcanic rocks with interbedded sediments. The Kavirondian system consists of argillaceous and arenaceous sediments with boulder conglomerates and grauwacke. The Karagwe-Ankolean system is composed of shale, sandstone, conglomerate, phyllite, schist and quartzite. The Tertiary and recent volcanic deposits are characteristically alkaline with some calcic-alkaline types and include phonolite, nephelinite and basalt.

21. Mozambique belt

Geology

The basement system forming the Mozambique belt occurs in southern Ethiopia, central Kenya, eastern Tanzania and the Niassa platform in Mozambique.

The rocks occupy an upper Precambrian geosyncline and were strongly metamorphosed during a phase of the Cambrian and again during the Caledonian orogeny. In Kenya and Tanzania the belt consists of metamorphic rocks and east of the Rift valley it is covered by basalt which effused from fissures and from volcanoes such as Mount Kenya and Mount Kilimanjaro. On the Niassa platform the metamorphism is more intense in the east and the basement system is intruded with syntectonic and post-orogenic intrusions. The Karroo system borders the Mozambique belt and it is believed that deposition occurred in and near the margins of the geosyncline. The Karroo rocks mainly overlie the basement system with unconformity and are frequently preserved by downfaulting.

Mesozoic and Tertiary rocks occur in Tanzania and Mozambique along the coast.

Lithology

The Mozambique belt is formed by the basement system and is composed of various metamorphosed rocks such as crystalline limestone, graphitic schist, gneiss, quartzite, amphibolite and charnockite. In eastern Mozambique it is intruded with granite and pegmatite and is locally granitized.

The Karroo system consists of Triassic sandstone with tillite, grits, conglomerate, siltstone, shale and coal measures.

The Mesozoic and Tertiary marine rocks are predominantly limestone and marl with some sandstone and shale. The effusives which cover part of the Mozambique belt consist of basalt, phonolite and nephelinite.

22. Zambian-Rhodesian highlands and Zambia-Nyasa trough zone

Geology

The monotony of the Rhodesian surface is due to the large area occupied by the granitized basement complex. Only small areas of more resistant Palaeozoic rocks occur. The Karroo beds in the west are strongly faulted in places and tilt gently northward. Near Victoria Falls the Bataka basalts corresponding to the upper Karroo overlie the Kalahari system. The Great Dyke, which crosses more than 500 km of the Rhodesian surface from north to south, is a high ridge only in the north, where it stands 450 metres above the adjacent plateau surface. The Rhodesian surface is largely the result of stream erosion into a pre-Kalahari surface which may be correlated with the African peneplain; in southern and central Africa it is elevated more than 400 metres.

The "African" peneplain occurs in the Zambian highlands, and is especially evident in the Lunda uplands in central Zambia where it has not yet been greatly incised by the headstreams of the Zambezi and its tributaries.

The Zambia-Nyasa trough zone was formed by pre-Karroo synclinal folding and post-Karroo faulting. Structurally the trough is bounded by the eastern African Rift system, but there is evidence that it was formed at the same time as the Mozambique channel. The Gwembe-Lungwa trough to the west is bordered by northeast-trending faults until it disappears under the Kalahari sands. The floor of the trough lies from 300 to 1 000 metres below the plateau and its surface consists of Karroo beds and Bataka basalt.

Lithology

The Rhodesian highlands are mainly composed of the granitized basement complex of granite, gneiss, schist, migmatite, and some ultrabasic and basic intrusives which are associated with the Great Dyke and consist of diorite, gabbro, peridotite and serpentinite. Palaeozoic schist, Umkonda or Waterberg sandstone and Lomagundi quartzite and dolomite (Transvaal system) are also found in places.

The Karroo beds in the west consist of Stormberg beds of clayey schist, sandstone, shale and arkose, and Dwyka beds of sandstone, conglomerate, tillite and Bataka basalt.

In the Zambian highlands the upper Precambrian Katanga formation consists of a limestone, dolomite and shale member, a schist and quartzite member and a series of sandstone with interbedded shale and conglomerate. The Zambia-Nyasa trough zone consists of the partly granitized lower and middle Precambrian basement complex. It is dominated by granitic gneiss, schist, quartzite, phyllite and other basement rocks.

23. Mozambique plain

Geology

The Mozambique plain is composed of marine Cretaceous and Tertiary sediments and has a uniform eastward tilt. The plain was probably formed during the detachment of Madagascar from the continent and has been uplifted more than 300 metres since the Cretaceous. The Cretaceous and Tertiary rocks, generally overlain with Plio-Pleistocene marine and alluvial deposits, are a prominent feature only in the Sheringoma plateau.

Lithology

The Cretaceous and Tertiary deposits consist of limestone, marl and calcareous sandstone.

The greater part of the Plio-Pleistocene sediments are marine and lagoonal sands, and clay. Recent alluvial deposits occur along the Changane river.

24. Limpopo depression, Transvaal plateau basin and Kaap plateau

Geology

The Limpopo depression stretches from the Witfontein Rand to the western edge of the Mozambique plain, where a west-oriented scarp of Cretaceous beds bounds the depression. The depression is a wide inselberg-studded plain which is part of the African surface and represents a very advanced stage of planation. The depression is mainly formed on the granitized part of the basement complex ("the old granite ") and the principal interruptions of the even surface are inselbergs or monadnocks composed of ball granite, the Waterberg formation, and patches of the upper Karroo beds.

The Transvaal plateau basin is a formation known as the Bushveld igneous complex. It is composed of an immense oval mass of plutonic rocks 450 km long and 250 km wide south of the Limpopo depression.

The Waterberg plateau consists of resistant red nearly-horizontal Waterberg sandstone. Near Mount Soutpansberg the strata dip strongly. The mountain is bounded by faults on the northern and eastern sides.

East of the Transvaal plateau is the Low Veld, a basin formed by erosion in the Drakensberg on the west and the Lebombo range on the east. It is developed on the easily weathered crystalline rocks of the basement complex and slopes toward the Lebombo range, which indicates the site of an early Jurassic fissure eruption belonging to the same volcanic phase as the Drakensberg lavas.

Southwest of the Transvaal plateau basin, the Kaap plateau separates the Karroo and Kalahari systems. The plateau is a dolomite plain covered with sand and tuff deposits. Occasional beds of resistant chert form small rises.

Lithology

The Limpopo depression is almost entirely formed by the granitized part of the basement complex. The Waterberg formation is composed of sandstone and conglomerate. In the centre and toward the south the Stormberg basalt overlies the Precambrian rocks. The Transvaal plateau basin is composed of granite, norite and felsite, overlain occasionally with Waterberg sandstone and lower and upper Stormberg sandstone and basalt. The Low Veld is formed on the old granite and the Swaziland system, and is composed of quartzite, shale and ironstone. The Lebombo range consists of basalt which is partly overlain with rhyolite and andesite. The Kaap plateau and the Transvaal system consist of dolomite and quartzite. The Witwatersrand system is composed of Precambrian quartzite, phyllite, slate and some quartz schist and banded ironstone.

25. Karroo system

Geology

The Karroo system originally covered most of the southern and central parts of Africa, from the Cape to the Congo basin. The greater part has since been denuded but still attains a thickness of 7 500 metres in South Africa. The age of the Karroo system varies from Carboniferous to lower Jurassic and the deposits rest with unconformity on the basement complex. The Karroo system, like the Nubian sandstone and the *continental intercalaire*, consists of continental deposits. Accumulated under conditions varying from glacial to arid, the Karroo sediments are the products of prolonged erosion of the basement complex, and their deposition was not continuous. The Karroo system covers the greater part of the High Veld, the southern part of the Middle Veld, the northern part of the southern Cape region and the eastern Cape-Natal uplands.

The Basuto highlands consist of upper Karroo lava beds. The summit plateau of the highlands rises to an altitude of 2 500 to 3 000 metres and presents a modified Gondwana landscape.

The upper Stormberg basalts of the Basuto highlands are surrounded by the lower Stormberg series, which are of upper Triassic age and consist of the debris of the Cape folded belt. These are in turn succeeded by the Beaufort series (upper Permian-lower Triassic), which form the greater part of the surface of the High Veld. The northern and eastern edges of the High Veld are occupied by the lower Permian Ecca beds.

In the southern Cape region the Great Karroo occupies a position between the Cape folded belt and the edge of the Great Escarpment. The Great Karroo consists of the Beaufort series. A narrow band of Ecca beds is exposed only at the southern edge.

The eastern Cape-Natal uplands are also found below the Great Escarpment and form a rolling, remarkably uniform landscape. They mainly consist of the Beaufort and Ecca beds which are sometimes intruded with dolerite and form table mountains and " kopjes " (inselbergs). Along the coast in Natal the basement complex and blocks of nearly horizontal Table Mountain sandstone are exposed.

Lithology

The Karroo system contains the Dwyka, Ecca, Beaufort and Stormberg series. The Dwyka series consist of two layers of clayey schist separated by a 150- to 400-metre-thick layer of tillite. The lower schists include clayey schists with intercalations of sandstone. The Dwyka tillite, exposed all around the Karroo basin, contains many pebbles and big blocks. The upper schists represent a change in the sedimentation process and a diminishing glacial influence. The lower Ecca series consist of clayey schist overlain by sandstone. The upper beds are an alternation of sandstone, clayey schist, and coal measures.

The Beaufort series are composed of sandstone with minor clayey schist and shale. The lower Stormberg consist of (from old to young): (*a*) the Molteno beds (sandstone, clayey schist and coal measures); (*b*) the red beds (sandstone and shale); (*c*) the Cave sandstone (white massive sandstone); and (*d*) the Drakensberg volcanics. The latter are composed mainly of basalt with some more acid igneous rocks such as gabbro, diorite, rhyolite and microgranite. The Eisenberg and Etaneno carbonatites are also believed to be part of this system.

26. Southern Cape ranges

Geology

The southern Cape ranges consist of two parallel mountain ranges running from east to west, while in the west the general trend is north-northwest. Folding took place during the post-Ecca (Permian) and pre-Cretaceous. During the upper Triassic and Jurassic the intermontane valleys were denuded to great depths. To the north the abundant debris from the rising mountain ranges was distributed in vast sheets as the lower Stormberg series. By the middle Cretaceous a landscape essentially like the present had been created.

As the mountain ranges do not lie parallel to the coastline, they are truncated at the coast, where numerous erosion terraces are found. Although they appear to have been subjected to marine erosion, they are sometimes covered with silcretes, an indication that the surface was originally part of a pediment. The Cape system consists of Table Mountain sandstone and the Bokkeveld and the Witteberg series. The western coastline is composed of the Malmesbury series, which are part of the basement complex.

Lithology

The Table Mountain series are mainly composed of sandstone and quartzite, although shale bands and one type of tillite occur. The Bokkeveld series are composed of shale and sandstone. Hard white quartzite is the dominant rock in the Witteberg series. Sandstone and shale also occur. The Malmesbury series are formed mainly of quartzite, slate and shale.

27. Southwestern Africa

Geology

Southwestern Africa comprises all the area west of the Kalahari basin. Inside the Great Escarpment it contains the greater part of the Cape Middle Veld and the southwestern African highlands. Outside the Great Escarpment are the Namib desert and the slopes of the western plateau. The "African" surface is developed throughout the Cape Middle Veld. The denudation of the valleys began during the Cretaceous and further deepening took place following the Miocene upheaval.

The southwestern African highlands consist of the Namaqua highlands (Namaqualand and Great Namaland) in the south, the Khomas highlands near Windhoek, the Damaraland plain and the Otavi and Chela highlands toward the north. With the exception of a granite area in the northwest, the structural character of the Namaqua highlands is determined by the Nama formation, which has a gentle eastward tilt.

Triassic basalts and Dwyka metamorphics outcrop in the extreme northeast but are generally covered by the sands of the Kalahari. The Khomas highlands are formed on upper Precambrian metamorphic rocks.

The Damaraland plain is formed on the basement complex, giving rise to an even plateau broken only by inselbergs of granite and gneiss or sandstone formations such as Mount Etjo and the Waterberg mountains.

The Otavi highlands in the north are composed of dolomitic rocks folded into well-marked ridges. Karst regions are found over most of this area. The Chela plateau is formed by the metamorphic Chela series. To the north the Benguela plateau mainly consists of the granitized metamorphic basement complex, and the presence of three distinct and widely distributed levels shows that repeated uplift of the Gondwana surface has taken place. The Benguela plateau rises gently toward the plateau edge in the west, where remains of the Oendolongo system form a hard protective covering. Outside the Great Escarpment only fragments of the Oendolongo system remain, forming isolated peaks and ridges. These fragments of the plateau testify to the regressive erosion which has taken place since the coastline was formed during the Cretaceous.

The highlands drop abruptly to the coastal terraces, forming a granite lowland which is bounded on the west by the Lunda axis, an ancient fault running from east to west which has been subjected to frequent arching. The Precambrian basement is covered by Cretaceous sediments and in the west is overlain with Tertiary deposits. The beds consist of two groups. The first, from early Cretaceous (Aptian) to Miocene age, was intensely folded and faulted during the middle Tertiary uplift, which brought the "African" erosion cycle to a close. After erosion, the truncated folds were covered by a series of Pliocene beds, which also were uplifted.

These deposits also occur from the Cabinda district of Angola to Libreville. The Mayombé mountains are composed of the late Precambrian Mayombé system and are strongly metamorphosed. The folded layers have a general south-southeast to north-northwest orientation.

The Chaillu massif forms the northern boundary of the southwestern African region. The massif consists of the granitized pre-Mayombé system and is bordered by a system of parallel ranges and depressions developed on the Mayombé system.

The southern Namib has been entirely covered by sand. Northwest of Windhoek the Kaokoveld forms an intermediate terrace about 150 km wide composed of horizontal Karroo system deposits, the upper level of which comprises the upper Stormberg series.

Toward the north and along the coast the northern Namib is covered with alluvial and aeolian deposits originating from the weathering of Tertiary and Cretaceous deposits.

Lithology

In the Cape Middle Veld the pre-Karroo Nama beds are composed of dolomite and limestone overlying quartzite. In the Namaqua highlands the Nama beds consist of basal quartzites and grits overlain with limestone, quartzite and shale. The Chela series consists of quartzite interbedded with limestone. The Oendolongo system is composed mainly of quartzite and ironstone. Near Lunda the Cretaceous deposits consist of sandstone and limestone and in the west are overlain with Neogene sandy limestone and dolomite.

The Mayombé system consists of crystalline schist, quartzite, greenstone and intrusives such as granite and diorite. The pre-Mayombé system on the Chaillu massif is composed of gneiss, granite, migmatite, quartzite, micaschist and amphibolite.

The Namib consists of the Precambrian granitized and migmatized part of the basement complex and upper Precambrian limestone and dolomite. The upper Stormberg series in the Kaokoveld are composed of rhyolite and quartz porphyries.

28. Kalahari basin

Geology

The Kalahari basin was formed by the uplifting of the surrounding highlands. Its basal structure is an ancient plain upon which terrestrial Cretaceous sediments accumulated upon a Gondwana erosion surface. The basin consists of three major internal drainage basins: the Etosha pan in the northwest, the Okavango basin in the north and centre and the Molopo-Nossob basin in the south, which once drained to the Orange river.

Although in places the Kalahari sand is obviously of fluvial origin, it was deposited on the basin floor by wind transportation under desert conditions. It is possible that the sand originated from the lower Stormberg sandstone, but most of it comes from the Kalahari itself. The Kalahari system consists of three groups. The basal group consists of the Botletle deposits. It is overlain by the Kalahari limestone group (e.g. the floor of Etosha pan), which in most places is covered by a mantle of sand which almost completely hides the underlying rock. In some places the Kalahari sands are 100 to 150 metres deep. The Kalahari system rests on the late Cretaceous erosion surface and predates the upper Pliocene levelling. It constitutes the equivalent of the *continental terminal* of northern and equatorial Africa.

On the eastern border of the Kalahari basin south of the Makarikari pan Triassic basalts underlie the sand deposits, which cover an extensive area and are very shallow and even absent in some places. Basement rocks are exposed in the north at the Congo-Zambezi watershed, especially by regressive erosion of the tributaries of the Lulua and Kasai rivers.

Lithology

The Botletle beds are composed of chalcedonic sandstone and grits. The Kalahari limestone group consists of limestone with calcareous sandstone and pipe sandstone overlain with salt, marl and calcareous tuff.

There are several types of Kalahari sand. The most common are the red sands, in which a red pellicle of iron oxide coats the grains, and the white sands in which the grains have a lime coating. The grains are mostly of quartz, but feldspar, epidote, chalcedony and mica also occur. The sand deposits have many accretions of calcrete, silcrete and ferricrite.

29. Congo basin

Geology

The occurrence of Karroo-age sediments in the Congo basin indicates that its formation began during the Palaeozoic as a downwarp in the Precambrian floor, despite the fact that there was probably no real basin at the time of deposition. During the upper Mesozoic the basin-forming process was well established, and the subsequent uplift of the surrounding highlands with an increasing tilt toward the basin brought renewed deposition. The Precambrian rocks forming the bottom and edge of the basin are only locally and lightly folded. Only toward the southeastern edge of the basin is the middle Precambrian strongly folded and metamorphosed. The base is formed by a Carboniferous tillite which may be correlated with the Dwyka series. The Triassic and Jurassic Lukuga series overlying the Carboniferous in the west may be correlated with the lower Stormberg. Toward the west the Congo basin is bordered by metamorphic lower Precambrian rocks and by the cuestas of the sandstone Bateke plateau. The plateau has a mean altitude of 600 metres which decreases toward the south. It is composed of lower Cenozoic polymorphic sandstone. Toward the north and east the basin is bordered by upper Precambrian sandstone.

In the basin the Precambrian rocks are covered by sediments which consist of continental deposits ranging from Palaeozoic to recent age and are believed to be 3 500 metres thick. They comprise the Karroo beds, *continental intercalaire*, *continental terminal* and the Quaternary sediments, which cover a 150 000 km² alluvial plain in the centre of the basin.

Lithology

The Carboniferous is composed of a tillite containing shale, slate and sandstone. The Lukuga series consist of sandstone.

The *continental intercalaire* is a 100-metre-thick sand deposit which is mostly silicified. It consists of layers of fine-grained quartz and chalcedony which are often very hard. At the base a conglomerate occurs. The ochre plateau sands are slightly consolidated or non-consolidated. The sands in the lower level are often calcareous and the base is formed by a calcrete.

In the centre of the Congo basin the Quaternary deposits are of fluviatile and lacustrine origin. They are often covered with a Pleistocene duricrust. Recent alluvial deposits are found along the main streams.

30. Madagascar

Geology

The Madagascar surface consists of an eastern crystalline mass mainly composed of the Precambrian basement complex, and a western sedimentary zone. The basement complex occupies the largest surface area, forming a dissected, rolling plateau with a summit level formed by the remnants of an old erosion surface. Extensive peneplains lie at the border of the basement complex. In the sedimentary zone there are many cuestas with an eastern trend.

It is believed that Madagascar was separated from Africa by late and post-Karroo tectonic disturbances after the break-up of Gondwanaland. The oldest basement rocks are these of the Androyan system, which forms the surface in southeastern Madagascar. The middle Precambrian Graphite system forms the basement over most of central and northern Madagascar, and is overlain in several places with the Vohibory system and the Cipolin and Quartzite series. Generally, the Graphite system is extremely metamorphosed and migmatized and is heavily intruded with granites. These intrusions, which are now exposed over extensive areas, are partly of upper Precambrian age. The Vohibory system consists in origin of sedimentary and effusive rocks, being intensely metamorphosed and granitized. The Cipolin series consist of 300-1 000 metre thicknesses of upper Precambrian sediments and outcrop near Antsirabe, where they are surrounded by the final Precambrian Quartzite series. Both strata are slightly metamorphic.

The crystalline mass of Madagascar is bounded on the southwest by a narrow band of the Sakoa group of Permian continental deposits which corresponds in age and facies with the Dwyka series and also contains a tillite. To the west the Triassic Sakamena and Isalo groups form a long zone with continental deposits in the south and marine deposits in the north left by an invasion of the sea. The continental facies includes Beaufort beds and Cave sandstone, as found in southern Africa.

The Triassic is bounded on the west by a band of Jurassic marine deposits and in the south by marine and continental deposits which are in turn overlain by Cretaceous marine rocks. The basaltic lavas south of Majunga and Maintirano are also believed to be Cretaceous. Eocene sediments border the Cretaceous over an extensive area in southwestern Madagascar.

The Ambre massif south of Diego Suarez and the Ankaratra massif in central Madagascar are Neogene volcanic massif formations where volcanism has continued into recent times.

Lithology

The Androyan system is composed of paragneiss, leptite, pyroxenite and cipolin. The Graphite system consists of migmatite, gneiss and granite with graphite layers. The Vohibory system contains paragneiss, micaschist, cipolin, serpentinite, migmatite, charnokite and amphibolite. The Cipolin series comprise crystalline and dolomitic limestone. The Quartzite series consist of quartzite and minor schist. The Sakoa group is composed of schist, slate and shale, as well as some tillite and coal measures. The Sakamena and Isalo groups are composed of shale and grits, and soft sandstone, respectively. The continental Jurassic and Cretaceous deposits are sandstone, while limestone and marl predominate in the marine facies. The Eocene sediments are limestone and marl with a little sandstone. The Cretaceous volcanic rocks are basalts. The Plio-cene-Pleistocene effusives are basalt, andesite and trachyte. In the Ankaratra massif the basaltic sheets overlie Pliocene (?) domes of trachyte and rhyolite. Recent alluvial deposits occur along the south and west coasts.

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5. THE SOILS OF AFRICA

Table 3 gives the composition of the soil associations, the area of the associations in thousands of hectares, the climate symbol,[1] the country of occurrence and the natural vegetation and lithology of the association area.

The information on vegetation and lithology is taken from Figures 2 and 5. It is therefore very general and is not meant to determine the exact relationship between pedogenesis and a particular type of soil or soil association.

Distribution of major soils

This chapter serves as an introduction to the following chapter on land use and soil suitability and presents a general picture of soil distribution based on 53 broad soil regions.

The soil regions indicated in Figure 6 at the back of this volume are numbered arbitrarily. Although they roughly correspond to the major ecological regions, their limits do not necessarily coincide with those of the regions under which vegetation, climate, geomorphology and geology are discussed because soils are a synthesis of all these factors.

This soil grouping is useful for interpreting the map in an overall way, and especially for specifying the use and suitability of the major regions where the climate, vegetation, parent rock and relief which determine pedogenesis and agricultural production are known.

Broad soil regions

Region 1. In the coastal region of northern Africa the presence of limestone, the dry summer season and the steep relief have produced dominant Calcic and Chromic Cambisols, Chromic Luvisols and Calcic Kastanozems, as well as some Rendzinas under brush cover. Orthic and even Albic Luvisols occur in the high, better watered, forested and therefore more strongly leached regions. Calcaric Fluvisols, Vertisols and some saline soils occur in low-lying zones.

Region 2. Rainfall is appreciably lower on the high plateaus and in the Libyan coastal zone, and the cold is notably more intense on the plateaus. Vegetation is of the steppe type. The Calcic and Gypsic Xerosol and Yermosol dominants are associated with Rendzinas, Chromic Luvisols and Vertisols, and calcareous and gypseous crusts are frequent. There are Calcaric Fluvisols in low-lying areas, and especially Solonchaks in the chotts.

Region 3. Extreme aridity and erosion prevent soil formation and produce many thin and very stony Lithosols and Yermosols. Calcareous flagstone outcrops frequently. Vegetation is rare in this hamada region. At the foot of the sterile plateaus there are some valleys of Calcaric Fluvisols which are suitable for oases, but they occur with saline soils.

Region 4. The great ergs of the Sahara are composed mainly of vegetationless shifting dunes, but there are also consolidated dunes. Calcaric Regosols occur especially in the northern Sahara, and Eutric Regosols in the south.

Region 5. Very stony Lithosols and Yermosols are dominant and soilless rock debris, shifting dunes and saline soils occur in places. This region differs from Region 3 in its non-calcareous parent rock.

Region. 6. The regs are mostly occupied by very thin pebble-covered Yermosols. There are often Lithosols, consolidated dunes (Eutric Regosols), shifting dunes and frequently Takyric Solonchaks.

Region. 7. This part of the Sahara (Libyan and Egyptian deserts) is also occupied by very thin Yermosols, as well as reg desert with Lithosols, but is highly calcareous, gypseous and saline.

Region 8. The Qattarah depression in the middle of the preceding zone is largely composed of Solonchaks and Solonetz.

Region 9. Calcic Fluvisols predominate in the Nile valley and are sometimes slightly saline. They become true Solonchaks in the delta. On either

[1] According to the Papadakis system. See the section on climate in Chapter 4 and J. Papadakis, *Climates of the world and their agricultural potentialities*, Buenos Aires, 1966.

side of the valley the colluvia and even alluvia of the small affluents are very stony.

Region 10. Typically composed of exposed rocks, rock debris and Lithosols, this region has only a few dried-up river beds and some depressions with stony Fluvisols and Regosols. The lower-lying coastal zone contains Yermosols and saline soils.

Region 11. In the Saharan mountain region comprising the Ahaggar, the Aïr and the Tassilis, rocks and vertical walls form a highly indented relief; rocky accumulations are frequent on slopes. The terrain is mainly composed of rock debris and Lithosols, but a few Regosols and Fluvisols in the valleys and a little water sustain oases.

Region 12. This complex desert region consists of rocks, consolidated dunes (Regosols), Yermosols with some shifting dunes and saline soils.

Region 13. These semiarid areas in Mauritania, Senegal, Mali, Niger and Sudan are still under the influence of the Sahara; they are very sandy, but climatic factors already allow some soil development. Cambic Arenosol dominants, often developed from ancient consolidated and fairly rubified dunes, occur with Calcaric Cambisols and Eutric Regosols which are perhaps derived from superficial reworking of ironstone crusts, the residue of a formerly more humid climate. In Niger leaching appears to be a little more intense and furrowed soils (Luvic Arenosols) seem to be dominant. Saline soils are also more frequent in the depressions, particularly along Lake Chad and the Bahr al-Ghazal valley.

Although they still belong to the semiarid zone, the following three regions are somewhat different.

Region 14. Saline and sodic alluvia have accumulated at the foot of the Darfur mountains and on the edge of the Chad basin, producing Solonetz, Planosol and Solonchak dominants.

Region 15. Although they suffer somewhat from sand encroachment, the Darfur and Ennedi mountains have produced Lithosols, Regosols and, toward the south, Eutric Cambisols and Chromic Luvisols. There are also many Calcaric Fluvisols in the valleys.

Region 16. This region is low-lying, but rocky outcrops are frequent; soils tend to be Xerosols as they carry some vegetation.

Region 17. This vast peneplain region extending from Senegal to the northern part of the Central African Empire receives fairly abundant summer rainfall. The dominant soils are Ferric Luvisols and their hydromorphic variants, Gleyic and Plinthic Luvisols. Incipient ironstone concretions and ancient iron deposits are frequent and are often topped by Regosols. The low-lying parts have Vertisols and Planosols. There are some Fluvisols, but Gleysols are dominant along the rivers, especially in the inner delta of the Niger.

Region 18. The low-lying alluvial region of the Logone and Chari rivers comprises many Eutric Fluvisols as well as Vertisols and Gleysols and, toward Chad, Sodic Planosols. There are often patches of Ferric or Gleyic Luvisols on the low plain.

Region 19. Vertisols predominate in these areas, especially in Sudan. In Chad they are associated with Ferric Luvisols and Ferralic Arenosols. In Sudan Gleysols are especially abundant in the marshes of the upper Nile.

Region 20. This region is determined on the basis of relief and basaltic parent rock. The moister southern part of the Ethiopian massif consists of red and fairly deep Eutric Nitosol dominants associated with Humic Cambisols, Vertisols, Ferralsols and Acrisols. Toward the north the drier climate gives rise to thinner soils, mostly Cambisols with some Regosols, Acrisols and Xerosols. Recent volcanism in the Awash fault has produced lava which carries Andosols; the valley itself is occupied by Xerosols, Fluvisols, Vertisols and saline soils.

Region 21. In the Danakil plain there are many Lithosols and Regosols with basaltic rock outcrops under a desert climate, but all depressions are occupied by Solonchaks, Solonetz and even large vegetationless saline areas. There are also some areas of non-saline Calcaric Fluvisols. The coastal strip contains Regosols and saline soils.

Region 22. The northwestern part of Somalia receives some rainfall and has Calcaric Cambisols, Rendzinas and even Chromic Luvisols. Along the coast there are consolidated calcareous dunes (Calcaric Regosols), Solonetz and Solonchaks. The rest of Somalia, about which little is known, is covered mainly by Xerosols and Yermosols with many calcareous and especially gypseous crusts. Very thin and stony Calcaric Regosols occupy the eastern and southern parts of this region. Northeastern Kenya belongs to the desert zone of Yermosols, Xerosols and Solonchaks.

Region 23. This is the best watered, most interesting part of Somalia. Vertisols are numerous but there are also many Solonetz, some Calcaric Fluvisols, both shifting and consolidated dunes and Cambic Arenosols. Red Eutric Nitosols have the appearance of paleosols. There are Chromic Luvisols which quickly become Ferric Luvisols further south.

Region 24. This semiarid region is covered with Eutric and Calcaric Regosols associated with Xerosols and immature lithic soils. Some Fluvisols, Vertisols and Solonchaks occur in the valleys.

Region 25. This region is noteworthy for its abundant ironstone crusts and concretions with Ferric, Gleyic and Plinthic Luvisols and immature soils (Dystric Regosols).

Region 26. These areas are characterized by red or yellowish sandy soils, i.e. Ferralic Arenosols developed from Carnot, Ouadda and Fouroumbala sandstones.

Region 27. This is a typical zone of Orthic, Xanthic, Rhodic and Plinthic Ferralsols. However, Nitosols, Acrisols and even Ferralic Cambisols also occur on young peneplains. Dystric Gleysols predominate in low-lying areas.

Region 28. Ferric, Orthic and Plinthic Acrisols predominate in this transition zone between Ferric Luvisols and Ferralsols. In the Fouta Djallon these dominants are associated with Ferralsols. The petroferric phase occurs frequently in the Fouta Djallon and in northern Ivory Coast.

Region 29. The heavy rainfall of the Guinean climate produces Orthic and Plinthic Ferralsols on the Precambrian basement and Xanthic Ferralsols on the coastal strip. The petric phase is well represented and often merges with the stoneline of reworked soils. Thionic Fluvisols, Gleysols and some dune-type sandy Regosols occur on the low-lying swampy coast.

Region 30. In this region the very sandy Tertiary and Pleistocene sediments of the Congo basin and the recent and Cretaceous sediments of the Douala basin have given rise to Xanthic Ferralsols, and to Arenosols under a very rainy and warm climate.

Region 31. Drainage conditions on the bottom of the Congo basin are very poor, producing Dystric, Humic and Plinthic Gleysols, Histosols, some patches of Xanthic Ferralsols and recent alluvia (Dystric Fluvisols).

Region 32. Old to recent river and coastal deposits explain the presence of Ferralic Arenosols, Xanthic Ferralsols, Dystric Gleysols and Dystric Fluvisols on the coasts of Equatorial Guinea, Gabon, Congo and the Cabinda district of Angola.

Region 33. This region is much drier and the dominant soils are Ferric Luvisols, Eutric Cambisols, Haplic Xerosols and Regosols, especially in the south. The coastal rivers deposit Eutric Fluvisols which are sometimes rather saline.

Region 34. Ferralsols predominate, but erosion acting on a strongly undulating region has given rise to colluvial soils, i.e. Ferralic Cambisols and Nitosols. In the south Xanthic and Plinthic Ferralsols have resulted from poor drainage due to a flatter relief.

Region 35. The sands of the Kalahari constituting the substratum of this region are covered with Ferralic Arenosols, Regosols and some Podzols. The least sandy parts are Xanthic Ferralsols. Valley slopes have Dystric Nitosols.

Region 36. In this region the Kalahari sands have given rise to less mature Cambic Arenosols, but poor drainage produces various Gleysols and Gleyic Podzols.

Region 37. This large region of Orthic and Rhodic Ferralsols and Dystric Nitosols is a continuation of Region 27 and also borders the Congo basin.

Region 38. The region of the great lakes is very complex. Recent volcanism has produced Andosols. The raised edges of the Great Rift valley have Humic Nitosols, Lithosols or Eutric Cambisols and the drier Rift floor has Vertisols and Solonetz. Ferralsols and Acrisols are closely associated in the area between the Rift and the rainier Lake Victoria. The drier zone southeast of the lake has Vertisols, Calcaric Cambisols and even Rendzinas. The depressions in the best watered part are occupied by Humic Gleysols, and in the drier part by Eutric Fluvisols.

Region 39. The northern plain region is occupied by Ferric Luvisols and some Vertisols, and the southern plain region by Ferric and Plinthic Acrisols and some Gleysols.

Region 40. This transitional region has highly varied climates and a wide range of soils (Vertisols, Planosols and Eutric Fluvisols) in the valleys and plains. Some very stony Chromic Cambisols are found in the eroded highlands and Ferric Acrisols occur in the rainier hills to the south. There are also Dystric Nitosols, Orthic Acrisols, Dystric Regosols, Ferralic Arenosols and even Orthic Ferralsols, which occur in Region 41.

Region 41. This region is mainly characterized by Rhodic and Orthic Ferralsols on the very rainy highlands, Ferric Luvisols in the lower and drier parts and Vertisols, Fluvisols, Regosols and some mangrove soils on the coast.

Region 42. In the north of this region are the lithosolic Muchinga mountains, in the central part there are Chromic Luvisols, and Ferric Luvisols predominate in the south. The basaltic dykes carry Eutric Nitosols. The higher and therefore better watered regions along Lake Malawi (Lake Nyasa) and the Mozambique frontier have Rhodic and Orthic Ferralsols.

Region 43. The Sul do Save and the Mozambique plain in general are characterized by aeolian and fluvial deposits of Tertiary and Pleistocene age which have given rise to large sandy areas of Cambic and Luvic Arenosols. The deltas of the Zambezi and Limpopo rivers consist of Eutric Fluvisols with Solonchaks. Large areas of Vertisols occur at the edges of this sandy plain.

Region 44. Luvisols (Calcic in the north, Chromic in the centre, Orthic and Chromic in the south) and Vertisols predominate in this region. Rhodic Ferralsols occur on the windward scarp of the plateau which receives rainfall.

Region 45. Apart from the mountains of Lesotho, which carry Lithosols, Cambisols and Luvisols, the western and southern parts of this region are characterized by large areas of Planosols, often sodic, and Solonetz.

Region 46. The soils of the Kalahari desert proper are mainly Cambic Arenosols, but sand leaching is intense in the depressions, producing even Albic Arenosols with deep-lying duripans. The less sandy and often alluvial areas carry Calcic Xerosols, Vertisols and Solonchaks.

Region 47. This region is mainly occupied by stony Calcic Xerosols with rock outcrops and Lithosols.

Region 48. In this desert region Gypsic and Calcic Yermosols often occur with a petrogypsic phase. South of Walvis Bay there are semiconsolidated dunes (Eutric Regosols) and shifting dunes.

Region 49. The Cape region is characterized by the soils typical of its Mediterranean-type climate, i.e. Chromic Luvisols. Along the coast ancient dunes are composed of Albic Arenosols with interdune Solonetz and Solonchaks.

Region 50. Exposed to the trade winds, the most humid part of this region is occupied mainly by Rhodic Ferralsols on basic rocks. Xanthic Ferralsols generally occur in ancient alluvia, and Ferralic Cambisols on steep slopes in association with rock outcrops. Outlier plateaus of ancient peneplains carry Plinthic Ferralsols with a petroferric phase, i.e. ironstone crusts.

Region 51. These areas are drier and very complex because of the variety of parent rocks. The main soils are Ferric and Chromic Luvisols and Chromic Cambisols, and Ferralic and Dystric Cambisols also occur on the slopes of the high plateaus and in general in all regions where erosion prevents soil formation. The valleys, which are very suitable for cultivation, contain Eutric Fluvisols. Eutric Nitosols occur on basaltic outcrops and Calcic Cambisols and Calcaric Regosols on sedimentary limestone.

Region 52. This region is characterized by large sandy expanses of Cambic Arenosols, but the river valleys are occupied by Calcaric Fluvisols, and their deltas by Solonchaks and Thionic Fluvisols.

Region 53. The calcareous plateaus of this karstic region carry Lithosols and Calcic Cambisols as well as some Chromic Luvisols and Cambic Arenosols.

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Af1			petric	924	Nigeria	1.482. 1.46.*	2a. 4a. 4c**	Precambrian (Dahomeyan): schist. quartzite. syenite. dolerite
Af1			petric	75	Cameroon	1.46	4a. 4c	Precambrian (Dahomeyan): schist. quartzite. syenite. dolerite
Af1-1/2a				269	Ghana	1.31	2a	Basement complex: orthogneiss. paragneiss. granite. micaschist. quartzite. Precambrian (Birrimian): schist. phyllite. grauwacke. sandstone. greenstone
Af2	Li	I		180	Ghana	1.42	4a. 4c	Basement complex: orthogneiss. paragneiss. granite. micaschist. quartzite. Voltaian: sandstone. shale. conglomerate. dolomitic limestone. schist
Af2	Lf	I		77	Nigeria	1.532	4e	Cretaceous sandstone and marl
Af2-2a	Lf	I		5 344	Guinea	1.483. 1.73. 1.132. 1482	4a. 4c	Basement complex: granitic gneiss. schist. quartzite: granitic batholiths
Af2-2a	Lf	I		377	Ivory Coast	1.482. 1483	2a	Basement complex: granitic gneiss. schist. quartzite: granitic batholiths
Af2-2a	Lf	I		32	Mali	1.483	4a. 4c	Basement complex: granitic gneiss. schist. quartzite: granitic batholiths
Af3-1/2a	Ap Fr	Gp Qf		16 299	Tanzania	1.812. 1.85	2c	Basement complex: orthogneiss. granite. migmatite. amphibolite. schist. quartzite
Af4-a	I Nd		petric	189	Nigeria	1.482	4a. 4c	Precambrian (Dahomeyan): schist. quartzite. syenite. dolerite
Af5	Ao Nd			554	Mali	1.484	4a. 4c	Basement complex: granitic gneiss. schist. quartzite: granitic batholiths
Af5	Ao Nd			604	Ivory Coast	1.483	4a. 4c	Basement complex: granitic gneiss. schist. quartzite: granitic batholiths
Af5	Ao Nd			30	Guinea	1.483	4a. 4c	Basement complex: granitic gneiss. schist. quartzite: granitic batholiths
Af5-1/2a	Ao Nd		petric	836	Liberia	1.132. 1.471	1a	Basement complex: granitic gneiss. schist. quartzite: granitic batholiths. Precambrian (Birrimian): schist. quartzite. greenstone
Af5-1/2a	Ao Nd		petric	3 196	Ivory Coast	1.132. 1.131. 1.122	1a	Basement complex: granitic gneiss. schist. quartzite: granitic batholiths. Precambrian (Birrimian): schist. quartzite. greenstone
Af12-1/2a	Ag Ap	I		1 162	Nigeria	1.46. 1.482	2a	Cretaceous dolomitic limestone. shale. sandstone
Af12-2b	Ag Ap	I		326	Nigeria	1.74	2c. 4a. 4c	Basement complex (Gwarian): granitic gneiss. micaschist. amphibolite. migmatite: granitic batholiths: basic effusive rocks: basalt. andesite
Af13-1a	Ap I			501	Nigeria	1.46. 1.482	2a	Cretaceous sandstone. shale
Af14-3c	Be I			478	Ethiopia	2.32. 1.843	1d. 4f	Trap series: basalt. phonolite. nephelinite. trachyte. rhyolite. pyroclastics

* According to Papadakis system (see Table 2 and climatic map).
** See chapter on vegetation and broad vegetation regions map.

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Af15	Ql Re	Lg	petric	305	Nigeria	1.532	4e	Cretaceous sandstone, marl
Af16-1/2b	Nd	Ag	petric	127	Ivory Coast	1.122	1a	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths
Af17-1/2ab	Lg	G I		3 081	Central African Empire	1.42, 1.414, 4.32, 1.483	2c, 4a, 4c	Precambrian: granitic gneiss, migmatite, schist, quartzite, syenite, dolerite; granitic batholiths; in the west partly overlain with *continental terminal:* poorly consolidated sandstone, shale, marl
Af18-1a	Ao Lp	I		285	Ivory Coast	1.411, 1.412	2a	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths
Af23-2a	Bf	Ag	petric	740	Ivory Coast	1.134	1a	Precambrian (Birrimian): schist, quartzite, greenstone
Af24-2a	Bf Fr	I		1 481	Ivory Coast	1.131, 1.134	1a	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths
Af25-1a	Bf	G I		85	Ghana	1.134	1a	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths
Af25-1a	Bf	G I		329	Ivory Coast	1.134, 1.122	1a	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths
Af26-a	Bf			108	Ivory Coast	1.134	1a	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths
Af27	Bf	I		237	Ivory Coast	1.131	1a	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths
Af27-1ab	Bf	I		76	Ivory Coast	1.131	1a	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths
Af28	Ap	Fr	petroferric	130	Ivory Coast	1.411, 1.483	4a, 4c	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths
Af28-a	Ap	Fr	petroferric	2 044	Ivory Coast	1.131, 1.482, 1.411, 1.412	1a, 2a	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths. Precambrian (Birrimian): schist, quartzite, greenstone
Af29-1/2a	Ap Ql		petroferric	854	Ivory Coast	1.483	4a, 4c	Basement complex: granitic gneiss, schist, quartzite, biotite, apatite, norite; granitic batholiths
Af30	I Lf			972	Ivory Coast	1.482, 1.483	4a, 4c	Basement complex: granitic gneiss, schist, quartzite, biotite, apatite, norite; granitic batholiths
Af31	Bf I			301	Nigeria	1.532	4c	Cretaceous sandstone, shale
Af31-2b	Bf I			1 159	Central African Empire	1.483	4a, 4c	Basement complex: granitic gneiss, mica-schist, migmatite; granitic batholiths
Af31-2b	Bf I			42	Chad	1.483	4a, 4c	Basement complex: granitic gneiss, mica-schist, migmatite; granitic batholiths
Af32-1/2a	Ap	Gp Vp I	lithic	71	Kenya	1.811	4a, 4c	Basement complex: orthogneiss, granite, migmatite, amphibolite, schist, quartzite

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Af32-1/2a	Ap	Gp Vp I	lithic	1 061	Tanzania	1.811	4g, 4a, 4c	Basement complex: orthogneiss, granite, migmatite, amphibolite, schist, quartzite
Af32-1/2b	Ap	Gp Vp I		315	Tanzania	1.32	2c	Karroo: conglomerate, tillite, sandstone, siltstone, clay, sand. Tertiary: sandstone, limestone, mudstone
Af32-2ab	Ap	Gp Vp I		2 137	Uganda	1.72, 1.76, 1.811	2a, 4a, 4c	Precambrian: schist, gneiss, amphibolite, charnockite, quartzite, cipolin. Basement complex: orthogneiss, migmatite, granite, amphibolite and ultrabasic and basic igneous rocks; argillaceous and arenaceous sediments
Af33-1/2a	Ap Qf	Vp		759	Tanzania	1.812, 1.846	4g	Basement complex: orthogneiss, granite, migmatite, amphibolite, schist, quartzite
Af34-1/2a	Ap	Gp		441	Tanzania	1.812	2c	Basement complex: orthogneiss, granite, migmatite, amphibolite, schist, quartzite
Af35-1/2a	Lp	Gc	stony	658	Tanzania	1.811, 1.812	2c, 4g	Basement complex: orthogneiss, granite, migmatite, schist, quartzite
Af36-2a	Lf Vp		stony	189	Tanzania	1.811	2c	Basement complex: orthogneiss, granite, migmatite, schist, quartzite
Af37-1/2bc	Lf Qf			280	Tanzania	1.32	2c	Karroo: conglomerate, tillite, sandstone, siltstone, clay, sand. Tertiary: sandstone, limestone, mudstone
Af28-1/2ab	Qf	I Vp		882	Tanzania	1.32, 1.846, 1.85	4g	Precambrian: schist, gneiss, charnockite, quartzite, cipolin. Basement complex: orthogneiss, granite, migmatite, amphibolite, schist, quartzite
Af39-1/2b	Qf	I Je		148	Tanzania	1.846	4g	Precambrian: schist, gneiss, charnockite, quartzite, cipolin
Af40-2b	Ne	Vp		2 375	Tanzania	1.32, 1.843, 1.85	4g, 2a	Precambrian: schist, gneiss, charnockite, quartzite, cipolin
Af41-2bc	Ap Qf	Gp I		995	Tanzania	1.73	2c	Precambrian: schist, gneiss, charnockite, quartzite, cipolin
Af41-2bc	Ap Qf	Gp I		18	Zambia	1.73	2c	Precambrian: schist, gneiss, charnockite, quartzite, cipolin
Af42-1/2bc	Bf	Gp I		548	Tanzania	1.741	2c	Karroo: conglomerate, tillite, sandstone, siltstone, shale, clay
Af43-1/2bc	Qf	I	stony	4 211	Tanzania	1.32, 1.741, 1.843	2a, 2c, 4e	Karroo: conglomerate, tillite, sandstone, siltstone, shale, clay. Jurassic: shale, marl, sandstone
Af44-2b	Fo Qa	Nd O		32	Madagascar	1.123	1a	Precambrian: migmatite, granite, quartzite, amphibolite, diabase; coastal sediments
Ao1-ab				2 812	Ghana	1.131, 1.134	1a, 2a	Dahomeyan: schist, gneiss, quartzite. Birrimian: schist, phyllite, grauwacke, sandstone, greenstone

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Ao1-2b			petric	267	Central African Empire	1.77	4a. 4c	Basement complex: granitic gneiss. mica-schist. migmatite: granitic batholiths
Ao1-2b			petric	438	Cameroon	1.73	4a. 4c	Basement complex: granitic gneiss. mica-schist. migmatite: granitic batholiths
Ao7	Fo			1 062	Cameroon	1.72. 1.73. 1.77	1a. 2a. 4a. 4c	Basement complex: granitic gneiss. mica-schist. migmatite. quartzite: batholiths of granite. syenite. dolerite
Ao7-a	Fo			89	Cameroon	1.77	4a. 4c	Basement complex: granitic gneiss. mica-schist. migmatite: granitic batholiths
Ao7-ab	Fo			456	Ivory Coast	1.122. 1.134	1a	Precambrian (Birrimian): schist. quartzite. greenstone. grauwacke. sandstone: granitic batholiths
Ao7-ab	Fo			993	Ghana	1.121. 1.134	1a	Precambrian (Birrimian): schist. quartzite. greenstone. grauwacke. sandstone: granitic batholiths
Ao7-2a	Fo			572	Cameroon	1.72	1a	Precambrian gneiss
Ao10	Af I			85	Ivory Coast	1.411	2a	Basement complex: granitic gneiss. schist. quartzite: granitic batholiths
Ao10-a	Af I			642	Ivory Coast	1.482. 1.411	2a	Basement complex: granitic gneiss. schist. quartzite: granitic batholiths
Ao10-a	Af I		petric	196	Ivory Coast	1.134	1a	Precambrian (Birrimian): schist. quartzite. greenstone
Ao10-1a	Af I			89	Ivory Coast	1.412	1a	Precambrian (Tarkwaian): schist. quartzite. conglomerate. sandstone: granitic batholiths
Ao10-1a	Af I			3	Ghana	1.412	1a	Precambrian (Tarkwaian): schist. quartzite. conglomerate. sandstone: granitic batholiths
Ao11-b	I Nd			82	Ghana	1.131	1a	Basement complex: orthogneiss. paragneiss. granite. micaschist. quartzite: Voltaian sandstone
Ao13	I			269	Ghana	1.131	1a. 2a	Precambrian (Dahomeyan): schist. gneiss. quartzite and (Tarkwaian): schist. quartzite. conglomerate. sandstone: granitic batholiths
Ao13-a	I			36	Ghana	1.131	1a	Greenstone
Ao29-b	I	Bf		210	Ghana	1.131	1a	Precambrian (Birrimian): schist. phyllite. grauwacke. sandstone. greenstone: granitic batholiths
Ao30-a	Bf Nd	I		288	Cameroon	1.77	4a. 4c	Basement complex: granitic gneiss. mica-schist. migmatite: granitic batholiths
Ao39-2b	Bh			63	Ethiopia	1.77	4f	Precambrian: gneiss. schist. quartzite: granitic batholiths

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Ao41-2bc	Bd			403	Ethiopia	1.77, 1.8	5a	Precambrian: gneiss, quartzite, cipolin, andesite, conglomerate, argillite, rhyolite; granitic batholiths
Ao43-1b		I		301	Nigeria	1.482	4a, 4c	Basement complex (Gwarian): granitic gneiss, micaschist, amphibolite, migmatite; granitic batholiths
Ao45-2a	Af Bf			627	Ivory Coast	1.122	1a	Precambrian (Birrimian): schist, quartzite, greenstone
Ao46-a	Af Bf	Ag		589	Ivory Coast	1.411	2a, 4a, 4c	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths
Ao48-1a	Af Ap			190	Ivory Coast	1.483	4a, 4c	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths
Ao48-1a	Af Ap		petric	623	Ivory Coast	1.483, 1.411, 1.132	4a, 4c	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths
Ao49-ac	I Rd			335	Ivory Coast	1.483	4a, 4c	Basement complex: granitic gneiss, schist, quartzite, biotite, apatite, norite; granitic batholiths
Ao59-a	Af Qf Fr	Gh		589	Ivory Coast	1.134	1a	Precambrian (Birrimian): schist, quartzite, greenstone, phyllite
Ao59-a	Af Qf Fr	Gh		1 059	Ghana	1.131, 1.134	1a	Precambrian (Birrimian): schist, quartzite, greenstone, phyllite, grauwacke, sandstone
Ao59-1a	Af Qf Fr	Gh		873	Ivory Coast	1.131	1a	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths
Ao60	Af Nd	Fo		794	Ivory Coast	1.483, 1.482	4a, 4c	Basement complex and Precambrian (Birrimian): schist, quartzite, greenstone
Ao60	Af Nd	Fo		60	Guinea	1.482	4a, 4c	Basement complex and Precambrian (Birrimian): schist, quartzite, greenstone
Ao63-3b		Bd Jd		316	Ethiopia	1.77, 2.35	4b, 4f	Precambrian: gneiss, quartzite, cipolin, andesite, conglomerate, argillite, rhyolite; granitic batholiths. Trap series: basalt, phonolite, nephelinite, trachyte, rhyolite, pyroclastics. Jurassic: dolomite, limestone, marl, minor sandstone
Ao64-2bc	Fo	Fr I		1 633	Angola	1.35, 1.77	2c, 4a, 4c	Basement complex: granitic gneiss, migmatite, schist, quartzite; granitic batholiths. Precambrian: gneiss, schist, quartzite, dolerite, syenite: granitic batholiths
Ao65-1/2a	Nd	I	stony	630	Tanzania	1.32	2c, 4e	Precambrian: schist, gneiss, charnockite, quartzite, cipolin
Ao66-2ab	Ap Qf	I	duripan	1 194	Tanzania	1.812, 1.85	4g	Basement complex: orthogneiss, granite, migmatite, amphibolite, schist, quartzite
Ao67-2bc	Af Lf	Gp		753	Tanzania	1.134, 1.32, 1.36	2a, 2c	Cretaceous and Tertiary: sandstone, marl, sand, clay. Precambrian: schist, gneiss, charnockite, quartzite, cipolin

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Ao68-1/2ab	Af Bf	I	stony	441	Tanzania	1.32	2c	Karroo: conglomerate. tillite. sandstone. siltstone. clay. sand
Ao69-1a	Be I Lc			1 260	South Africa	1.62. 2.21. 2.26	2a. 7a	Precambrian: dolomite. quartzite. schist. conglomerate. Karroo: sandstone. clayey schist. shale. Palaeozoic: sandstone
Ap15-1a	Af I		petric	483	Nigeria	1.46. 1.482	2a	Cretaceous sandstone and shale
Ap16-2a	Af		petric	832	Ivory Coast	1.134	1a	Precambrian (Birrimian): schist. quartzite. greenstone
Ap17-2a	Af Fp		petric	351	Ivory Coast	1.134	1a	Precambrian (Birrimian): schist. quartzite. greenstone
Ap18-2a	Bf Fp		petroferric	848	Ivory Coast	1.412. 1.411. 1.134	1a	Precambrian (Birrimian): schist. quartzite. greenstone. phyllite. grauwacke. sandstone
Ap18-2a	Bf Fp		petroferric	26	Ghana	1.134	1a	Precambrian (Birrimian): schist. quartzite. greenstone. phyllite. grauwacke. sandstone
Ap20	Ag I	Be	petroferric	332	Ivory Coast	1.483	4a. 4c	Basement complex: granitic gneiss. schist. quartzite. biotite. apatite. norite: granitic batholiths
Ap20	Ag I	Be	petroferric	51	Mali	1.484	4a. 4c	Basement complex: granitic gneiss. schist. quartzite. biotite. apatite. norite: granitic batholiths
Ap22-2a	I Lf	Ql	petroferric	1 734	Ivory Coast	1.483. 1.411	4a. 4c	Basement complex: orthogneiss. paragneiss. granite. micaschist. quartzite. Precambrian (Birrimian): schist. quartzite. phyllite. grauwacke. sandstone. greenstone
Ap22-2a	I Lf	Ql	petroferric	111	Upper Volta	1.484	4a. 4c	Basement complex: orthogneiss. paragneiss. granite. micaschist. quartzite. Precambrian (Birrimian): schist. phyllite. grauwacke. sandstone. greenstone
Ap23-1/2a	Af I	Be Bf	petroferric	103	Mali	1.484	4a. 4c	Precambrian (Birrimian): schist. quartzite. greenstone
Ap23-1/2a	Af I	Be Bf	petroferric	1 095	Ivory Coast	1.483	4a. 4c	Precambrian (Birrimian): schist. quartzite. greenstone
Bc6-2ab	Lc			1 006	Algeria	6.163. 6.142	5b. 6d. 6e	Cretaceous and Miocene limestone: Eocene flysch deposits: Pliocene and Quaternary alluvial. lagoonal and lacustrine deposits
Bc6-2b	Lc			93	Algeria	6.141	5a	Oligocene: sandstone. granite. dacite
Bc7-2b	I Lc			165	Algeria	6.163	6d. 6e	Eocene flysch deposits and Pliocene lagoonal deposits
Bc7-2bc	I Lc		stony	1 711	Mozambique	1.929. 1.918. 3.22	2a. 4e	Karroo: basalt. andesite. rhyolite. Cretaceous and Tertiary: limestone. marl. calcareous sandstone
Bc7-2bc	I Lc		stony	1 369	South Africa	2.29. 2.23. 2.26. 1.9291. 3.22	2d. 4e	Karroo: basalt. andesite. rhyolite. Cretaceous and Tertiary: limestone. marl. calcareous sandstone. Precambrian: quartzite. phyllite. slate. schist. ironstone

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION *(continued)*

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Bc7-2bc	I Lc		stony	38	Rhodesia	3.22	2d	Cretaceous and Tertiary: limestone. marl. calcareous sandstone
Bc7-2/3b	I Lc			1 845	Mozambique	1.485. 1.533	2d. 4e	Cretaceous: limestone. marl. Basic effusive rocks: basalt. phonolite. nephelinite
Bc7-2/3b	I Lc			79	Malawi	1.533	2d	Cretaceous: limestone. marl: Basic effusive rocks: basalt. phonolite. nephelinite
Bc8-2b	Be I			139	Sudan	4.31	4g	Quaternary alluvial and lacustrine deposits
Bc9-2b	Vc			160	Sudan	4.31	4g	Quaternary alluvial and lacustrine deposits
Bc14-2bc	I Rd	Ap	stony	1 020	Kenya	1.33. 1.77. 2.31	4a. 4c. 4g	Tertiary-recent volcanics: basalt. phonolite. *nephelinite. pyroclastics. tuff. Precambrian*: schist. gneiss. amphibolite. charnockite. quartzite. cipolin
Bc14-2bc	I Rd	Ap	stony	2 387	Tanzania	1.32. 1.741. 1.812. 1.843. 2.31	2b. 2c. 4g	Precambrian: schist. gneiss. charnockite. quartzite. cipolin. Basement complex: orthogneiss. granite. migmatite. amphibolite. schist. quartzite
Bc15-2ab	Be	I	petrocalcic	891	Tanzania	1.846	4g	Tertiary-recent volcanics: basalt. phonolite. nephelinite. pyroclastics. tuff. Precambrian: schist. gneiss. charnockite. quartzite. cipolin
Bc15-2ab	Be	I	petrocalcic	147	Kenya	1.72	4g	Tertiary-recent volcanics: basalt. phonolite. nephelinite. pyroclastics. tuff
Bc16-2a	Bk	I Vp		504	Tanzania	1.812	4g	Basement complex: orthogneiss. granite. migmatite. amphibolite. schist. quartzite. shale. sandstone. conglomerate. phyllite
Bc16-2a	Bk	I Vp		91	Zanzibar Island (Tanzania)	1.12	2a	Neogene: marine sediments
Bc17-2bc	I R	Ne	stony	145	Mozambique	1.741	2c	Precambrian: schist. gneiss. charnockite, quartzite. cipolin
Bc17-2bc	I R	Ne	stony	4 548	Tanzania	1.73. 1.741. 1.812	2c	Precambrian: schist. gneiss. charnockite, quartzite. cipolin
Bc18-c	I Rd	Ao	stony	4 069	Tanzania	1.32. 1.741. 1.811. 1.843. 2.33	2c	Precambrian: shale. sandstone. conglomerate. phyllite. schist, gneiss, charnockite, quartzite. cipolin
Bc19-2a	Lc Lf	Kh Kl		2 863	Madagascar	1.574. 1.918. 2.14. 4.32	4g. 4c, 4e	Precambrian: migmatite. gneiss. pyroxenite. amphibolite. cipolin. wernerite: some granitic batholiths
Bc20-2a	Lc Qc	Re	petrocalcic	70	Madagascar	1.574	8a	Pliocene: sandstone. sand and clay often overlain with Quaternary sands
Bc21-2a	Bk		petrocalcic	47	Canary Islands	6.84	8c	Basic and some acid effusive rocks: basalt. trachyte. rhyolite
Bc21-2b	Bk			25	Canary Islands	6.892	4g	Basic and some acid effusive rocks: basalt. trachyte. rhyolite
Bc22-3a	I Lc	Vc		326	South Africa	4.41. 1.9291	4e	Karroo: clayey schist, sandstone. shale. arkose. basalt. andesite. rhyolite

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Bc22-3a	I Lc	Vc		235	Swaziland	2.21	4e	Karroo: clayey schist, sandstone, shale, arkose, basalt, andesite, rhyolite
Bd30-2/3c	Ao Lc	I	lithic	475	Ethiopia	1.843	1d	Precambrian: gneiss, schist, quartzite; granitic batholiths. Jurassic and Cretaceous: limestone, marl, sandstone, gypsum
Bd31-2c		Bh	lithic	61	Sudan	2.39	4b	Precambrian: gneiss, quartzite, cipolin, andesite, conglomerate, rhyolite: granitic batholiths
Bd31-2c		Bh	lithic	2 018	Ethiopia	1.533, 1.77, 2.32, 2.39	4f, 5a	Precambrian: gneiss, quartzite, cipolin, andesite, conglomerate, rhyolite; granitic batholiths
Bd33-2a	Lc Lf	Bc		3 734	Madagascar	1.21, 1.123, 1.462, 1.484, 1.73, 1.574, 1.918, 2.14, 2.25	4c, 2c, 4e, 4g	Triassic sandstone; Jurassic sandstone; Precambrian gneiss and migmatite; Permian schist
Be1				98	Nigeria	1.482	4a, 4c	Basement complex: granitic gneiss, micaschist, amphibolite, migmatite; granitic batholiths
Be1				30	Ghana	1.42	4e	Basement complex: orthogneiss, paragneiss, granite, micaschist, quartzite
Be1-b				11	Tunisia	6.1311	5a	Cretaceous limestone
Be1-b				80	Mali	1.532	4g	Cambrian: calcareous schist, quartzite, dolerite; recent alluvial deposits
Be3	I Vc			160	Mali	1.484	4a, 4c	Inselbergs of basic intrusives: dolerite, diabase
Be3	I Vc			73	Guinea	1.484	4a, 4c	Inselbergs of basic intrusives: dolerite, diabase
Be7-1b	I	G		69	Ghana	1.411	4a, 4c	Precambrian (Tarkwaian): schist, quartzite, conglomerate, sandstone; granitic batholiths; basic effusives: basalt
Be8-3c	Lc	I Vp	stony	609	Ethiopia	1.77, 2.32	4f	Trap series: basalt, phonolite, nephelinite, trachyte, rhyolite, pyroclastics
Be9-3c	Lc	Vp		10 739	Ethiopia	1.77, 1.843, 1.533, 2.21, 2.32, 2.35, 2.37	4b, 4f, 5a	Jurassic: dolomite, limestone, marl, minor sandstone. Trap series: basalt, phonolite, nephelinite, trachyte, rhyolite, pyroclastics
Be9-3c	Lc	Vp		54	Sudan	1.533	4b	Jurassic: dolomite, limestone, marl, minor sandstone. Trap series: basalt, phonolite, nephelinite, trachyte, rhyolite, pyroclastics
Be25	Bv	Vc Bg		11	Tunisia	6.171	5b	Oligocene sandstone and Eocene limestone
Be25	Bv	Vc Bg		568	Upper Volta	1.484	4a, 4c, 4e	Precambrian (Birrimian): schist, quartzite, greenstone
Be26	Bf			50	Upper Volta	1.484	4a, 4c	Greenstone
Be26	Bf			39	Mali	1.484	4a, 4c	Basic intrusive rocks: diorite, dolerite, gabbro

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Be26	Bf			32	Ivory Coast	1.484	4a, 4c	Acid intrusive rocks: granite, diorite
Be27	Re			141	Niger	1.534	4g	Greenstone
Be28	Ql Ws			178	Niger	1.534	4g	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths
Be28	Ql Ws			10	Upper Volta	1.534	4g	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths
Be28-1a	Ql Ws		sodic	297	Niger	1.534	4g	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths
Be30	Fr			110	Cameroon	1.483	4a, 4c	Precambrian (Dahomeyan): schist, quartzite, syenite, dolerite
Be42	Bv I	Ne		79	Ivory Coast	1.131, 1.132	2a	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths
Be42-2/3a	Bv I	Ne		234	Ivory Coast	1.411	4a, 4c	Precambrian (Birrimian): schist, quartzite, greenstone
Be42-2/3b	Bv I	Ne		231	Ivory Coast	1.483, 1.411	4a, 4c	Greenstone
Be42-2/3b	Bv I	Ne		44	Upper Volta	1.484	4a, 4c	Greenstone
Be45-2a	Th			173	Sudan	4.31	4g	Precambrian: schist, quartzite, syenite, dolerite
Be47-2a	Vp	Je		200	Ethiopia	1.77	5a	Quaternary lacustrine deposits
Be48-3c		Lc Vc	lithic	603	Ethiopia	1.77	4f	Jurassic: limestone, marl, gypsum. Quaternary: alluvial deposits
Be49-3c	Ao I	Vp	stony	2 062	Ethiopia	1.77, 1.85, 2.32	1d, 5a	Trap series: basalt, phonolite, nephelinite, trachyte, rhyolite, pyroclastics
Be49-3c	Ao I	Vp	stony	58	Kenya	2.31	4g	Tertiary-recent volcanics: basalt, phonolite, nephelinite, pyroclastics, tuff
Be50-2/3c		I Lc Vp	stony	388	Ethiopia	1.85, 3.11	4f	Trap series: basalt, phonolite, nephelinite, trachyte, rhyolite, pyroclastics. Quaternary: lacustrine deposits
Be51-2a	Bc Vc	Xk Zo Jc		1 961	Sudan	1.533, 1.534	4b	Nubian sandstone: sandstone, mudstone, clay, marl, conglomerate. Trap series: basalt, phonolite, nephelinite, trachyte, rhyolite, pyroclastics
Be51-2a	Bc Vc	Xk Zo Jc		903	Ethiopia	1.533	4b	Nubian sandstone: sandstone, mudstone, clay, marl, conglomerate. Trap series: basalt, phonolite, nephelinite, trachyte, rhyolite, pyroclastics
Be52-2/3a	Bc	Vp		153	Zaire	1.42	2a	Quaternary alluvial deposits
Be53-1/2a	Ge Gh	L R		999	Angola	1.73	2c	*Continental intercalaire:* sandstone, shale, conglomerate
Be54-2/3a	Vp	I Lf		745	Angola	1.34, 1.35, 1.574	4e	Neogene limestone and marl. Quaternary: alluvial, lagoonal and deltaic deposits

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION *(continued)*

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Be55-2/3ab	Vc	Ge Vp X		225	Angola	1.34, 1.35, 1.574	4e	Cretaceous and Neogene: sandstone, marl, limestone
Be56-2/3ab	Vc	Je X		44	Angola	1.574	4e	Cretaceous: sandstone, marl, limestone
Be57-2/3a	Xh	Lf Re Vc		339	Angola	1.574	4e	Cretaceous: sandstone, marl, limestone
Be58-2/3b	I	X		60	Angola	1.574	4e	Cretaceous: sandstone, marl, limestone
Be59-2bc	Bh To	Tv		100	Madagascar	1.123, 2.25	4a	Pliocene basalt and trachyte
Be60-3b	Bv I	Qc Vc	stony	324	Madagascar	1.918	4g, 8a	Cretaceous basalt and rhyolite
Be61-2a	To			152	Canary Islands	6.81	8c	Basic and some acid effusive rocks: basalt, trachyte, rhyolite
Be62-2bc	Bc Lc			148	Canary Islands	6.892	4g	Basic and some acid effusive rocks: basalt, trachyte, rhyolite
Be63-2/3b		I Lc		896	South Africa	4.45, 2.27	2a, 4e	Basement complex: granite, gneiss, schist, phyllite, amphibolite, greenstone
Be64-1/2ab	Qa	I		212	South Africa	4.45	2a	Palaeozoic sandstone: Karroo: sandstone, shale, mudstone
Bf2-3a	Fr			21	Liberia	1.132	2a, 4c	Basic intrusives: dolerite, diorite, gabbro
Bf2-3a	Fr			232	Guinea	1.73, 1.483, 1.132	2a, 4c	Basic intrusives: dolerite, diorite, gabbro
Bf3		I		184	Ivory Coast	1.131, 1.132	1a	Basement complex: granitic gneiss, schist, quartzite: granitic batholiths: diorite, dolerite. Precambrian (Birrimian): schist, quartzite, greenstone
Bf3		I		35	Liberia	1.471	1a	Basement complex: granitic gneiss, schist, quartzite: granitic batholiths
Bf3-2b		I		665	Ivory Coast	1.122	1a	Basement complex: granitic gneiss, schist, quartzite: granitic batholiths. Precambrian (Birrimian): schist, quartzite, greenstone
Bf3-2b		I		77	Liberia	1.121	1a	Basement complex: granitic gneiss, schist, quartzite: granitic batholiths. Precambrian (Birrimian): schist, quartzite, greenstone
Bf4	Ah Fh	I		66	Ivory Coast	1.411	1a	Basement complex: granitic gneiss, schist, quartzite: granitic batholiths
Bf4-2b	Ah Fh	I		44	Ivory Coast	1.131	1a	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths
Bf5-ab	Be Ne	I		351	Ivory Coast	1.134, 1.412	2a	Precambrian (Birrimian): schist, quartzite, greenstone
Bf5-b	Be Ne	I		29	Ivory Coast	1.412	2a	Precambrian (Birrimian): schist, quartzite, greenstone

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Bf5-2/3ab	Be Ne	I		168	Ivory Coast	1.131. 1.411. 1.412	1a. 2a	Basic intrusive rocks: diorite. dolerite. gabbro. Basement complex: granitic gneiss, schist. quartzite: granitic batholiths: greenstone
Bf5-2/3ab	Be Ne	I		3	Ghana	1.412	1a	Greenstone
Bf6	Fo	I		105	Nigeria	1.132	1a	Cretaceous: dolomitic limestone. shale. sandstone
Bf7-2b	Bh Fh	I		35	Liberia	1.132	1a	Basement complex: granitic gneiss. schist. quartzite. biotite. apatite. norite: granitic batholiths
Bf7-2b	Bh Fh	I		585	Ivory Coast	1.132	1a	Basement complex: granitic gneiss. schist. quartzite, biotite. apatite. norite: granitic batholiths
Bf7-2b	Bh Fh	I		94	Guinea	1.132	1a	Basement complex: granitic gneiss. schist. quartzite, biotite. apatite. norite: granitic batholiths
Bf8-2bc	Fo Rd	I		329	Madagascar	2.25	1a. 4a	Granite
Bf9-2bc	Fo Ne	I Gd Fp		198	Equatorial Guinea	1.132	1a	Crystalline schist. quartzite. greenstone: granite and diorite intrusives
Bf9-2bc	Fo Ne	I Gd Fp		4 520	Gabon	1.132	1a	Crystalline schist. quartzite. greenstone: granite and diorite intrusives
Bf9-2bc	Fo Ne	I Gd Fp		48	Angola (Cabinda dist.)	1.132	1a	Crystalline schist. quartzite. greenstone: granite and diorite intrusives
Bf9-2bc	Fo Ne	I Gd Fp		596	Congo	1.132	1a	Crystalline schist. quartzite. greenstone: granite and diorite intrusives
Bf10-2/3b	Fo Qf	Ag	lithic	367	Equatorial Guinea	1.11	1a	Crystalline schist. quartzite. greenstone: granite and diorite intrusives. Cretaceous: sandstone. marl. limestone
Bf10-2/3b	Fo Qf	Ag	lithic	4 678	Gabon	1.121, 1.132. 1.72	1a	Crystalline schist. quartzite. greenstone: granite and diorite intrusives. Cretaceous: sandstone. marl. limestone. Precambrian: calcareous schist. dolomite. conglomerate. tillite
Bf10-2/3b	Fo Qf	Ag	lithic	298	Congo	1.132. 1.73	2a	Crystalline schist. quartzite, greenstone: granite and diorite intrusives. Precambrian: calcareous schist. dolomite. conglomerate. tillite
Bf11-2c	Af	Rd U		3 348	Madagascar	1.72. 1.73. 1.74. 2.14. 2.25. 2.31	1a. 1d. 4a, 4e	Granite. Precambrian: amphibolite. pyroxenite, migmatite. gneiss. Quaternary: basalt and acid intrusions
Bg1				73	Nigeria	1.916. 1.917	4d	Quaternary alluvial and lacustrine deposits
Bg2-2a	Gd Jd	Qc Od		32	Ivory Coast	1.121	1a	Quaternary alluvial and deltaic deposits
Bh4-2c	I		lithic	1 434	Ethiopia	1.77. 1.8. 2.35. 2.39	5a	Precambrian: gneiss. quartzite. cipolin. andesite. conglomerate. argillite. rhyolite; granitic batholiths. Trap series: basalt. phonolite. nephelinite. trachyte. rhyolite. pyroclastics

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Bh8-bc	Fh Th			164	Cameroon	1.73	1a	Basic effusive rocks: basalt. andesite
Bh11-1b		Je		88	Ethiopia	1.77	4f	Jurassic limestone. marl and gypsum
Bh12-3c...	Ao	Jd	lithic	4 690	Ethiopia	1.42. 1.77. 1.843. 2.32. 2.35	1d. 4b. 5a	Precambrian: gneiss. granitic gneiss. schist. quartzite. cipolin. andesite. conglomerate. argillite. rhyolite: granitic batholiths
Bh12-3c	Ao	Jd	lithic	211	Sudan	1.77	4b	Precambrian: granitic gneiss, schist. quartzite: granitic batholiths
Bh13-2/3c		Ao Jd I		550	Ethiopia	2.21. 2.35	4f	Precambrian: gneiss. quartzite. cipolin. andesite. conglomerate, argillite. rhyolite. Jurassic: dolomitic limestone. marl. minor sandstone
Bh14-3c	Ne	I Je O		71	Kenya	1.811. 2.31	2b. 4a. 4c	Tertiary-recent volcanics: basalt. phonolite. nephelinite. pyroclastics. tuff. carbonatite
Bh14-3c	Ne	I Je O		111	Rwanda	1.76	4f	Precambrian: shale. sandstone, conglomerate. phyllite. schist. quartzite
Bh14-3c	Ne	I Je O		70	Burundi	1.76	4f	Precambrian: shale. sandstone. conglomerate. phyllite. schist. quartzite
Bh14-3c	Ne	I Je O		143	Uganda	1.8	4a. 4c	Trap series: basalt. phonolite, nephelinite. trachyte. rhyolite. pyroclastics
Bh15-2b	Fh Th	G Fp	stony	59	Mauritius	1.22	1a	Pleistocene basalt
Bk2-bc	I			251	Algeria	6.142	6d. 6e	Cretaceous limestone and marl
Bk2-2ab	I			1 508	Algeria	6.741. 6.912	6d. 6e	Jurassic and lower Cretaceous: limestone. dolomite
Bk2-2b	I			72	Algeria	6.833	5b	Cretaceous limestone and dolomite overlain with recent alluvial and lacustrine deposits
Bk2-2bc	I			273	Algeria	6.1912. 6.163	6d. 6e	Jurassic: limestone and dolomite. Palaeozoic: schist. quartzite. Pliocene: lacustrine deposits. Lower Cretaceous limestone
Bk3-2a	Qc Ql			642	Senegal	1.533. 1.534	4g	Eocene nummulitic limestone; Quaternary alluvial and lagoonal deposits
Bk4-1a				109	Senegal	1.533, 1.534	4g	Palaeogene marine phosphatic limestone
Bk4-1a				570	Mauritania	1.534. 1.544	4g	Palaeogene marine phosphatic limestone
Bk6-2/3a	Vc			294	Algeria	6.163	5b	Pliocene and Quaternary alluvial and lacustrine deposits
Bk10-1ab	I Rc	Lc	petrocalcic	89	Morocco	6.1924. 6.232	8a	Cretaceous limestone: Neogene lacustrine deposits
Bk10-2b	I Rc	Lc	lithic	954	Morocco	6.1322. 3.24	8a	Jurassic and Cretaceous limestone and dolomite
Bk11-1b		I Rc	petrocalcic	217	Morocco	6.232	8a	Jurassic limestone and dolomite overlain mainly with Quaternary. lagoonal and aeolian deposits

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Bk12-2a	Kk			71	Morocco	6.1314	8a	Pliocene and Quaternary lacustrine and aeolian deposits
Bk13-2ab	Kk	I Lc		455	Morocco	6.1313	5b	Upper Cretaceous and Neogene marl
Bk13-2ab	Kk	I Lc	petrocalcic	18	Morocco	6.1314	5b	Neogene marl
Bk14-2b	I Lc			269	Algeria	6.1922	6d, 6e	Jurassic limestone and dolomite
Bk14-2b	I Lc			3	Morocco	6.1922	6d, 6e	Jurassic limestone and dolomite
Bk14-2bc	I Lc			664	Algeria	6.142, 6.162	6d, 6e	Upper Cretaceous and Miocene limestone; Pliocene and Quaternary alluvial, lagoonal and lacustrine deposits
Bk14-2c	I Lc			1 020	Algeria	6.163	5b, 6d, 6e	Cretaceous and Miocene limestone; Eocene flysch deposits
Bk14-2c	I Lc		petrocalcic	250	Morocco	6.161	6d, 6e	Cretaceous and Eocene flysch deposits
Bk15-2c	I Xk Xl		petrocalcic	110	Morocco	6.512	6d, 6e	Jurassic sandstone and limestone
Bk16-2b	Rc			372	Morocco	6.512	6d, 6e	Cretaceous: schist, hard limestone, sandstone (flysch)
Bk17-2c	I X		petrocalcic	303	Morocco	6.922	6d, 6e	Jurassic dolomite and limestone
Bk18-bc	E I	Jc Lc		15	Tunisia	6.171	5b	Miocene and Pliocene: calcareous sandstone, shale, limestone
Bk19-2c	I Rc			1 146	Algeria	6.922	8d	Cretaceous and Eocene limestone and marl
Bk20-2ab	E			93	Algeria	6.1912	6d, 6e	Cretaceous crystalline limestone
Bk21-2bc	Bc Lc	I		1 673	Algeria	6.1912, 6.741	5a, 6d, 6e	Cretaceous limestone and marl; Eocene and Miocene limestone; Quaternary alluvial and lacustrine deposits
Bk21-2bc	Bc Lc	I		22	Tunisia	6.1311	5a, 6d, 6e	Cretaceous limestone and marl; Eocene and Miocene limestone; Quaternary alluvial and lacustrine deposits
Bk22-a	E	Jc Lc X		336	Tunisia	3.24	8d	Cretaceous limestone and marl; Eocene and Miocene limestone; Quaternary alluvial and lacustrine deposits
Bk22-a	E	Jc Lc X		68	Algeria	3.24	8d	Cretaceous limestone and marl; Eocene and Miocene limestone; Quaternary alluvial and lacustrine deposits
Bk23-2/3ab	E K	Jc Zo		45	Tunisia	6.171	5b	Pliocene shale and sandstone; Quaternary alluvial and lagoonal deposits
Bk24-bc	E I	Be Jc Vp		2 318	Tunisia	6.1311, 6.833 6.171, 6.151	5a, 5b, 6a, 6d, 6e, 8d	Cretaceous limestone and marl; Eocene and Miocene limestone; Oligocene sandstone
Bk24-bc	E I	Be Jc Vp		122	Algeria	6.741	6d, 6e	Cretaceous limestone and marl; Eocene and Miocene limestone; Oligocene sandstone
Bk24-2bc	E I	Be Jc Vp		175	Ethiopia	1.85	4b	Cretaceous limestone, marl, sandstone; some outcroppings of Precambrian gneiss, schist, quartzite; granitic batholiths

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Bk24-2bc	E I	Be Jc Vp		1 125	Somalia	1.85	4b	Cretaceous: limestone. marl. sandstone: some outcrops of Precambrian gneiss. schist. quartzite: granitic batholiths
Bk25-2a	Be	Vp We		10	Zaire	1.72	4f	Quaternary alluvial deposits
Bk25-2a	Be	Vp We		78	Uganda	1.72	4f	Quaternary alluvial deposits
Bk25-2a	Be	Vp We		716	Kenya	1.812	4f	Quaternary alluvial and lacustrine deposits. Tertiary-recent volcanics: basalt. phonolite. nephelinite. pyroclastics. tuff
Bk25-2a	Be	Vp We	petrocalcic	910	Tanzania	1.32. 1.812	4e. 4g	Quaternary alluvial and lacustrine deposits. Tertiary-recent volcanics: basalt. phonolite. nephelinite. pyroclastics. tuff
Bk26-2/3a	Bc Bg	Ge I		895	Tanzania	1.812	4g	Quaternary alluvial and lacustrine deposits
Bk27-2ab	Bc Lk	Gc Vp I	stony	636	Tanzania	1.812	4g	Basement complex: orthogneiss. granite. migmatite. amphibolite. schist. quartzite
Bk28-2b	Ne	Vp		302	Tanzania	1.32	4e	Jurassic limestone and marl
Bk29-2ab	Bc	To Vp	petrocalcic	135	Tanzania	1.812. 1.846	2b	Tertiary-recent volcanics: basalt. phonolite. nephelinite. pyroclastics. tuff
Bk30-2b	E Rc	Bc		179	Madagascar	1.37. 1.142. 1.144. 1.574	2c. 4e	Quaternary calcareous sandstone: Eocene limestone: Jurassic and Cretaceous marl
Bk31-2a	Be	Vp		261	Kenya	1.77	4g	Tertiary-recent volcanics: basalt. phonolite. nephelinite. pyroclastics, tuff
Bv1				36	Ghana	1.42	4e	Voltaian sandstone
Bv1				61	Upper Volta	1.534	4g	Basement complex: granitic gneiss. schist. quartzite: granitic batholiths
Bv1-a				124	Benin	1.484. 1.532	4e	Precambrian: granitic gneiss. micaschist. migmatite. quartzite
Bv2	I V			67	Mali	1.533	4g	Inselbergs of basic intrusive rocks: dolerite. diabase
Bv2	I V			238	Upper Volta	1.533. 1.532	4e	Basement complex: granitic gneiss. schist. quartzite: granitic batholiths
Bv2	I V			7	Ghana	1.42	4e	Basement complex: granitic gneiss. schist. quartzite: granitic batholiths
Bv2-1bc	I V			124	Senegal	1.483	4a. 4c	Cambrian: calcareous schist, quartzite. pelites
Bv2-1bc	I V			45	Guinea	1.483	4a. 4c	Cambrian: calcareous schist. quartzite. pelites
Bv2-3a	I V			121	Upper Volta	1.532	4e	Basement complex: granitic gneiss. schist. quartzite: granitic batholiths. Precambrian (Birrimian): schist. quartzite. greenstone
Bv3	Ws			34	Upper Volta	1.532	4e	Basement complex: granitio gneiss, schist, quartzite: granitic batholiths

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Bv4	Re V	I		44	Upper Volta	1.533	4e	Precambrian (Birrimian): schist, quartzite, greenstone
Bv4-3a	Re V	I		94	Upper Volta	1.532, 1.533	4e	Precambrian (Tarkwaian): schist, quartzite, conglomerate, sandstone
Bv5-2a	Re	I		126	Niger	1.534	4g	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths; greenstone
Bv5-2a	Re	I		312	Upper Volta	1.532, 1.534, 1.533	4e, 4g	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths; greenstone
Bv6	Be Vc	I		54	Upper Volta	1.532	4e	Precambrian (Birrimian): schist, quartzite, greenstone
Bv7-a	Qc			175	Niger	1.54, 3.21	8c	Recent alluvial deposits
Bv7-a	Qc			260	Mali	3.22, 1.54	8c	Recent alluvial deposits
Bv8-3a	Bg		sodic	203	Nigeria	1.916	2c, 4c	Palaeogene: sandstone, shale; basic effusive rocks: basalt
Bv13-3a	V	I Be		703	Rhodesia	2.15, 4.22, 4.322	2d	Karroo: clayey schist, sandstone, shale, arkose and effusive rocks: basalt and rhyolite. Kalahari: sand, ironstone, chalcedony
Bv14-2/3b	Vc	Ge	petrocalcic	2 437	Namibia	2.16, 4.22	4g, 7b	Precambrian: quartzite, arkose, chert, limestone partly overlain with Kalahari: sand, ironstone, chalcedony. Quaternary lacustrine sediments
E2-2ac	Bk I Vp	Lc		197	Tunisia	6.812, 3.24	5b	Cretaceous limestone; Villafranchian lacustrine deposits
E11-2c	Rc			119	Morocco	6.872	6d, 6e	Upper Cretaceous limestone
E12-2c	I Lc	Kk Rc	lithic	1 896	Morocco	6.922	6a, 6d, 6e	Jurassic limestone and dolomite
E14-2c	I Jc	Yy Yk		84	Tunisia	3.24	8d	Neogene limestone and marl; Quaternary alluvial and lacustrine deposits
E15-bc	Be Bk	I Bv		47	Tunisia	6.171	5b	Miocene limestone
E16-2a	Be Bk	I		261	Tanzania	1.812	4g	Quaternary alluvial and lacustrine deposits
Fh1-ab				493	Cameroon	1.73	4a	Acid and basic effusive rocks: rhyolite, basalt, andesite
Fh1-3b				62	Cameroon	1.77	4a	Basic effusive rocks: basalt, andesite
Fh4-3bc	Fo Nh	Gh		140	Uganda	1.72	2a	Basement complex: orthogneiss, granite, migmatite, amphibolite, schist, quartzite, cipolin; granitic batholiths
Fh4-3bc	Fo Nh	Gh		997	Zaire	1.72	2a	Basement complex; orthogneiss, granite, migmatite, amphibolite, schist, quartzite, cipolin; granitic batholiths
Fh5-2c	*Fr I*		*lithic*	*10*	*Comoro Islands*	*1.121*	*1a*	*Basalt and rhyolite*

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Fh6-2b	Ah Bf			120	Ivory Coast	1.131	2a	Basement complex: granitic gneiss, schist, quartzite: granitic batholiths
Fh7-3b	Fx Gh	Fo I	petric	327	Liberia	1.471, 1.476, 1.73	1a	Basement complex: granitic gneiss, schist, quartzite: granitic batholiths
Fh8-3b	Nh	G		447	Zaire	1.73	2b	Basement complex: granitic gneiss, migmatite, schist, quartzite: granitic batholiths
Fh9-2bc	Nd	I		150	Malawi	2.13	2c	Basement complex: granitic gneiss, migmatite, schist, quartzite: granitic batholiths. Precambrian: schist, quartzite, syenite, dolerite
Fh10-3b	Nh	G O		231	Burundi	1.76, 1.811	4f	Precambrian: shale, sandstone, conglomerate, phyllite, schist, quartzite
Fh10-3b	Nh	G O		301	Rwanda	1.76	4f	Precambrian: shale, conglomerate, sandstone, phyllite, schist, quartzite
Fo1				462	Cameroon	1.73, 1.77	4a	Precambrian (Dahomeyan): schist, quartzite, syenite, dolerite
Fo1-ab				10 088	Cameroon	1.72, 1.73	1a, 2a, 4a, 4c	Precambrian (Dahomeyan, Birrimian): gneiss, quartzite, micaschist, syenite, dolerite: granitic batholiths
Fo1-ab				414	Central African Empire	1.73, 1.121	1a	Precambrian (Dahomeyan, Birrimian): gneiss, quartzite, micaschist, syenite, dolerite: granitic batholiths
Fo2-1/2a	Qf			844	Congo	1.121, 1.122	1a	Polymorphic sandstone and sand
Fo2-2ab	Qf		petric	63	Zaire	1.471	4a, 4c	Precambrian: granitic gneiss, migmatite, schist, quartzite, syenite, dolerite: granitic batholiths
Fo2-2ab	Qf		petric	12 179	Central African Empire	1.471, 1.482	4a, 4c	Precambrian: granitic gneiss, migmatite, schist, quartzite, syenite, dolerite: granitic batholiths
Fo2-2ab	Qf		petric	340	Sudan	1.482, 1.483	4a, 4c	Precambrian: granitic gneiss, migmatite, schist, quartzite, syenite, dolerite: granitic batholiths
Fo8-2ab	Af Lf		petric	485	Central African Empire	1.482, 1.483	4a, 4c	Precambrian: schist, quartzite, syenite, dolerite
Fo9-bc	Fr		stony	1 130	Cameroon	1.73	2a	Precambrian (Dahomeyan): schist, quartzite, syenite, dolerite
Fo9-bc	Fr		stony	45	Nigeria	1.73	2a	Precambrian (Dahomeyan): schist, quartzite, syenite, dolerite
Fo9-2/3bc	Fr			266	South Africa	2.27, 2.38	1d	Karroo: clayey schist, sandstone, shale, arkose
Fo14	Ao			791	Cameroon	1.77	4a	Precambrian: granitic gneiss, micaschist, migmatite, quartzite: granitic batholiths: syenite, dolerite

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Fo14-2a	Ao		petric	1 531	Cameroon	1.73	1a, 2a, 4a, 4c	Basement complex: granitic gneiss, micaschist, migmatite; granitic batholiths; some quartzite, syenite, dolerite
Fo14-2a	Ao		petric	67	Central African Empire	1.73	4a, 4c	Basement complex: granitic gneiss, micaschist, migmatite; granitic batholiths; some quartzite, syenite, dolerite
Fo14-2/3a	Ao			164	Cameroon	1.72	1a	Precambrian (Birrimian): gneiss, quartzite, micaschist
Fo14-2/3a	Ao		petric	1 205	Cameroon	1.72, 1.121	1a	Precambrian (Birrimian): gneiss, quartzite, micaschist. Basic intrusive rocks: diorite, gabbro, peridotite
Fo14-2/3a	Ao		petric	141	Congo	1.121, 1.72	1a	Precambrian (Birrimian): gneiss, quartzite, micaschist. Basic intrusive rocks: diorite, gabbro, peridotite
Fo14-2/3a	Ao		petric	555	Central African Empire	1.73, 1.121	1a	Precambrian (Birrimian): gneiss, quartzite, micaschist. Basic intrusive rocks: diorite, gabbro, peridotite
Fo20-1ab	I			664	Guinea	1.462	2a, 4c	Ordovician fine sandstone
Fo21-2ab	I Rd			281	Central African Empire	1.482, 1.483	4a, 4c	Basement complex; granitic gneiss, migmatite, schist, quartzite; granitic batholiths
Fo22-2a	Af Ao			169	Central African Empire	1.471, 1.73	2a	Precambrian: schist, quartzite, syenite, dolerite
Fo26	Nd	I		329	Cameroon	1.73	1a	Precambrian (Dahomeyan); schist, quartzite, syenite, dolerite
Fo26-ab	Nd	I		3 493	Cameroon	1.72	1a	Basement complex: granitic gneiss, micaschist, migmatite; granitic batholiths
Fo26-ab	Nd	I		7	Congo	1.72	1a	Basement complex: granitic gneiss, micaschist, migmatite; granitic batholiths
Fo26-ab	Nd	I		10	Gabon	1.72	1a	Basement complex: granitic gneiss, micaschist, migmatite; granitic batholiths
Fo28-3ab	Gd			55 581	Zaire	1.121, 1.72, 1.73, 1.471	1a, 2a, 2c, 4c	Basement complex: gneiss, migmatite, schist, quartzite, amphibolite, micaschist, dolerite, syenite; granitic batholiths; limestone, dolomite, shale sometimes overlain with polymorphic sandstone
Fo28-3ab	Gd			168	Zambia	1.77	2c	Precambrian: schist, quartzite, syenite, dolerite, limestone, dolomitic shale, sandstone, shale and arkose
Fo28-3ab	Gd			34	Uganda	1.73	4a, 4c	Precambrian: granitic gneiss, migmatite, schist, quartzite, dolerite, syenite; granitic batholiths
Fo28-3ab	Gd			1 300	Central African Empire	1.471	2a	Precambrian: granitic gneiss, migmatite, schist, quartzite, dolerite, syenite; granitic batholiths

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION *(continued)*

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Fo28-3ab	Gd			1 723	Sudan	1.73	2a	Precambrian: granitic gneiss, migmatite, schist, quartzite, dolerite, syenite; granitic batholiths
Fo32-1a	G Qf	Lg Vc	petric	25	Chad	1.42	4a, 4c	*Continental terminal:* poorly consolidated sandstone, shale, marl
Fo32-1a	G Qf	Lg Vc	petric	1 251	Central African Empire	1.42, 1.483	4a, 4c	*Continental terminal:* poorly consolidated sandstone, shale, marl
Fo33-ab	Gh			1 859	Cameroon	1.123, 1.11	1a	Precambrian (Dahomeyan): schist, quartzite, syenite, dolerite
Fo33-2ab	Gh			1 530	Equatorial Guinea	1.72, 1.73	1a	Basement complex: granitic gneiss, migmatite, amphibolite, micaschist
Fo33-2ab	Gh			1 151	Cameroon	1.72, 1.73	1a	Basement complex: granitic gneiss, migmatite, amphibolite, micaschist
Fo33-2ab	Gh			1 055	Gabon	1.72, 1.73	1a	Basement complex: granitic gneiss, migmatite, amphibolite, micaschist
Fo34-3a	Vc	Re	petric	307	Kenya	1.77, 1.81	4g	Tertiary-recent volcanics: basalt, phonolite, nephelinite, pyroclastics, tuff
Fo35	Od			1 113	Cameroon	1.121, 1.73	1a, 2a	Precambrian: schist, quartzite, gneiss, syenite, dolerite
Fo35-3ab	Od			240	Cameroon	1.72	1a	Basement complex: granitic gneiss, micaschist, migmatite; granitic batholiths
Fo35-3ab	Od			14	Gabon	1.72	1a	Basement complex: granitic gneiss, micaschist, migmatite; granitic batholiths
Fo36-2b	Fp	I	petric	1 696	Guinea	1.483, 1.73	2a, 4c	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths
Fo36-2b	Fp	I	petric	887	Sierra Leone	1.476	2a, 4c	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths
Fo37-2b	Bf I		petric	1 033	Sierra Leone	1.476	1a	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths; pegmatite
Fo37-2b	Bf I		petric	24	Liberia	1.471	1a	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths; pegmatite
Fo38-2a	Fp G	Jd	petric	478	Sierra Leone	1.476	1a	Precambrian (Birrimian): schist, quartzite, greenstone
Fo39-2b	Bf Fp	J G		1 192	Sierra Leone	1.476	1a, 2a	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths; pegmatite
Fo39-2b	Bf Fp	J G		263	Guinea	1.462	2a, 4c	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths; pegmatite
Fo40-1/2a	I Lf			545	Equatorial Guinea	1.462	2a, 4c	Devonian schist and sandstone
Fo41	Fp I		petroferric	85	Ivory Coast	1.121	1a	Granite

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION *(continued)*

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Fo41	Fp I		petroferric	7	Ghana	1.121	1a	Greenstone. granite
Fo42-2b	Af N	I Je O		9	Kenya	1.83	4g	Granite
Fo42-3b	Af N	I Je O		547	Uganda	1.72. 1.811	2a. 4a. 4c	Precambrian: sandstone. quartzite. calcareous schist. arkose. mudstone. siltstone. clay. shale and coal. schist. gneiss. amphibolite. charnockite. cipolin. granite and basic igneous rocks
Fo42-3b	Af N	I Je O		670	Burundi	1.811. 1.812	2c. 4a. 4c	Precambrian: sandstone, quartzite. calcareous schist. arkose. mudstone. siltstone. clay. shale and coal
Fo42-3b	Af N	I Je O		189	Tanzania	1.811. 1.812	2c. 4a. 4c	Precambrian: sandstone. quartzite. calcareous schist. arkose. mudstone. siltstone. clay. shale and coal
Fo42-3b	Af N	I Je O		577	Rwanda	1.811	4a. 4c	Precambrian: sandstone. quartzite. calcareous schist. arkose. mudstone. siltstone. clay. shale and coal
Fo43-2b	Af Fx	I Je O		1 350	Uganda	1.811. 2.7	2a. 4a. 4c	Basement complex: orthogneiss. migmatite. granite. amphibolite. schist. quartzite. Precambrian: shale. sandstone. conglomerate. phyllite. schist. quartzite: acid and basic volcanic rocks; argillaceous and arenaceous sediments
Fo43-2b	Af Fx	I Je O		433	Kenya	1.76	4a. 4c	Precambrian: schist. gneiss. amphibolite. charnockite, quartzite. cipolin
Fo43-2b	Af Fx	I Je O		95	Tanzania	1.72. 1.811	2a	Precambrian: schist. gneiss. amphibolite. charnockite. quartzite. cipolin
Fo44-2b	A Fr	Je		1 792	Uganda	1.72. 1.76. 1.811	2a. 4a. 4c	Precambrian: schist. gneiss. amphibolite. charnockite. quartzite. cipolin: acid and basic volcanic rocks: argillaceous and arenaceous sediments: granitic intrusions
Fo45-2b	Fx Gh	I	petric	2 292	Liberia	1.471. 1.476	1a	Basement complex: granitic gneiss. schist. quartzite: granitic batholiths
Fo46-3bc	Fr Gh	Be Je Nd	petric	63	Sierra Leone	1.476	1a	Basement complex: granitic gneiss. schist. quartzite: granitic batholiths
Fo46-3bc	Fr Gh	Be Je Nd	petric	155	Ivory Coast	1.132	1a	Basement complex: granitic gneiss. schist. quartzite: granitic batholiths
Fo46-3bc	Fr Gh	Be Je Nd	petric	567	Guinea	1.471	1a	Basement complex: granitic gneiss. schist. quartzite: granitic batholiths
Fo46-3bc	Fr Gh	Be Je Nd	petric	1 759	Liberia	1.73. 1.471. 1.132	1a	Basement complex: granitic gneiss. schist. quartzite: granitic batholiths
Fo47-2ab	Ap Fx	Gp		2 187	Uganda	1.42. 1.73. 1.76. 1.811	4a. 4c	Precambrian: schist. gneiss. amphibolite. charnockite. quartzite. cipolin

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION *(continued)*

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Fo47-2ab	Ap Fx	Gp		286	Kenya	1.76. 1.811	4a. 4c	Precambrian: schist. gneiss. amphibolite. charnockite. quartzite. cipolin: acid and basic volcanic rocks; argillaceous and arenaceous sediments: granitic intrusions
Fo48-2ab	Fp	Ap Vc		396	Kenya	1.33. 1.73. 1.77. 1.811	2b. 4a. 4c	Precambrian: schist. gneiss. amphibolite. charnockite. quartzite. cipolin
Fo48-2ab	Fp	Ap Vc		3 260	Uganda	1.811	2a. 4a. 4c	Precambrian: schist. gneiss. amphibolite. charnockite. quartzite. cipolin
Fo48-2ab	Fp	Ap Vc		41	Sudan	1.811	4a. 4c	Precambrian: schist. gneiss. amphibolite. charnockite, quartzite. cipolin
Fo49-2a	Fp	Gp		507	Uganda	1.811	4a. 4c	Precambrian: schist. gneiss. amphibolite. charnockite. quartzite. cipolin
Fo49-2a	Fp	Gp		350	Kenya	1.811	4a. 4c	Precambrian: acid and basic volcanic rocks: argillaceous and arenaceous sediments: sandstone. quartzite, arkose. mudstone. siltstone. clay. shale and coal
Fo50-2a		Ap Vp		14	Sudan	1.811	4a. 4c	Precambrian: schist. gneiss. amphibolite. charnockite. quartzite. cipolin. Tertiary-recent volcanics: basalt. phonolite. nephelinite. pyroclastics. tuff
Fo50-2a		Ap Vp		22	Kenya	1.811	4a. 4c	Precambrian: schist, gneiss. amphibolite. charnockite. quartzite. cipolin. Tertiary-recent volcanics: basalt. phonolite. nephelinite. pyroclastics. tuff
Fo50-2a		Ap Vp		784	Uganda	1.811. 1.83	4a. 4c	Precambrian: schist. gneiss. amphibolite, charnockite, quartzite. cipolin
Fo51-3a	Nd			1 859	Zaire	1.73	2a	Basement complex: granitic gneiss. migmatite. schist. quartzite: granitic batholiths
Fo53-2/3b	Ao	Fr Lf I		780	Angola	1.35. 1.42	4a. 4c	Precambrian: gneiss. schist. quartzite, dolerite. syenite: granitic batholiths
Fo54-2/3ab	Nd	Fx Fp		3 677	Angola	1.42. 1.73	1a, 4a. 4c	Precambrian: crystalline schist. quartzite. greenstone: granite and diorite intrusives
Fo54-2/3ab	Nd	Fx Fp		789	Zaire	1.42	1a	Precambrian: crystalline schist. quartzite. greenstone: granite and diorite intrusives
Fo54-2/3ab	Nd	Fx Fp		6	Angola (Cabinda dist.)	1.42	1a	Precambrian: crystalline schist. quartzite. greenstone: granite and diorite intrusives
Fo55-2/3ab	Ne	Fr Fp		457	Angola	1.73	2a	Precambrian: calcareous schist. dolomite. conglomerate. tillite
Fo55-2/3ab	Ne	Fr Fp		1 352	Zaire	1.23, 1.73	2a	Precambrian: calcareous schist. dolomite. conglomerate. tillite
Fo55-2/3ab	Ne	Fr Fp		67	Congo	1.132. 1.73	2a	Precambrian: calcareous schist. dolomite. conglomerate. tillite
Fo56-2/3a		Gh Ge		44	Angola	1.73	2a	Precambrian: calcareous schist. dolomite. conglomerate. tillite

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Fo57-2a		Fr		216	Angola	1.73	4a, 4c	Precambrian: calcareous schist, dolomite, conglomerate, tillite; polymorphic sandstone
Fo58-2b	Lf	Fr Q R		73	Angola	1.73	2c	Precambrian: calcareous schist, dolomite, conglomerate, tillite
Fo59-2/3b	Qf	Fr Lf		120	Angola	1.73	2c	Precambrian: calcareous schist, dolomite, conglomerate, tillite; polymorphic sandstone
Fo60-2/3bc	Ne	Fr Nh		105	Angola	1.73	1a	Precambrian: sandstone, quartzite, calcareous schist
Fo61-2ab	Fx Fr	Qf Fp Ao		8 115	Angola	1.73, 1.77, 2.12, 2.13	2c, 4a, 4c	Precambrian: gneiss, schist, quartzite, dolerite, syenite, calcareous schist, dolomite, conglomerate, tillite. A cover of polymorphic sandstone and sands. Basement complex: granitic gneiss, migmatite; granitic batholiths
Fo62-2bc	Lf	I		111	Angola	1.35, 1.73	1a	Precambrian: gneiss, schist, quartzite, diorite, syenite
Fo63-2a	Fx	F L		368	Angola	1.77, 2.12, 2.13	2c	Precambrian: gneiss, schist, quartzite, dolerite, syenite; polymorphic sandstone
Fo64-2ab	I	F Lo		812	Angola	1.73	2c	*Continental intercalaire:* sandstone, shale, conglomerate; polymorphic sandstone: sands
Fo65-2b	Ao Lf	I Lo		159	Angola	1.73	2c	Kalahari: sand, chalcedony, ironstone, lacustrine sediments
Fo66-2/3b	Fr	Fx Q I		885	Zaire	1.73	2a	Precambrian: gneiss, schist, quartzite, dolerite, syenite
Fo66-2/3b	Fr	Fx Q I		2 314	Angola	1.73, 2.13, 2.25	2c	Precambrian: limestone, dolomitic shale, schist, quartzite, sandstone, shale, arkose. Polymorphic sandstone: consolidated and unconsolidated sands
Fo67-2ab	Q			54	Angola	1.73	2c	Polymorphic sandstone
Fo68-2b	Fr Fx	Lo Gp		165	Angola	1.73	2c	Polymorphic sandstone
Fo69-2ab	Fr	Ao Fx		618	Angola	2.12, 2.25	2c	Precambrian: gneiss, schist, quartzite, dolomite, syenite; granitic batholiths
Fo70-2ab	Fr	Fx To		238	Angola	2.12	2c	Precambrian: gneiss, schist, quartzite, dolomite, syenite; granitic batholiths
Fo71-2ab	Fr Fx			108	Angola	1.77	4a, 4c	Basement complex: granitic gneiss, migmatite, schist, quartzite; granitic batholiths
Fo72-bc	Ao F	I		181	Angola	1.77	4a, 4c	Basement complex: granitic gneiss, migmatite, schist, quartzite; granitic batholiths
Fo73-2ab	I	Lf		86	Angola	2.27	2c	Precambrian: quartzite, arkose and limestone, conglomerate
Fo74-2/3a	Fr Fx	Fp Q		228	Angola	2.12, 2.13	2c	Polymorphic sandstone: consolidated and unconsolidated sand, shale and conglomerate

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION *(continued)*

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Fo75-1/2ab	F	Nd G		1 578	Tanzania	1.32	2c, 4e	Basement complex: schist, gneiss, charnockite, quartzite, cipolin
Fo75-2/3a	F	Nd G		472	Zambia	1.77	2c	Basement complex: granitic gneiss, migmatite, schist, quartzite, limestone, dolomitic shale, sandstone, shale and arkose; granitic batholiths
Fo75-2/3ab	F	Nd G		9 312	Mozambique	1.741, 2.13	2c	Precambrian: graphitic schist, gneiss, amphibolite, charnockite, quartzite, crystalline limestone; granitic batholiths
Fo75-2/3ab	F	Nd G		729	Malawi	2.13	2c	Precambrian: graphitic schist, gneiss, amphibolite, charnockite, quartzite, crystalline limestone; granitic batholiths
Fo75-2/3ab	F	Nd G		1 222	Zambia	2.13	2c	Precambrian: graphitic schist, gneiss, amphibolite, charnockite, quartzite, crystalline limestone; granitic batholiths
Fo76-1/2ab	Fx	G I N		840	Tanzania	1.32	2c	Precambrian: schist, gneiss, charnockite, quartzite, cipolin
Fo76-2/3a	Fx	G I N		19 648	Zambia	1.77, 2.13, 2.26	2c	Basement complex: granitic gneiss, migmatite, schist, quartzite, limestone, dolomitic shale, sandstone, shale, arkose; granitic batholiths
Fo76-2/3a	Fx	G I N		875	Zaire	2.13, 2.26	2c	Basement complex: granitic gneiss, migmatite, schist, quartzite, limestone, dolomitic shale, sandstone, shale, arkose; granitic batholiths
Fo76-2/3a	Fx	G I N		1 070	Malawi	2.13	2c	Basement complex: granitic gneiss, migmatite, schist, quartzite, limestone, dolomitic shale, sandstone, shale, arkose; granitic batholiths
Fo77-2b	Nd	F G		403	Tanzania	1.32	2c	Precambrian: schist, gneiss, charnockite, quartzite, cipolin
Fo77-2/3a	Nd	F G		2 804	Zambia	2.13	2c	Precambrian: gneiss, schist, phyllite, dolomite, limestone, quartzite, slate
Fo78-2/3a	Fh Fx	J G		1 621	Zambia	1.77	2c	Basement complex: granitic gneiss, migmatite, schist, quartzite, limestone, dolomitic shale, sandstone, shale, arkose; granitic batholiths
Fo78-2/3a	Fh Fx	J G		70	Zaire	2.13	2c	Basement complex: granitic gneiss, migmatite, schist, quartzite, limestone, dolomitic shale, sandstone, shale, arkose; granitic batholiths
Fo79-2bc	Fx I			1 506	Zambia	1.77, 2.26	2c	Basement complex: granitic gneiss, migmatite, schist, quartzite, limestone, dolomitic shale, sandstone, shale, arkose; granitic batholiths
Fo80-2ab	Ao	Bf Fh G		6 341	Madagascar	1.11, 1.121, 1.123, 1.222, 1.142, 1.72, 2.25	1a, 4a	Precambrian: migmatite, gneiss, leptite, pyroxenite, quartzite, cipolin, amphibolite, rhyolite; Triassic sandstone; acid intrusives and granite
Fo81-2b	Ah Fh	Gh		4 357	Madagascar	1.11, 1.121, 1.222, 1.72, 1.918, 2.25	1a, 4a	Precambrian: migmatite, gneiss; granite and charnockite

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Fo82-2b	Ao Nd	Jd Gd Fr		4 825	Madagascar	1.123, 1.484, 1.72, 1.73, 2.25	4c, 4a	Precambrian: migmatite, gneiss, leptite, pyroxenite, cipolin; some granitic batholiths
Fo83-2b	Ao Nd	Af Gd		3 083	Madagascar	1.72, 1.73, 2.25	1a, 4a	Granite; Precambrian migmatite and gneiss
Fo84-2/3b	Fh Th	Bv Be To		101	Reunion Island	1.64	4c	Miocene-Pliocene basalt
Fo85-2b	Fr Ne	Be		50	Comoro Islands	1.143	1a, 4a	Basalt and rhyolite
Fo86-3ab	Fx	Fr G N		1 879	Zaire	1.23, 1.73, 2.26	2a, 2c	Precambrian: calcareous schist, dolomite, conglomerate, tillite. Quaternary: alluvial and lacustrine deposits
Fo86-3ab	Fx	Fr G N		543	Congo	1.23, 1.73	2a	Precambrian: calcareous schist, dolomite, conglomerate, tillite
Fo86-3ab	Fx	Fr G N		686	Zambia	1.77	2c	Precambrian: limestone, dolomitic shale, schist, quartzite, sandstone, shale, arkose; granitic batholiths
Fo87-2b		Jd Gd	petric	2 750	Gabon	1.121, 1.73	1a	Basement complex: granitic gneiss, migmatite, amphibolite, micaschist
Fo87-2b		Jd Gd	petric	2 171	Congo	1.73	1a	Basement complex: granitic gneiss, migmatite, amphibolite, micaschist
Fo88-2b	Fx Qf			395	Congo	1.23, 1.73	2a	Precambrian: calcareous schist, dolomite, conglomerate, tillite
Fo89-2b	Fr Nd			473	Congo	1.121, 1.122	1a	Polymorphic sandstone; Quaternary alluvial and lacustrine deposits
Fo90-2/3b	Bf	Jd Gd		1 072	Congo	1.122, 1.73	1a	Basement complex: granitic gneiss, migmatite, amphibolite, micaschist
Fo90-2/3b	Bf	Jd Gd		6 572	Gabon	1.121, 1.73	1a	Basement complex: granitic gneiss, migmatite. amphibolite, micaschist
Fo90-2/3b	Bf	Jd Gd		86	Equatorial Guinea	1.73	1a	Basement complex: granitic gneiss, migmatite, amphibolite, micaschist
Fo91-2b	Nd	Fr Bf		1 340	Congo	1.121, 1.72	1a	Precambrian: gneiss, quartzite, micaschist
Fo92-2/3b	Fx			3 698	Mozambique	1.23, 1.77	2c	Precambrian: graphitic schist, gneiss, amphibolite, charnockite, quartzite, crystalline limestone; granitic batholiths
Fo93-2/3c	Fh G	Fr		159	Malawi	2.13	2c	Precambrian: schist, quartzite, syenite, dolerite
Fo93-2/3c	Fh G	Fr		58	Zambia	2.13	2c	Precambrian: schist, quartzite, syenite, dolerite
Fo94-2ab	Fr I			241	Malawi	1.36	2c	Precambrian: granitic gneiss, schist, amphibolite, charnockite, quartzite, cipolin; granitic batholiths; greenstone
Fo94-2bc	Fr I			201	Malawi	2.13	2c	Precambrian: schist, quartzite, syenite, dolerite

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Fo96-3b	Nd	I V		166	Rwanda	1.811	4a, 4c	Basement complex: orthogneiss, granite, migmatite, amphibolite, schist, quartzite
Fo96-3b	Nd	I V		47	Burundi	1.811	4a, 4c	Basement complex: orthogneiss, granite, migmatite, amphibolite, schist, quartzite
Fo97-3b	Fp Nd	G		297	Rwanda	1.811	4a, 4c	Precambrian: shale, sandstone, conglomerate, phyllite, schist, quartzite
Fo97-3b	Fp Nd	G		1 005	Burundi	1.811	2c, 4a, 4c	Precambrian: shale, sandstone, conglomerate, phyllite, schist, quartzite
Fp2-a	I			58	Cameroon	1.73	2a	Basic effusive rocks: basalt and andesite
Fp3-2c	I Rd		petroferric	212	Sierra Leone	1.476	2a, 4c	Precambrian (Birrimian): schist, quartzite, greenstone
Fp4-2b	Fo Nd		petric	355	Sierra Leone	1.476	1a	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths
Fp5-2a	Gh	Jd	petric	230	Sierra Leone	1.476	1a	Precambrian (Birrimian): schist, quartzite, greenstone
Fp6-2b	Fx	Gd I Nd	petric	913	Liberia	1.471	1a	Basement complex: granitic gneiss, schist, quartzite: granitic batholiths
Fp7-2ab	Af Lf		petric	56	Chad	1.483, 1.42	4a, 4c	Basement complex: granitic gneiss, mica-schist, migmatite; granitic batholiths
Fp7-2ab	Af Lf		petric	10 651	Central African Empire	1.483	4a, 4c	Basement complex: granitic gneiss, mica-schist, migmatite; granitic batholiths
Fp8-2ab	Af Rd	Gd I Jd	petric	34	Uganda	1.42	4a, 4c	Precambrian: schist, quartzite, syenite, dolerite
Fp8-2ab	Af Rd	Gd I Jd	petric	5 515	Central African Empire	1 482, 1.483	2c, 4a, 4c	Precambrian: schist, quartzite, syenite, dolerite
Fp8-2ab	Af Rd	Gd I Jd	petric	13 436	Sudan	1.42, 1.483	4a, 4c	Precambrian: schist, quartzite, syenite, dolerite
Fp9-3a	I	Ne Vp		859	Ethiopia	1.85, 2.32, 2.37	4f	Trap series: basalt, phonolite, nephelinite, trachyte, rhyolite, pyroclastics. Jurassic and Cretaceous: limestone, marl, sandstone, gypsum
Fp10-2a	So Vp	Gp		31	Kenya	1.811	4a, 4c	Quaternary alluvial deposits
Fp10-2a	So Vp	Gp		532	Uganda	1.811, 1.42	2a, 4a, 4c	Precambrian: schist, gneiss, amphibolite, charnockite, quartzite, cipolin
Fp10-2a	So Vp	Gp		23	Zaire	1.42	4a, 4c	Precambrian: schist, gneiss, amphibolite, charnockite, quartzite, cipolin
Fp11-2a	Fx	Gp Vp		428	Angola	2.13	2c	Precambrian: gneiss, schist, quartzite, dolerite, syenite and acid intrusive rocks: granite, diorite, dolerite, gabbro
Fp12-2a	Fo Fx	Fr		171	Angola	2.13	2c	Precambrian: gneiss, schist, quartzite, dolerite, syenite

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Fp13-2/3a	Fx Lf Lp	Fr V		22	Angola	2.27	2c	Quaternary: alluvial sediments overlying acid intrusive rocks: granite, diorite
Fp14-2a	I Nd	Ao	petroferric	1 140	Madagascar	1.73, 2.14, 2.25, 4.32	4c	Granite. Precambrian: gneiss, migmatite, leptite, pyroxenite, quartzite
Fp16-2/3a	G	Je		9	Zambia	2.13	2c	Precambrian: schist, quartzite, syenite, dolerite
Fp16-2/3a	G	Je		448	Malawi	2.13, 1.36	2c	Precambrian: schist, quartzite, syenite, dolerite
Fr2-2/3b	I Rd	Fh	petroferric	2 055	Central African Empire	1.471, 1.482	2a, 4a, 4c	Precambrian: schist, quartzite, syenite, dolerite
Fr2-2/3b	I Rd	Fh	petroferric	139	Zaire	1.73, 1.471	2a	Precambrian: schist, quartzite, syenite, dolerite
Fr3-2a	Fo			15	Rhodesia	2.27	2c	Basement complex: granite, gneiss, migmatite. Basic intrusive rocks: diorite, gabbro
Fr3-2ac	Fo			152	Rhodesia	2.15	2c	Basement complex: granite, gneiss, migmatite. Basic intrusive rocks: diorite, gabbro
Fr6-2/3a	Fo Nd	Fh		1 038	Cameroon	1.77	4a, 4c	Basement complex: granitic gneiss, mica-schist, migmatite; granitic batholiths. Basic effusive rocks: basalt and andesite
Fr6-2/3ac	Fo Nd	Fh		1 925	Mozambique	2.14	2c	Precambrian: granitic gneiss, schist, amphibolite, charnockite, quartzite, cipolin; granitic batholiths; greenstone
Fr6-2/3ac	Fo Nd	Fh		855	Rhodesia	2.26	2c	Precambrian: granitic gneiss, schist, amphibolite, charnockite, quartzite; granitic batholiths; greenstone
Fr7-2a	Fo	Vp		614	Kenya	1.33	4a, 4c	Precambrian: schist, gneiss, amphibolite, charnockite, quartzite, cipolin
Fr7-2a	Fo	Vp		520	Uganda	1.811, 1.83	4a, 4c, 4g	Precambrian: schist, gneiss, amphibolite charnockite, quartzite, cipolin
Fr7-2a	Fo	Vp		7	Madagascar	1.37	4e	Quaternary basalt
Fr8-2/3b	Ne Rd	I	petroferric	678	Central African Empire	1.121, 1.471, 1.482	2a	Precambrian: schist, quartzite, syenite, dolerite
Fr9-2a	Fo	Vp Gp		356	Kenya	1.811	4a, 4c	Precambrian: acid and basic volcanic rocks, argillaceous and arenaceous sediments; granitic intrusions
Fr10-2/3a	Fh Fo	Fp		257	Angola	1.73	4a, 4c	Precambrian: sandstone, quartzite, calcareous schist
Fr11-3a	Fo Vp			114	Angola	2.13	2c	Basic intrusive rocks: dolerite, gabbro, peridotite
Fr12-2/3a	Fx	Lf Lp		41	Angola	2.13, 2.12	2c	Basic and ultrabasic igneous rocks; basic intrusive rocks: dolerite, gabbro
Fr13-2ab	Fp	I Ao Fx		355	Angola	2.13	2c	Precambrian: gneiss, schist, quartzite, dolerite, syenite; intrusive basic and ultrabasic rocks

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Fr13-2ab	Fp	I Ao Fx		34	Zambia	1.742	2c	Intrusive basic and ultrabasic rocks
Fr14-3a	Fo	Fp G		4 409	Zambia	2.26	2c	Precambrian: limestone and dolomitic shale. schist. quartzite. sandstone. shale. arkose: granitic batholiths
Fr14-3a	Fo	Fp G		8 859	Zaire	1.482. 1.73. 2.26	2c	Precambrian: limestone and dolomitic shale. schist. quartzite. sandstone. shale. arkose: granitic batholiths
Fr14-3ab	Fo	Fp G		7 375	Zaire	1.482	2a. 2c	Precambrian: schist. quartzite. syenite. dolerite. sandstone. calcareous schist
Fr15-3a	Nd	I Fp		20	Madagascar	1.11	1a	Cretaceous basalt
Fr15-3a	Nd	I Fp	petric	441	Madagascar	1.222	4a	Cretaceous basalt
Fr16-3c	Fo Th	Fp Fh		256	Madagascar	2.25	4a	Pliocene basalt and trachyte
Fr17-3c	Fh Ne	Th		249	Madagascar	1.121	1a. 4e	Quaternary basalt
Fr18-2/3b	Fa			298	Malawi	1.741	2c	Precambrian: graphitic schist. gneiss. amphibolite. charnockite. quartzite. crystalline limestone: granitic batholiths
Fr18-2/3b	Fa			756	Mozambique	1.741. 2.13	2c	Precambrian: graphitic schist. gneiss. amphibolite. charnockite. quartzite. crystalline limestone: granitic batholiths
Fr19-3bc	Fh			1 058	Mozambique	1.77	2c	Precambrian: graphitic schist. gneiss. amphibolite. charnockite. quartzite. crystalline limestone: granitic batholiths
Fr20-3bc	Fx			462	Swaziland	2.38	7a	Basement complex: granite. gneiss. schist. phyllite. amphibolite. greenstone. basalt. andesite. rhyolite
Fr20-3bc	Fx			2 077	South Africa	4.45. 2.21. 2.26. 2.38	1d. 2a. 4e. 7a	Precambrian: dolomite. quartzite. schist. conglomerate. Palaeozoic and Karroo: sandstone. shale. mudstone. Basement complex: granite. gneiss. schist. phyllite. amphibolite. greenstone. basalt. andesite. rhyolite
Fx1-b				705	Ghana	1.121. 1.122	1a	Basement complex: orthogneiss. paragneiss. granite. micaschist. quartzite. Precambrian (Birrimian): schist. phyllite. grauwacke. sandstone. greenstone
Fx1-b				133	Ivory Coast	1.121	1a	Basement complex: orthogneiss. paragneiss. granite. micaschist. quartzite. Precambrian (Birrimian): schist. phyllite. grauwacke. sandstone. greenstone
Fx1-1a				705	Cameroon	1.123	1a	Cretaceous: limestone. shale. *Continental terminal:* poorly consolidated sandstone. shale. conglomerate. grits. sand. clay
Fx2-2a	Qf			23	Ghana	1.122	1a	*Continental terminal:* slightly consolidated sandstone. shale. marl. sand. clay
Fx2-2a	Qf			731	Ivory Coast	1.122	1a	*Continental terminal:* slightly consolidated sandstone. shale. marl. sand. clay
Fx7-3b	Ao Fo	Ap	petric	505	Liberia	1.476	1a	Basement complex: granitic gneiss. schist. quartzite. granitic batholiths

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Fx8-1a	Ao Nd	G Ph		205	Cameroon	1.123	1a	Cretaceous limestone, shale and sandstone
Fx8-1a	Ao Nd	G Ph		1 029	Nigeria	1.123	1a	Cretaceous limestone, shale and sandstone. Quaternary lagoonal and aeolian deposits
Fx9-1a	Gd Gh	Od		77	Central African Empire	1.471	1a	Quaternary alluvial and lacustrine deposits
Fx9-1a	Gd Gh	Od		3 752	Congo	1.121, 1.122	1a	Quaternary alluvial and lacustrine deposits
Fx10-2a	Fo	G		18 716	Zaire	1.121, 1.72	1a	*Continental intercalaire:* sandstone, shale, conglomerate. Neogene and Quaternary: alluvial, lacustrine and aeolian deposits
Fx11-1b	Gh	Fp		369	Sierra Leone	1.133	1a	Recent coastal and lagoonal deposits
Fx11-1b	Gh	Fp		30	Guinea	1.133	1a	Recent coastal and lagoonal deposits
Fx12-2ab	Ao Fp Gh	Gd I	petric	3 348	Liberia	1.476, 1.121	2a	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths
Fx12-2ab	Ao Fp Gh	Gd I	petric	247	Ivory Coast	1.121	1a, 2a	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths
Fx13-2a	Fo Fp	Fr Q		545	Angola	1.73, 2.13	2c, 4a, 4c	Precambrian: calcareous schist, dolomite, conglomerate, tillite; polymorphic sandstone. Quaternary: alluvial sediments overlying acid intrusive rocks: granite, diorite
Fx14-2a	Lo	F G R		2 292	Angola	2.12	2c	Precambrian: gneiss, schist, quartzite, dolerite, syenite, calcareous schist, dolomite, conglomerate, tillite; a cover of polymorphic sandstone and sands
Fx15-2a		Fp Gp		593	Angola	1.73, 1.77	2c, 4a, 4c	Basement complex: granitic gneiss, migmatite, schist, quartzite; granitic batholiths. Kalahari: sand, chalcedony, ironstone, lacustrine sediments
Fx16-2a	Fp	Fo G		317	Angola	1.73, 2.13, 2.27	2c	Precambrian: gneiss, schist, quartzite, dolerite, syenite. Quaternary: alluvial sediments overlying acid intrusive rocks: granite, diorite. Basement complex: granitic gneiss, migmatite; granitic batholiths
Fx16-2a	Fp	Fo G		212	Zaire	1.73	2c	Precambrian: gneiss, schist, quartzite, dolerite, syenite
Fx17-2a		Fo Fp		805	Angola	2.12	2c	Precambrian: granitic gneiss, migmatite, schist, quartzite, dolerite, syenite; granitic batholiths
Fx18-2b	Fo	Ao Fr		396	Angola	1.77	4a, 4c	Basement complex: granitic gneiss, migmatite, schist and quartzite; granitic batholiths
Fx19-3a	Fo	Lf Vp		117	Angola	2.13	2c	Basic intrusive rocks: dolerite, gabbro, peridotite

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION *(continued)*

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Fx20-2a	Fo	Fp Fr		43	Zambia	1.742	2c	Precambrian: gneiss, amphibolite, mica-schist, quartzite, limestone, dolomitic shale, schist, sandstone, shale, arkose
Fx20-2a	Fo	Fp Fr		1 712	Angola	1.742, 2.13, 2.25	2c	Precambrian: gneiss, schist, quartzite, amphibolite, micaschist, dolerite, syenite, limestone, dolomitic shale, sandstone, shale, arkose; granitic batholiths
Fx21-2ab	Fo Fr Qc	G Fp		2 419	Angola	1.742, 1.77, 2.13	2c	Polymorphic sandstone: consolidated and unconsolidated sand. Precambrian: gneiss, schist, quarzite, dolerite, syenite; acid intrusive rocks: granite, diorite
Fx21-2ab	Fo Fr Qc	G Fp		202	Zaire	1.73	2c	Polymorphic sandstone: consolidated and unconsolidated sand
Fx21-2ab	Fo Fr Qc	G Fp		1 621.	Zambia	1.73, 2.25	2c	Polymorphic sandstone: consolidated and unconsolidated sand
Fx22-2ab	Fo Fr	Fp		241	Angola	2.13	2c	Precambrian: gneiss, schist, quartzite, dolerite, syenite
Fx23-2a	I	Fo L		143	Angola	2.13	2c	Quaternary: alluvial sediments overlying acid intrusive rocks: granite, diorite
Fx24-2ab	Fp Nd		petric	595	Madagascar	1.222, 2.25	1a, 4a	Granite. Precambrian: migmatite and gneiss, leptite, pyroxenite, quartzite, cipolin
Fx25-2a	Fh Qf			325	Congo	1.23, 1.73	1a	Polymorphic sandstone and sand
Fx26-1a	Qf	Gd Qc		44 535	Zaire	1.121, 1.72, 1.73, 1.23, 1.482	1a, 2a	*Continental intercalaire:* sandstone, shale, conglomerate, mostly overlain with Quaternary alluvial and lacustrine deposits
Fx26-1a	Qf	Gd Qc		245	Congo	1.23, 1.122	1a, 2a, 4c, 2c	*Continental intercalaire:* sandstone, shale, conglomerate, mostly overlain with Quaternary alluvial and lacustrine deposits
Fx26-1a	Qf	Gd Qc		3 980	Zambia	2.26	2c	Basement complex: granitic gneiss, migmatite, schist, quartzite, limestone, dolomitic shale, sandstone, shale, arkose; granitic batholiths
Fx26-1/2a	Qf	Gd Qc		165	Angola	1.77	2c	Polymorphic sandstone: consolidated and unconsolidated sand
Fx26-1/2a	Qf	Gd Qc		2 998	Zaire	1.73	2c	Polymorphic sandstone: consolidated and unconsolidated sand
Fx27-2a	Fp G	J		6 477	Zaire	1.121	1a	Quaternary alluvial and lacustrine deposits
Fx28-2/3ab	G	Bd Bh		241	Gabon	1.132	2a	Precambrian: calcareous schist, dolomite, conglomerate, tillite
Fx28-2/3ab	G	Bd Bh		603	Congo	1.132	2a	Precambrian: calcareous schist, dolomite, conglomerate, tillite
Fx29-3a	Ap Nd	Jd G Bh	petric	1 547	Gabon	1.121, 1.132	1a, 2a	Crystalline schist, quartzite, greenstone; granite and diorite intrusives. Neogene: sandy limestone and marl. Precambrian: calcareous schist, dolomite, conglomerate, tillite

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION *(continued)*

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Fx29-3a	Ap Nd	Jd G Bh	petric	2 764	Congo	1.132, 1.23	1a	Precambrian: calcareous schist, dolomite, conglomerate, tillite
Fx30-1/2a	G Pg	Qa		1 055	Congo	1 122	2a	Polymorphic sandstone: consolidated fine sandstone
Fx31-1/2a	G			1 776	Congo	1.122	1a, 2a	Quaternary alluvial and lacustrine deposits
Fx31-1/2a	G			265	Gabon	1.121	1b, 1c	Alluvial deposits
G1				1 968	Mali	1.533, 1.534, 1.54	4d	Recent alluvial deposits
G1-3a			sodic	118	Ghana	1.35	3a	Recent lagoonal deposits
G2-a	J			99	Cameroon	1.72	2a	Quaternary alluvial deposits. Basement complex: granitic gneiss, micaschist, migmatite; granitic batholiths
G2-2/3a	J			2 349	Nigeria	1.123, 1.132, 1.46, 1.482	3a, 4h	Recent alluvial, lagoonal and deltaic deposits
G2-3a	J			186	Mali	1.533, 1.484	4c	Recent alluvial deposits
G3	Je			17	Nigeria	1.532	4d	Recent alluvial deposits
G3	Je			7	Niger	1.533	4d	Recent alluvial deposits
G3	Je			62	Senegal	1.533	4g	*Continental terminal:* shale, marl, sand, clay, recent alluvial deposits
G3-2a	Je			99	Mali	3.14	4g	Recent alluvial deposits
G3-2a	Je		saline	2 770	Mali	1.54, 1.534, 3.14	4h	Recent alluvial deposits
G4-a	I Je			88	Ghana	1.42	4d	Recent alluvial deposits
G5-a	Lp Vc			69	Ghana	1.42	4d	Basement complex: orthogneiss, paragneiss, granite, micaschist, quartzite. Voltaian: sandstone
G6-a	J	Vp Zg		52	Ghana	1.31, 1.35	4d	Recent alluvial deposits
G7-2a	Jd	Z		204	Congo	1.132, 1.35	4d	Quaternary alluvial and lagoonal deposits
Gd5-2a	Jd			116	Central African Empire	1.471	1b, 1c	Quaternary alluvial deposits overlying Precambrian sandstone, quartzite and calcareous schist
Gd5-2a	Jd			82	Sudan	1.42	4a, 4c	Quaternary alluvial deposits
Gd6-2a	Fo Jd	Af		176	Central African Empire	1.471	1b, 1c	Quaternary alluvial deposits overlying Precambrian sandstone, quartzite and calcareous schist
Gd14-2a	Gp Jd	Od		9 495	Zaire	1.121, 1.122	1b, 1c	Quaternary alluvial and lacustrine deposits
Gd14-2a	Gp Jd	Od		81	Congo	1.121, 1.122	1b, 1c	Quaternary alluvial and lacustrine deposits
Gd16-2/3a	Jd Jt Zg		sodic/saline	192	Cameroon	1.123	3a	Recent alluvial and lagoonal deposits

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Gd16-2/3a	Jd Jt Zg		sodic/saline	319	Nigeria	1.123	3a	Recent alluvial and lagocnal deposits
Gd20-2a	Gh Je			222	Madagascar	1.121, 1.123, 1.142, 1.37 1.484	4h	Quaternary alluvial deposits
Gd21-a	Gh Jd Od	Jt		95	Ivory Coast	1.122	4c	Recent alluvial, lagoonal and deltaic deposits
Gd21-1/2a	Gh Jd Od	Jt		51	Ivory Coast	1.122	3a	Recent coastal and deltaic deposits
Ge1			sodic	417	Nigeria	1.532	4d	Recent alluvial deposits
Ge1			sodic	93	Niger	1.532	4d	Recent alluvial deposits
Ge1-2/3a				46	Chad	1.533	4h	Quaternary alluvial deposits
Ge1-2/3a				69	Cameroon	1.533	4h	Quaternary alluvial deposits
Ge2	J	Gh S Ws Z		3	Togo	1.35, 1.412	4d	Recent alluvial deposits
Ge2	J	Gh S Ws Z		235	Benin	1.135, 1.412	4d	Recent alluvial deposits
Ge5-1a	Ql			995	Niger	1.533, 1.534, 1.54	4d	Recent alluvial deposits
Ge5-1a	Ql			49	Nigeria	1.532	4d	Recent alluvial deposits
Ge10-1a	Zg		sodic	208	Niger	1.918	4g	Quaternary alluvial and lacustrine deposits
Ge10-1a	Zg		sodic	150	Nigeria	1.918	4g	Quaternary alluvial and lacustrine deposits
Ge16	Qc Vp			41	Cameroon	1.532	4e	Quaternary alluvial and lacustrine deposits
Ge16	Qc Vp			39	Chad	1.532	4d	Quaternary alluvial and lacustrine deposits
Ge22-a	Je Lg	Vp Zo		32	Chad	1.915	4d	Quaternary alluvial and lacustrine deposits
Ge22-a	Je Lg	Vp Zo		481	Central African Empire	1.915	4d	Quaternary alluvial and lacustrine deposits
Ge23-2/3a	Gm Vp			343	Sudan	1.533	4d	Quaternary alluvial and lacustrine deposits
Ge25-1a		Re Gh Gp		13	Angola (Cabinda dist.)	1.34	4d	Quaternary alluvial and lagoonal deposits
Ge25-1a		Re Gh Gp		3 741	Angola	1.73, 1.77, 2.12, 4.22	4d	Polymorphic sandstone: sandstone. Quaternary: alluvial and lacustrine deposits
Ge25-1a		Re Gh Gp		37	Zambia	2.13	4d	Polymorphic sandstone: sandstone. Quaternary: alluvial, lagoonal and lacustrine deposits
Ge26-1/2a	Gh Od			73	Angola	1.77	4d	Quaternary alluvial deposits

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Ge27-1a	Gh Od	Pp		1 363	Angola	2.13. 4.22	4d	Quaternary alluvial and aeolian deposits
Ge28-1a	Gd Qc	Od Ph		5 031	Angola	2.13. 4.22	4d. 4e	Kalahari sand. ironstone. chalcedony
Ge28-1a	Gd Qc	Od Ph		1 646	Zambia	2.13	4d. 4e	Quaternary alluvial and lacustrine deposits, overlying polymorphic sandstone: and sand
Ge29-1a	Gd Qc	Ph		818	Angola	2.13. 4.22	4d	Kalahari sand. ironstone. chalcedony
Ge29-1a	Gd Qc	Ph		1 512	Zambia	2.13. 4.22	4d	Quaternary alluvial and lacustrine deposits
Ge30-1a	Be	Gh O Je		317	Angola	4.22	4d	Quaternary alluvial deposits
Ge31-1a		Je V Od		2 257	Zambia	2.26	4d. 4h	Quaternary alluvial and lacustrine deposits
Ge32-2/3a	Gc Je	Oe		518	Zambia	1.77	4h	Quaternary alluvial and lacustrine deposits
Ge33-2/3a	Je	Gh Oe		2 012	Zambia	1.73. 1.76. 2.26	4d. 4h	Quaternary alluvial and lacustrine deposits.
Ge33-2/3a	Je	Gh Oe		1 199	Zaire	1.482. 1.73	4h	Quaternary alluvial and lacustrine deposits
Gh1-1/2a				938	Congo	1.122. 1.73	1b. 1c	Quaternary alluvial and lacustrine deposits
Gh1-3a				325	Cameroon	1.532. 1.533	4h	Quaternary alluvial and lacustrine deposits
Gh4	Gd Od	Jd		65	Cameroon	1.73	4a	Quaternary alluvial and lacustrine deposits
Gh4-a	Gd Od	Jd		432	Cameroon	1.73	4h	Quaternary alluvial and lacustrine deposits
Gh7-2a	Od	Je		584	Kenya	1.5. 1.534. 3.12	4c	Quaternary and recent alluvial and lacustrine deposits
Gh7-2a	Od	Je		1 537	Tanzania	1.72. 1.811. 1.812. 1.85	4h	Quaternary and recent alluvial and lacustrine deposits
Gh7-2a	Od	Je		1 810	Uganda	1.42. 1.811. 1.72	4d. 4h	Quaternary alluvial and lacustrine deposits
Gh7-2a	Od	Je		76	Rwanda	1.811	4h	Quaternary alluvial and lacustrine deposits
Gh8-b	Nd			178	Cameroon	1.123. 1.73	2a	Quaternary: alluvial deposits. Basement complex: granitic gneiss. micaschist. migmatite: granitic batholiths
Gh9-2a	Gd Od	Jd Fx		575	Madagascar	1.11. 1.222. 1.484. 1.72. 1.73. 2.31. 2.25	4h	Quaternary alluvial and lacustrine deposits

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Gh10-1a	Fx Pg	Ph Qa		717	Congo	1.121, 1.122	1b, 1c	Recent alluvial deposits
Gh11-2a	Fx Od			1 342	Zaire	1.122	1b, 1c	Quaternary alluvial and lacustrine deposits
Gh11-2a	Fx Od			5 605	Congo	1.121, 1.122	1b, 1c	Quaternary alluvial and lacustrine deposits
Gm15-2a	Je Oe	Ge Vc		108	Kenya	1.534	4g	Quaternary alluvial and lacustrine deposits
Gm15-2a	Je Oe	Ge Vc		3 194	Sudan	1.532, 1.533, 1.534	4d	Quaternary alluvial and lacustrine deposits
Gp4-1a	R	Q I F		450	Angola	1.73	2c	*Continental intercalaire:* sandstone, shale, conglomerate; polymorphic sandstone and Quaternary (?) alluvial cover
Gp5-1a		Gd Q		241	Angola	2.12, 2.13, 2.27	2c, 4c	Quaternary alluvial and lacustrine deposits
Gp6-2/3a	Je	V		48	Mozambique	1.36	4c	Quaternary alluvial and lagoonal deposits
Gp6-2/3a	Je	V		907	Tanzania	1.32, 1.36, 1.73, 1.812	4c	Quaternary alluvial, lagoonal and lacustrine deposits
Hh9-2b	I Vc			343	Nigeria	1.916	4c	Basic effusive rocks: basalt
Hl35-2a	Bk I		lithic	54	Morocco	3.24	5b	Nummulitic limestone and marl
Hl36-2a	I Xk	Lc	lithic	48	Morocco	3.24	5b	Nummulitic limestone and marl
Hl37-2a	Kl Lc	Bk I V		285	Morocco	6.1313	5b	Nummulitic limestone and marl with recent gravelly deposits
I				66	Sierra Leone	1.133, 1.476	1a	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths; pegmatite. Basic intrusives: gabbro, dolerite, diorite
I				1 610	Libya	3.23	9b, 9d	*Continental intercalaire:* sandstone, conglomerate, shale. Cambro-Ordovician: sandstone
I				260	Chad	4.32	4e 9d	Cambro-Ordovician and Precambrian: sandstone, schist, quartzite
I				476	Sudan	4.31, 4.32	8c	*Continental intercalaire:* sandstone, conglomerate, shale. Precambrian: schist, quartzite, syenite, dolerite
I				383	Central African Empire	1.42, 4.32	4a, 4c, 4e	Precambrian: schist, quartzite, syenite, dolerite

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
I				298	Nigeria	1.483. 1.484. 1.916	2c. 4a. 4c	Basement complex (Gwarian): granitic gneiss. micaschist. amphibolite. migmatite: granitic batholiths. Palaeogene: sandstone. shale
I				84	Upper Volta	1.532. 1.484	4e	Basement complex: granitic gneiss. schist. quartzite: granitic batholiths
I				30	Guinea	1.462	2a, 4c	Silurian schist and quartzite
I				31	Guinea-Bissau	1.462	2a, 4c	Silurian schist and quartzite
I				16	Angola	2.13	2c	Precambrian quartzite
I				243	Cameroon	1.73. 1.484	4a. 4c. 4e	Precambrian: granitic gneiss. micaschist. migmatite. quartzite: granitic batholiths: syenite. dolerite. Basic effusive rocks: basalt. andesite
I				161	Ghana	1.131	1a. 2a	Basement complex: orthogneiss. paragneiss. granite. micaschist. quartzite: greenstone. Voltaian: sandstone
I			petric	35	Mali	1.484	4a. 4c	Granite
I			petroferric	225	Central African Empire	1.483	4a. 4c	Precambrian: schist. quartzite, syenite. dolerite
I			petroferric	36	Sierra Leone	1.133	1a	Peridotite
I			rock debris	7 856	Algeria	3.23. 3.21	9d	Devonian and Carboniferous: sandstone. shale. limestone. Cambro-Ordovician: sandstone. marl. clayey marl. Silurian: clayey schist
I			rock debris	596	Mali	1.533	4g	Infracambrian: sandstone, tillite with minor limestone. Ordovician: sandstone with intercalations of quartzite and clayey marl. Silurian: clayey schist
			rock debris	10 580	Mauritania	1.534. 1.544. 3.21. 3.22. 3.14. 3.12	4g. 8c	Infracambrian: sandstone. tillite with minor limestone. Ordovician: sandstone with intercalations of quartzite
I			rock debris	2 332	Niger	3.21. 3.23	9d	*Continental intercalaire:* sandstone. shale. oolitic limestone. Cambro-Ordovician: sandstone and marl
I			rock debris	1 214	Egypt	3.23	9b	Precambrian: granite. gneiss, schist, quartzite

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
I			rock debris	384	Sudan	3.23	9b	Precambrian: granite, gneiss, schist, quartzite
I			rock debris	4 697	Libya	3.23	9b	Precambrian: granite, gneiss, schist, quartzite. *Continental intercalaire:* sandstone, shale, oolitic limestone. Cambro-Ordovician: sandstone and marl
I			stony	1 489	Tunisia	3.23	6c, 9b	Cretaceous limestone and marl
I			stony	815	Algeria	3.23, 3.21	9b	Precambrian granitized and metamorphic rocks
I			stony	90	Libya	3.23	9b	Cretaceous limestone and marl
I			stony	531	Niger	3.23	9b	Precambrian granitized and metamorphic rocks
I-a			petroferric	1 195	Senegal	1.532, 1.533, 1.534	4g	*Continental terminal:* sandstone, shale and marl, sand and clay
I-a			petroferric	51	Guinea	1.141	4c	Basic intrusive rocks: peridotite
I-a			shifting sands	490	Libya	3.23	9d, 9f	Precambrian: granite, gneiss, migmatite, leptite, micaschist, cipolin, schist, quartzite
I-a			shifting sands	3 787	Chad	3.23	9d, 9f	Precambrian: granite, gneiss, migmatite, leptite, micaschist, cipolin, schist, quartzite
I-ab			petroferric	62	Senegal	1.483	4a, 4c	Basic intrusive rocks: dolerite, diabase
I-ab			petroferric	1 500	Guinea	1.483	4a, 4c	Basic intrusive rocks: dolerite, diabase
I-ab			petroferric	167	Mali	1.484, 1.483	4a, 4c	Basic intrusive rocks: dolerite, diabase
I-b				114	Togo	1.42	4e	Precambrian: sandstone, conglomerate, dolomite
I-b				39	Ghana	1.42, 1.134	2a, 4e	Precambrian: sandstone, conglomerate, dolomite
I-b				167	Niger	3.21, 3.22	8c	Cretaceous: sandstone, shale, conglomerate
I-bc				455	Nigeria	1.483, 1.484	2c, 4a, 4c	Basement complex (Gwarian): granitic gneiss, micaschist, amphibolite, migmatite; granitic batholiths
I-bc				2 665	Algeria	3.21	9b	Precambrian: granite, gneiss, schist, quartzite, cipolin. Palaeozoic: clayey schist, sandstone, shale, marl, limestone

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
I-bc				9 717	Niger	3.21	8c, 9b, 9d	Precambrian: granite, gneiss, schist, quartzite, cipolin, Palaeozoic: clayey schist, sandstone, shale, marl, limestone
I-c				1 040	Nigeria	1.483, 1.74, 1.484, 1.916	2c, 4a, 4c	Basement complex (Gwarian): granitic gneiss, micaschist, amphibolite, migmatite; granitic batholiths, Cretaceous: sandstone, shale, Precambrian (Dahomeyan): schist, quartzite, syenite, dolerite
I-c				84	Ethiopia	3.11, 3.12	8c	Trap series; basalt, phonolite, nephelinite, trachyte, rhyolite, pyroclastics. Cretaceous: limestone, marl, sandstone
I-c				81	Somalia	3.11	8c	Trap series; basalt, phonolite, nephelinite, trachyte, rhyolite, pyroclastics; Cretaceous: limestone, marl, sandstone
I-c				183	Algeria	3.24	8d	Cretaceous marl and limestone
I-c				310	Tunisia	3.24	8d, 9b	Cretaceous marl and limestone
I-c				46	Zaire	1.72	2b	Precambrian; schist, gneiss, amphibolite, charnockite, quartzite, cipolin
I-c				16	Uganda	1.72	2b	Precambrian: schist, gneiss, amphibolite, charnockite, quartzite, cipolin
I-c				154	Kenya	2.7, 3.12	8a	Tertiary-recent volcanics; basalt, phonolite, nephelinite, pyroclastics, tuff
I-c				74	Mali	1.534, 1.54	4g	Precambrian schist and quartzite
I-lc			petroferric	241	Guinea	1.483, 1.484	4a, 4c	Cambrian: sandstone, tillite, minor limestone
I-lc			petroferric	2 314	Mali	1.484, 1.532	4a, 4c	Cambrian: sandstone, tillite, minor limestone
I-A-R-bc			stony	98	Kenya	1.812, 2.31	2b	Tertiary-recent volcanics: basalt, phonolite, nephelinite, pyroclastics, tuff
I-Ag-Fo-2b			petroferric	18	Senegal	1.483	4a, 4c	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths; calcareous schist, pelites, sandstone
I-Ag-Fo-2b			petroferric	4 227	Guinea	1.462, 1.483, 1.476	2a, 4a, 4c	Basement complex; granitic gneiss, schist, quartzite; granitic batholiths; calcareous schist, pelites, sandstone

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
I-Ag-Fo-2b			petroferric	60	Sierra Leone	1.476	2a, 4c	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths; calcareous schist, pelites, sandstone
I-Af-Lg			petric	129	Nigeria	1.916, 1.484	2c, 4c, 4e	Basement complex (Gwarian): granitic gneiss, micaschist, amphibolite, migmatite; granitic batholiths
I-Ao				210	Ghana	1.482	1a	Precambrian: sandstone, conglomerate, dolomite. Birrimian: schist, phyllite, grauwacke, sandstone, greenstone
I-Ao-2bc			stony	730	Guinea	1.73	2a	Precambrian (Dahomeyan): schist, gneiss, quartzite
I-Ao-N c				701	Angola	1.73, 1.77, 2.27	2c, 4e	Precambrian: calcareous schist, dolomite, conglomerate, tillite. *Continental intercalaire:* sandstone, shale, conglomerate. Basement complex: granitic gneiss, migmatite, schist, quartzite; granitic batholiths
I-Bc				715	Botswana	2.23, 2.29	4e	Precambrian: shale, siltstone, sandstone, conglomerate; intrusions of granite, diorite and gabbro
I-Bc				32	Madagascar	1.37	4e	Cretaceous: sandstone, marl, limestone
I-Bc-c				183	Tanzania	1.36	2c	Precambrian: schist, graphitic schist, gneiss, amphibolite, charnockite, quartzite, cipolin, crystalline limestone; granitic batholiths; basic intrusive rocks
I-Bc-c				1 765	Malawi	1.36, 1.77, 1.741, 2.13	2c	Precambrian: schist, quartzite, syenite, dolerite, graphitic schist, gneiss, amphibolite, charnockite, crystalline limestone; granitic batholiths
I-Bc-c				591	Mozambique	1.23, 1.36	2c	Precambrian: graphitic schist, amphibolite, charnockite, quartzite, crystalline limestone; granitic batholiths
I-Bc-c				140	Zambia	1.77	2c	Precambrian: graphitic schist, gneiss, amphibolite, charnockite, quartzite, crystalline limestone; granitic batholiths
I-Bc-Be				74	Madeira Islands	6.441	4g	Basic and some acid effusive rocks: basalt, trachyte, rhyolite
I-Bc-L-2/3c				1 046	South Africa	2.432	7c	Karroo: basalt, dolerite and some diorite and gabbro

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
I-Bc-L-2/3c				2 109	Lesotho	2.432	7c	Karroo: basalt, dolerite and some diorite and gabbro
I-Bc-Tv-2/3bc				532	Sudan	4.31	4g	Basic effusive rocks: basalt. andesite
I-Bc-V				4 699	Rhodesia	2.15. 2.26. 2.27. 2.14. 4.322	2c. 2d	Precambrian: gneiss. quartzite. schist. phyllite: greenstone. Basic intrusive rocks: diorite. gabbro. Karroo: basalt. rhyolite
I-Bc-V				149	Zambia	4.322	2d	Karroo: basalt. rhyolite
I-Bc-V				37	Malawi	1.533	2d	Karroo: clayey schist. sandstone: greenstone. Jurassic and Cretaceous: sandstone. shale
I-Bc-V				284	Botswana	2.29. 4.342	2d	Karroo: basalt. rhyolite
I-Bc-V				2 709	Mozambique	4.22. 1.918. 1.534. 1.915	2c. 2d	Karroo: clayey schist. sandstone: greenstone. Jurassic and Cretaceous: sandstone. shale
I-Bc-V-ac				292	Rhodesia	4.322	2d	Karroo: clayey schist. sandstone. shale. arkose
I-Bd-Nd-b				56	Ghana	1.121	1a	Precambrian (Birrimian): schist. phyllite. grauwacke. sandstone. greenstone: granitic batholiths
I-Be				20	Upper Volta	1.532	4e	Precambrian (Birrimian): schist. quartzite. greenstone: granitic batholiths
I-Be-a			stony	826	Ghana	1.42	4a. 4c	Basement complex: orthogneiss. paragneiss. granite. micaschist. quartzite
I-Be-bc				2 515	Sudan	4.31	4e	Precambrian: gneiss. quartzite, cipolin. andesite. conglomerate. argillite. rhyolite: granitic batholiths
I-Be-Tv-c				76	Comoro Islands	1.121	4e	Basalt, rhyolite
I-Bf				274	Central African Empire	1.471	2a	Precambrian: schist. quartzite. syenite. dolerite. sandstone
I-Bf-bc			stony	2 097	Guinea	1.462	2a. 4c	Silurian sandstone: Devonian schist. and sandstone
I-Bf-bc			stony	585	Guinea-Bissau	1.462	2a. 4c	Silurian sandstone: Devonian schist. and sandstone
I-Bf-Rd				22	Ivory Coast	1.121	1a	Precambrian (Birrimian): schist. quartzite, greenstone
I-Bk-bc				499	Algeria	6.142. 6.741	6d. 6e	Cretaceous limestone: Eocene flysch: Miocene limestone and marl

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
I-Bk-c				25	Algeria	6.741	6d. 6e	Jurassic limestone and dolomite
I-Bk-E-b				720	Madagascar	1.142. 1.144. 1.484	2c. 4e	Jurassic and Cretaceous limestone
I-Bk-R-bc			stony	433	Kenya	1.33. 1.812	4g	Tertiary-recent volcanics: basalt, phonolite, nephelinite, pyroclastics, tuff
I-Bk-Rc-a			petrocalcic	1 322	Madagascar	1.574. 1.583	8a	Eocene calcareous sandstone; Jurassic marl
I-Bk-X-2c			petrocalcic	1 551	Morocco	3.271	6d. 6e. 8d	Jurassic: limestone. dolomite. granite. Palaeozoic: schist and quartzite
I-Bv				117	Madagascar	1.121	2c. 4e	Jurassic limestone
I-Bv-c				455	Mali	1.532	4g	Basic intrusives: dolerite and diabase. Palaeozoic: metamorphic rocks
I-Bv-Lc-2/3ab				924	Libya	6.172. 6.183. 6.822. 6.922	6c. 9f	Palaeogene: limestone. Neogene: limestone. marl. gypsum
I-Bv-Q-a				147	Senegal	1.32	4e	Eocene nummulitic limestone
I-E-bc				349	Somalia	1.85, 3.51	4b	Precambrian: gneiss. schist. quartzite: granitic batholiths. Jurassic: limestone, marl. gypsum
I-E-2c				18	Algeria	3.23	9b	Upper Cretaceous limestone and marl: Pliocene lacustrine deposits
I-E-2c				409	Tunisia	3.24	9b	Upper Cretaceous limestone and marl: Pliocene lacustrine deposits
I-E-Lc-bc				206	Somalia	1.85	4b	Precambrian: gneiss. schist. quartzite: granitic batholiths. Cretaceous: limestone. marl. sandstone
I-E-X-2c				193	Tunisia	3.24. 6.812	8d	Upper Cretaceous and Palaeogene: limestone and marl partly covered with recent alluvial deposits
I-F-c				95	Angola	1.77. 2.13	2c	Precambrian: gneiss. amphibolite. mica-schist. quartzite. limestone. dolomitic shale. schist. sandstone. shale, arkose
I-Fh-Fr-2b				791	Guinea	1.73. 1.476. 1.462. 1.483	2a. 4c	Basic intrusive rocks: dolerite. diabase
I-Fo-c				18	Guinea	1.483	2a. 4c	Granite
I-Fo-c				158	Sierra Leone	1.476	4c. 2a	Granite. Basement complex: granitic gneiss. schist. quartzite; granitic batholiths: pegmatite

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
I-Fo-1b				42	Guinea	1.483	2a, 4c	Cambrian: calcareous schist, quartzite, *pelites*
I-Fo-2bc				70	Liberia	1.132	2a	Precambrian (Dahomeyan): schist, gneiss, quartzite
I-Fo-2bc				516	Guinea	1.132	2a	Precambrian (Dahomeyan): schist, gneiss, quartzite
I-Fo-Fx			petric	394	Sierra Leone	1.476	2a, 4c	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths; pegmatite
I-Fp-ac			petroferric	905	Sierra Leone	1.476	1a	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths; pegmatite
I-Fr-3ab				374	Guinea	1.476	2a, 4c	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths. Precambrian: schist, quartzite, greenstone
I-Fr-3ab				84	Sierra Leone	1.476	2a, 4c	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths. Precambrian: schist, quartzite, greenstone
I-Fx-1ab				523	Liberia	1.471	1a	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths
I-G				98	Ghana	1.42	4a, 4c	Precambrian: sandstone, conglomerate, dolomite
I-Jc-Xk-2/3bc			stony	2 356	Libya	3.23	8d	Neogene: limestone, marl, gypsum. Quaternary: alluvial, lagoonal and marine deposits
I-Je				155	Libya	3.23	9b	Palaeogene: limestone and arenaceous gypsiferous clay; recent alluvial and lacustrine deposits
I-L-ab				130	Angola	1.73	2c	*Continental intercalaire:* sandstone, shale, conglomerate
I-L-1b				266	Mozambique	1.23, 1.32, 1.485	2c	Precambrian: graphitic schist, gneiss, amphibolite, charnockite, quartzite, crystalline limestone; granitic batholiths
I-L-Q-bc			stony	5 858	Zambia	1.842, 2.13	2c, 2d	Precambrian: granitic gneiss, schist, quartzite, syenite, dolerite, limestone, dolomitic shale, sandstone, shale, arkose. Karroo: conglomerate, siltstone
I-L-Q-bc			stony	43	Mozambique	1.842	2c	Karroo: conglomerate, siltstone
I-L-Q-bc			stony	32	Rhodesia	4.2214	2d	Syenite, dolerite

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION *(continued)*

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
I-L-R-bc			stony	1 839	Tanzania	1.36, 1.812, 1.846, 1.85	2a, 2c, 4g	Precambrian: schist, gneiss, charnockite, quartzite, cipolin; granitic intrusions
I-L-Re-2c			lithic	1 242	Morocco	6.872, 6.75, 6.922	6d, 6e	Precambrian and Cambrian: metamorphic rocks, granite
I-Lc-a				76	Rhodesia	2.15	2d	Precambrian: gneiss, quartzite, schist, phyllite, greenstone
I-Lc-2bc				199	Mozambique	2.21	2a	Karroo: basalt, andesite. rhyolite
I-Lc-2bc				152	South Africa	2.21, 2.27	2a	Karroo: basalt, andesite, rhyolite
I-Lc-2bc				58	Swaziland	2.21	2a	Karroo: basalt, andesite, rhyolite
I-Lc-Re-b			stony	3 310	Sudan	4.31, 4.32	4g	Precambrian: schist, quartzite, syenite, dolerite
I-Lc-X-2c			lithic	1 474	Morocco	3.23	6d, 6e	Precambrian and Cambrian: schist, gneiss. amphibolite
I-Lf				651	Nigeria	1.484, 1.482	2c, 4a, 4c	Basement complex (Gwarian): granitic gneiss, micaschist, amphibolite, migmatite; granitic batholiths
I-Lf				104	Upper Volta	1.533	4e	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths. Precambrian (Birrimian): schist. quartzite, greenstone
I-Lf			petric	82	Cameroon	1.484	4a, 4c	Basement complex: granitic gneiss, micaschist, migmatite; granitic batholiths
I-Lf-bc			stony	994	Nigeria	1.482	4a, 4c	Precambrian (Dahomeyan): schist, quartzite, syenite. dolerite; acid and basic effusive rocks: rhyolite, basalt, andesite
I-Lf-bc			stony	120	Cameroon	1.484	4a, 4c	Precambrian (Dahomeyan): schist. quartzite, syenite, dolerite; acid and basic effusive rocks: rhyolite, basalt, andesite
I-Lf-c				233	Ghana	1.481, 1.482	1a	Voltaian sandstone
I-Lf-1b				501	Nigeria	1.916, 1.484	2c, 4c	Basement complex (Gwarian): granitic gneiss, micaschist, amphibolite, migmatite; granitic batholiths
I-Lf-Lg-b				17	Nigeria	1.482	4a, 4c	Basement complex (Gwarian): granitic gneiss, micaschist. amphibolite, migmatite; granitic batholiths
I-Lf-Lp				141	Upper Volta	1.532	4e	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
I-Lf-Ne			petroferric	3 045	Guinea	1.483, 1.484	4a, 4c	Precambrian: schist, quartzite, greenstone
I-Lf-Ne			petroferric	654	Mali	1.484	4a, 4c	Precambrian: schist, quartzite, greenstone
I-Lf-Qc			petroferric	420	Nigeria	1.532	4e	Palaeogene: limestone, marl, shale. *Continental intercalaire:* poorly consolidated sandstone, shale, conglomerate, grits, sand, clay
I-Lf-Qc			petroferric	4	Niger	1.533	4e	Palaeogene: limestone, marl, shale. *Continental intercalaire:* poorly consolidated sandstone, shale, conglomerate, grits, sand, clay
I-Lf-Ql				80	Nigeria	1.532, 1.916	2c, 4a, 4c	Basement complex (Gwarian): granitic gneiss, micaschist, amphibolite, migmatite; granitic batholiths. Cretaceous: sandstone, arkose, shale
I-Lf-Ql				30	Niger	1.917	4e	Basement complex (Gwarian): granitic gneiss, micaschist, amphibolite, migmatite; granitic batholiths. Cretaceous: sandstone, arkose, shale
I-Lf-Ql-ab				1 414	Nigeria	1.532, 1.484, 1.916	2c, 4c	Basement complex (Gwarian): granitic gneiss, micaschist, amphibolite, migmatite; granitic batholiths
I-Lf-Rd			stony	82	Ghana	1.471	1a	Precambrian: sandstone, conglomerate, dolomite. Birrimian: schist, phyllite, sandstone, greenstone
I-Lf-Rd			stony	811	Togo	1.471, 1.482, 1.484	1a, 4a, 4c	Precambrian: sandstone, conglomerate, dolomite. Birrimian: schist, phyllite, grauwacke, sandstone, greenstone
I-Lf-Rd			stony	613	Benin	1.484	4e	Precambrian: sandstone, conglomerate, dolomite, Birrimian: schist, phyllite, grauwacke, sandstone, greenstone
I-Lf-Re				175	Nigeria	1.482	2a, 4a, 4c	Basement complex (Gwarian): granitic gneiss, micaschist, amphibolite, migmatite; granitic batholiths
I-Lf-Re			petroferric	73	Nigeria	1.412, 1.482	2a	Cretaceous limestone and marl
I-Lf-Re			petroferric	3	Benin	1.412	4a, 4c	Cretaceous limestone and marl
I-Lf-Re-1b				1 554	Nigeria	1.482, 1.74	4a, 4c	Basement complex (Gwarian): granitic gneiss, micaschist, amphibolite, migmatite; granitic batholiths; basic effusive rocks: basalt, andesite
I-Lf-Vc-1b			petroferric	545	Mali	1.533	4g	Basic intrusives: dolerite, diabase. Palaeozoic: metamorphic rocks·
I-Lg			petroferric	471	Mali	1.483, 1.484	4a, 4c	Precambrian: schist, quartzite, greenstone

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION *(continued)*

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
I-Lg			petroferric	185	Senegal	1.483	4a, 4c	Precambrian: schist, quartzite, greenstone
I-Lg			petroferric	30	Guinea	1.483	4a, 4c	Precambrian: schist, quartzite, greenstone
I-Lf-2b				17	Nigeria	1.482	4a, 4c	Basement complex (Gwarian): granitic gneiss, micaschist, amphibolite, migmatite; granitic batholiths
I-Lg-Re			petroferric	1 207	Senegal	1.483, 1.532	4c, 4e	Precambrian and Cambrian: calcareous schist, quartzite, pelites
I-Lg-Re			petroferric	417	Guinea	1.483	2a, 4c	Precambrian and Cambrian: calcareous schist, quartzite, pelites
I-Lp				73	Nigeria	1.916	2c, 4c	Precambrian (Dahomeyan): schist, quartzite, syenite, dolerite
I-Lp				17	Upper Volta	1.532	4e	Greenstone
I-Lp				16	Ghana	1.484	4e	Greenstone
I-Lv				140	Nigeria	1.916	2c, 4c	Precambrian (Dahomeyan): schist, quartzite, syenite, dolerite
I-N-c			stony	66	Rwanda	1,811	4a, 4c	Precambrian: shale, sandstone, conglomerate, phyllite, schist, quartzite
I-Nd				150	Nigeria	1.483, 1.484	4a, 4c	Basement complex (Gwarian): granitic gneiss, micaschist, amphibolite, migmatite; granitic batholiths. Cretaceous: sandstone and shale
I-Nd				72	Cameroon	1.73	2a	Basement complex: granitic gneiss, micaschist, migmatite; granitic batholiths
I-Nd-Rd-1bc				984	Nigeria	1.131, 1.482	1a, 4a, 4c	Basement complex (Gwarian): granitic gneiss, micaschist, amphibolite, migmatite; granitic batholiths. Cretaceous; sandstone and shale
I-Ne				10	Nigeria	1.482	2a	Basement complex (Gwarian): granitic gneiss, micaschist, amphibolite, migmatite; granitic batholiths
I-Ne			petroferric	347	Guinea	1.462, 1.483	2a, 4c	Precambrian; crystalline schist, quartzite
I-Ne			petroferric	62	Senegal	1.483	2a, 4c	Precambrian: crystalline schist, quartzite
I-Ne-To				218	Equatorial Guinea	1.131	1a	Basic effusive rocks: basalt, andesite, pyroclastics
I-Nh-Rd-b				28	Nigeria	1.482	4a, 4c	Precambrian (Dahomeyan); schist, quartzite, syenite, dolerite
I-Nh-Rd-b			stony	84	Nigeria	1.482	4a, 4c	Precambrian (Dahomeyan): schist, quartzite, syenite, dolerite
I-Qc				90	Botswana	2.29	4g	Karroo: clayey schist, sandstone, shale, arkose; effusive rocks: basalt, rhyolite

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
I-Ql-Re				14	Nigeria	1.482	4a, 4c	Basement complex (Gwarian): granitic gneiss, micaschist, amphibolite, migmatite; granitic batholiths
I-Ql-Re				130	Mauritania	1.533	4g	Cambrian: calcareous schist, quartzite, pelites, sandstone, tillite
I-R				269	Sudan	1.534	4g	Trap series: basalt, phonolite, nephelinite, trachyte, rhyolite, pyroclastics
I-R				37	Uganda	1.83	4g	Trap series: basalt, phonolite, nephelinite, trachyte, rhyolite, pyroclastics
I-R				1 812	Kenya	1.534	4g	Trap series: basalt, phonolite, nephelinite, trachyte, rhyolite, pyroclastics
I-R			stony	703	Kenya	1.81, 1.812, 2.31	4g	Tertiary-recent volcanics: basalt, phonolite, nephelinite, pyroclastics, tuff
I-R-bc			stony	2 389	Kenya	1.33, 1.582, 1.811, 1.812, 1.83, 1.534	2b, 4g	Precambrian: schist, gneiss, amphibolite, charnockite, quartzite, cipolin. Tertiary-recent volcanics: basalt, phonolite, nephelinite, pyroclastics, tuff
I-R-bc			stony	60	Tanzania	1.33	4g	Precambrian: schist, gneiss, amphibolite, charnockite, quartzite, cipolin. Tertiary-recent volcanics: basalt, phonolite, nephelinite, pyroclastics, tuff
I-R-bc			stony	1 838	Uganda	4.2, 1.83, 1.73, 1.42	4a, 4c, 4e	Precambrian: schist, gneiss, amphibolite, charnockite, quartzite, cipolin. Tertiary-recent volcanics: basalt, phonolite, nephelinite, pyroclastics, tuff
I-R-bc			stony	146	Sudan	1.42	4e	Precambrian: schist, gneiss, amphibolite, charnockite, quartzite, cipolin. Tertiary-recent volcanics: basalt, phonolite, nephelinite, pyroclastics, tuff
I-Rc				25	Ethiopia	1.85	4b	Aden volcanic series: basalt, basaltic breccias, tuff
I-Rc				561	Somalia	3.51	4b	Palaeogene limestone and marl
I-Rc-bc				727	Somalia	3.11, 3.51	8a	Palaeogene limestone and marl; recent aeolian coastal deposits
I-Rc-1/2bc			petrocalcic	216	Algeria	6.741, 3.24	8d'	Cretaceous crystalline limestone; Neogene clayey marl
I-Rc-1/2c				83	Morocco	3,272	8d	Jurassic limestone and dolomite
I-Rc-1/2c				172	Algeria	3.272	8d	Jurassic limestone and dolomite

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION *(continued)*

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
I-Rd				94	Upper Volta	1.484	4a. 4c	Cambrian: sandstone. tillite. minor limestone
I-Rd				306	Sudan	1.917. 3.22	4e. 4g. 8c	Basement complex: granitic gneiss. migmatite. schist. quartzite: granitic batholiths
I-Rd				5 246	Chad	1.917, 3.22	4e. 4g. 8c	Basement complex: granitic gneiss. migmatite. schist. quartzite: granitic batholiths
I-Rd			stony	35	Nigeria	1.484	4a. 4c	Precambrian (Dahomeyan): schist. quartzite. syenite. dolerite
I-Rd-bc				22	Mauritius	1.22	4a	Tertiary: basalt and some trachyte
I-Rd-bc				182	Cameroon	1.77	4a. 4c	Precambrian: granitic gneiss. micaschist. migmatite. quartzite. syenite. dolerite; granitic batholiths
I-Rd-c				175	Nigeria	1.482	4a. 4c	Precambrian (Dahomeyan): schist. quartzite. syenite. dolerite
I-Rd-c			stony	27	Cameroon	1.73. 1.77	4a. 4c	Precambrian (Dahomeyan): schist. quartzite. syenite. dolerite
I-Rd-c			stony	322	Nigeria	1.482	4a. 4c	Precambrian (Dahomeyan): schist. quartzite. syenite. dolerite
I-Rd-So				1 241	Chad	1.916. 1.917. 4.32	4e	Precambrian: granitic gneiss. migmatite. schist. quartzite. syenite. dolerite: granitic batholiths. Quaternary: alluvial and lacustrine deposits
I-Rd-So				68	Sudan	4.32	4e	Precambrian: granitic gneiss. migmatite. schist, quartzite. syenite. dolerite: granitic batholiths. Quaternary: alluvial and lacustrine deposits
I-Re				3 643	Sudan	1.917, 4.31, 4.32	4e. 4g	Precambrian: schist. quartzite. syenite. dolerite
I-Re				590	Mauritania	3.12	8c	*Continental terminal:* sandstone. shale. marl. sand. clay
I-Re				679	Libya	3.23	9b	Palaeozoic and *continental intercalaire:* sandstone
I-Re				108	Niger	1.919	4g	*Continental intercalaire:* sandstone. arkose. shale. conglomerate
I-Re				126	Central African Empire	1.483	4a. 4c	Basement complex: granitic gneiss. micaschist. migmatite: granitic batholiths
I-Re				113	Cameroon	1.483, 1.532	4a. 4c	Precambrian (Dahomeyan): schist. quartzite. syenite. dolerite. Basement complex: granitic gneiss. micaschist. migmatite: granitic batholiths

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION *(continued)*

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
I-Re				786	Chad	1.532	4a, 4c, 4e, 4g	Precambrian (Dahomeyan): schist, quartzite, syenite, dolerite. Basement complex: granitic gneiss, micaschist, migmatite: granitic batholiths
I-Re			petroferric	450	Mauritania	1.543	4g	*Continental terminal:* sandstone, shale, marl, sand, clay
I-Re			shifting sands	5 797	Chad	3.21, 3.22	8c	*Continental terminal:* poorly consolidated sandstone, shale, conglomerate, grits, sand, clay. Pleistocene and recent alluvial and aeolian deposits. Quaternary alluvial and lacustrine deposits
I-Re			shifting sands	93	Niger	3.21	9b	*Continental terminal:* poorly consolidated sandstone, shale, conglomerate, grits, sand, clay. Quaternary: alluvial and lacustrine deposits
I-Re-a				623	Nigeria	1.916	2c, 4c	Precambrian (Dahomeyan): schist, quartzite, syenite, dolerite
I-Re-a			petric	5 712	Mali	3.21, 3.22	8c, 9b	*Continental terminal:* sandstone, shale, chert
I-Re-b				655	Nigeria	1.916	2c, 4c	Precambrian (Dahomeyan): schist, quartzite, syenite, dolerite
I-Re-b				238	Upper Volta	1.532	4e	Voltaian; sandstone, shale, conglomerate, dolomitic limestone, schist
I-Re-b				850	Mali	1.533, 1.534, 1.54	4e, 4g	Precambrian schist and quartzite
I-Re-b			stony	1 231	Mali	3.22	4g, 8c	Eocene limestone, marl and calcareous sandstone, mostly overlain with *continental terminal:* poorly consolidated sandstone, mudstone, conglomerate, grits
I-Re-b			stony	89	Niger	3.22	8c	Eocene limestone, marl and calcareous sandstone, mostly overlain with *continental terminal:* poorly consolidated sandstone, mudstone, conglomerate, grits
I-Re-b			stony	48	Sudan	1.534	4g	Trap series: basalt, phonolite, nephelinite, trachyte, rhyolite, pyroclastics
I-Re-bc			rock debris	13 069	Egypt	3.21, 3.271	9a, 9b	Basement complex: orthogneiss, granite, diorite, syenite. Precambrian: serpentinite, gabbro, basic effusives, conglomerate, schist, grauwacke. Mesozoic: muschelkalk and marly and dolomitized limestone. Palaeogene limestone

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION *(continued)*

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
I-Re-bc			rock debris	5 818	Sudan	3.23	8c	Basement complex: granitic gneiss, mica-schist and dolerite dykes. Precambrian gneiss, quartzite, schist, cipolin, conglomerate, argillite, andesite, rhyolite; granitic batholiths
I-Re-bc			rock debris/ stony	24 394	Algeria	3.23, 3.21	9b, 9d	Cambrian: gneiss, schist, quartzite, cipolin, conglomerate, sandstone, arkose, intruded with granite
I-Re-bc			rock debris/ stony	1 104	Niger	3.21	9b, 9d	Cambrian: gneiss, schist, quartzite, cipolin, conglomerate, sandstone, arkose, intruded with granite
I-Re-bc			rock debris/ stony	1 436	Mali	3.21	9b, 9d	Cambrian: gneiss, schist, quartzite, cipolin
I-Re-c				98	Cape Verde	1.584	4g	Cretaceous and Tertiary: limestone, marl, shale
I-Re-c				24	Mauritius	1.22	4g	Tertiary: basalt and some trachyte
I-Re-3a			saline	909	Kenya	1.534	8a	Tertiary-recent volcanics: basalt, phonolite, nephelinite, pyroclastics, tuff
I-Re-3a			saline	8 317	Ethiopia	1.85, 3.11	4b, 8a, 8c, 9c	Aden volcanic series: basalt, basaltic breccias, tuff. Trap series: basalt, phonolite, nephelinite, trachyte, rhyolite, pyroclastics. Quaternary: coastal and alluvial deposits
I-Re-3a			saline	128	Somalia	3.11	8c	Trap series: basalt, phonolite, nephelinite, trachyte, rhyolite, pyroclastics. Aden volcanic series: basalt, basaltic breccias, tuff
I-Re-3a			saline	1 682	Territory of the Afars and the Issas	3.12	8c	Trap series: basalt, phonolite, nephelinite, trachyte, rhyolite, pyroclastics. Aden volcanic series: basalt, basaltic breccias, tuff
I-Re-T-c			stony	34	Kenya	1.33	4g	Tertiary-recent volcanics: basalt, phonolite, nephelinite, pyroclastics, tuff
I-Re-T-c			stony	180	Tanzania	1.33, 1.846, 2.7	4g	Tertiary-recent volcanics: basalt, phonolite, nephelinite, pyroclastics, tuff
I-Re-Tm-a				308	Zaire	1.72	2b	Effusive rocks: basalt, rhyolite, dacite, trachyte, pyroclastics, tuff
I-Re-Tm-a				62	Uganda	1.72	2b	Effusive rocks: basalt, rhyolite, dacite, trachyte, pyroclastics, tuff
I-Re-Tv-1c			stony	95	Reunion Island	1.64	1a, 4a	Quaternary basalt

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
I-To-Xh-b				108	Cape Verde	1.573, 1.584	4g	Basic effusive rocks: basalt, pyroclastics, tuff
I-Tv				101	Canary Islands	6.41, 6.443, 6.84	6b	Basic and some acid effusive rocks: basalt, trachyte, rhyolite
I-Tv-c				54	Cape Verde	1.573	4g	Basic effusive rocks: basalt, pyroclastics, tuff
I-U-c				25	Uganda	2.7	2b	Tertiary-recent volcanics: basalt, phonolite, nephelinite, pyroclastics, tuff
I-U-c				7	Zaire	2.7	2b	Tertiary-recent volcanics: basalt, phonolite, nephelinite, pyroclastics, tuff
I-U-c				184	Kenya	2.12, 2.7	2b	Tertiary-recent volcanics: basalt, phonolite, nephelinite, pyroclastics, tuff
I-V				117	Kenya	1.81, 1.812	2b	Tertiary-recent volcanics: basalt, phonolite, nephelinite, trachyte, rhyolite, pyroclastics, tuff
I-V-b				458	Kenya	1.33, 1.72, 1.846	4g	Tertiary-recent volcanics: basalt, phonolite, nephelinite, pyroclastics, tuff
I-Ws				141	Upper Volta	1.532	4e	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths
I-X-c				45	Libya	3.23	9b	Jurassic and Cretaceous: dolomitic limestone and marl
I-X-c				916	Tunisia	3.23	9b	Jurassic and Cretaceous: dolomitic limestone and marl
I-X-c				127	Angola	3.37	4e	Basement complex: granitic gneiss, migmatite, schist, quartzite; granitic batholiths. Cretaceous: limestone, marl, sandstone
I-X-c			rock debris	3 119	Angola	1.77, 3.37, 3.51	7b, 8c	Basement complex: granitic gneiss, schist, migmatite, quartzite, phyllite; granitic batholiths. Basic and ultrabasic intrusive rocks: diorite, gabbro, peridotite. Precambrian: dolomitic schist, quartzite. Palaeozoic: quartzite, limestone
I-X-c			rock debris	8 388	Namibia	3.43, 3.26, 2.16, 3.51	4g, 8c, 9b	Basement complex: granite, gneiss, schist, phyllite. Basic and ultrabasic intrusive rocks: diorite, gabbro, peridotite. Precambrian: dolomitic schist, quartzite. Palaeozoic: quartzite, limestone
I-X-c			rock debris	7 528	South Africa	3.4, 3.5, 3.82, 5.741, 5.622, 2.36, 3.26	8c	Basement complex: granite, gneiss, schist, phyllite. Palaeozoic: sandstone, quartzite, shale, tillite

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
I-X-Y-2c			lithic	467	Morocco	3.271	8d, 9b	Palaeozoic: schist, quartzite
I-Xh-2a				56	Cape Verde	1.573	4g	Basic effusive rocks: basalt, pyroclastics, tuff. Tertiary: limestone, marl, shale. Quaternary: coastal deposits
I-Xk-2b				253	Libya	3.23	9b	Cretaceous dolomite and limestone
I-Y			rock debris	30	Mauritania	3.23	8c, 9b	Devonian and Carboniferous limestone with intercalations of sandstone and schist
I-Y			rock debris	1 826	Spanish Sahara	3.21, 3.23	8c, 9b	Devonian and Carboniferous limestone with intercalations of sandstone and schist
I-Y			stony	851	Algeria	3.23	9d	Precambrian: gneiss, micaschist, quartzite, cipolin, granite
I-Y			stony/ shifting sands	5 471	Sudan	3.21, 3.22	9b	Precambrian: gneiss, quartzite, schist, cipolin, andesite, rhyolite, conglomerate, argillite; granitic batholiths. *Continental intercalaire:* sandstone, conglomerate, shale
I-Y-a			petrocalcic	155	Morocco	3.23	8c	Cretaceous and Eocene calcareous sandstone and limestone
I-Y-a			petrocalcic	837	Spanish Sahara	3.34, 3.23, 3.21	8c	Cretaceous and Eocene calcareous sandstone and limestone
I-Y-a			stony	122	Morocco	3.271, 3.34	8d	Cretaceous limestone
I-Y-a			stony/ shifting sands	5 600	Mauritania	3.21	9b, 9c	Cambrian: granite, gneiss, schist, quartzite, partly overlain with Palaeozoic sandstone and *continental terminal*
I-Y-ab			stony	19 028	Chad	3.21, 3.23	8c, 9b, 9d	Cambro-Ordovician and Silurian sandstone; Devonian sandstone
I-Y-ab			stony	411	Sudan	3.21	9b	Devonian sandstone
I-Y-ab			stony	134	Niger	3.23	9d	Cambro-Ordovician and Silurian sandstone
I-Y-ab			stony	736	Algeria	3.23	9b	Precambrian: granite, gneiss, schist, quartzite, some sandstone, slate, limestone and rhyolite
I-Y-ab			stony	202	Mali	3.23	9b	Precambrian: granite, gneiss, schist, quartzite, some sandstone, slate, limestone and rhyolite
I-Y-ab			stony	9 003	Spanish Sahara	3.23, 3.21, 3.11	8c, 9b	Precambrian: granite, gneiss, schist, quartzite, some sandstone, slate, limestone and rhyolite

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
I-Y-ab			stony	12 230	Mauritania	3.23, 3.21, 3.11	8c	Precambrian: granite, gneiss, schist, quartzite, some sandstone, slate, limestone and rhyolite
I-Y-ab			stony	320	Libya	3.23	9d	Cambro-Ordovician and Silurian sandstone
I-Y-ab			shifting sands	890	Sudan	3.21, 3.22	9b	Ordovician sandstone; recent aeolian cover
I-Y-ab			shifting sands	740	Chad	3.21, 3.22	9b	Ordovician sandstone; recent aeolian cover
I-Y-b				596	Libya	3.23	9d	Precambrian: cipolin, schist, quartzite. Palaeozoic: sandstone
I-Y-b				523	Chad	3.23	9d	Precambrian: cipolin, schist, quartzite. Palaeozoic; sandstone
I-Y-b			stony/ rock debris	150	Mauritania	3.23	9b	Basement complex: granite, gneiss, schist, quartzite
I-Y-b			stony/ rock debris	6 001	Algeria	3.23	9b	Basement complex: granite, gneiss, schist, quartzite
I-Yk-a			petrocalcic	16 932	Algeria	3.23	9b, 9f	Neogene and Quaternary: calcareous slightly consolidated sediments
I-Yk-ab			stony/ petrocalcic	3 406	Morocco	3.23	9a, 9b	Villafranchian: limestone, calcareous marl, sandstone, travertine. Upper Cretaceous: limestone
I-Yk-ab			stony/ petrocalcic	4 693	Algeria	3.23	9a, 9b	Villafranchian: limestone, calcareous marl, sandstone, travertine. Upper Cretaceous: limestone
I-Yk-2/3b			stony	720	Egypt	3.271	9a, 9b	Cretaceous: marly and dolomitized limestone. Palaeogene: limestone. Neogene: limestone, marl and gypsum
I-Yy-b			shifting sands	1 332	Algeria	3.23	9c	Neogene marl partly covered with aeolian sand
I-Z				68	Morocco	3.23	8c	Upper Cretaceous calcareous sandstone and limestone
I-Zo			lithic	1 337	Somalia	1.543	8c	Quaternary coastal deposits
J2	G			178	Togo	1.412, 1.35	4d, 4e	Recent alluvial deposits
J2-a	G			40	Upper Volta	1.532	4e	Recent alluvial deposits
J2-a	G			56	Benin	1.42	4e	Recent alluvial deposits

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
J2-a	G			205	Togo	1.42	4e	Recent alluvial deposits
J2-a	G			141	Ghana	1.42, 1.482	4a, 4c	Recent alluvial deposits
J2-1/2a	G			2 408	Nigeria	1.482, 1.484, 1.916	4a, 4c, 4e	Recent alluvial deposits
J2-1/2a	G			205	Cameroon	1.484, 1.532	4e	Recent alluvial deposits
J3-2a	Gd			103	Mali	1.484	4a, 4c	Recent alluvial deposits
J3-2a	Gd			314	Guinea	1.483, 1.484	4a, 4c	Recent alluvial deposits
J4-a	G Fx		sodic/ saline	308	Cameroon	1.123	3a	Recent coastal and lagoonal deposits
J4-1	G Fx			78	Sierra Leone	1.133	4c	Recent alluvial and lagoonal deposits
Jc1				410	Mauritania	3.21, 3.23	9b	Recent alluvial and lacustrine deposits
Jc1				474	Algeria	3.23	9b	Recent alluvial and lacustrine deposits
Jc1			stony	110	Mauritania	3.21	9b	Recent alluvial deposits
Jc1-a				219	Tunisia	3.23, 3.24, 6.812, 6.171	5b, 9b	Recent alluvial and lagoonal deposits
Jc1-2a				130	Mauritania	3.23, 1.543	4g, 9b	Recent alluvial deposits
Jc1-2a				24	Spanish Sahara	3.23	9b	Recent alluvial deposits
Jc1-2a			saline	50	Mauritania	3.23	9b	Recent alluvial deposits
Jc2-2a	Gc	Z		2 573	Sudan	1.533, 1.534, 1.544, 3.11, 3.21	4g, 8c, 9f	Recent alluvial deposits
Jc3	Z			496	Algeria	3.23	9f	Recent alluvial and lacustrine deposits
Jc3-a	Z			358	Tunisia	6.833, 6.1311	5a, 5b	Recent alluvial and lacustrine deposits
Jc3-a	Z			589	Algeria	3.23	9f	Recent alluvial and lacustrine deposits
Jc3-a	Z			134	Morocco	3.23	9f	Recent alluvial and lacustrine deposits
Jc3-1a	Z			95	Tunisia	3.24, 6.833	5b	Recent alluvial and lacustrine deposits
Jc3-2a	Z			422	Morocco	3.23	9a, 9b	Recent alluvial deposits
Jc3-2a	Z			54	Algeria	3.23	9b	Recent alluvial deposits
Jc4-2a	V			387	Sudan	1.544	4g	Recent alluvial deposits

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION *(continued)*

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Jc5-2a	X	Re Zo	stony	55	Reunion Island	1.64	4e	Quaternary alluvial deposits
Jc5-2a	X	Re Zo	saline	741	Sudan	1.544, 3.12	8c	Recent alluvial deposits
Jc6-2a	Zo	Oe Re		1 169	Ethiopia	1.533, 1.534, 1.843, 1.85, 3.11	4b, 4g, 8c	Recent alluvial and lacustrine deposits
Jc6-2a	Zo	Oe Re		270	Kenya	1.81, 1.534, 3.12	4g	Recent alluvial and lacustrine deposits
Jc6-2a	Zo	Oe Re		71	Territory of the Afars and the Issas	3.12	8c	Recent alluvial deposits
Jc6-2a	Zo	Oe Re		244	Somalia	3.12	4b, 8a	Recent alluvial deposits
Jc8-2a	Z	Yl S		64	Libya	3.43	9f	Recent alluvial and lagoonal deposits
Jc9-2a	Y	Z		119	Morocco	3.23, 3.24	8a	Recent alluvial deposits
Jc10-a	R Y	Z		1 770	Algeria	3.23	9b	Recent alluvial and lacustrine deposits
Jc10-2a	R Y	Z	saline	282	Morocco	3.23	9b	Recent alluvial and lacustrine deposits
Jc11-2a	Y Z			425	Morocco	3.23	9b	Recent alluvial deposits
Jc11-2a	Y Z		saline	39	Morocco	3.23	9b	Recent lacustrine deposits
Jc11-3a	Y Z			172	Algeria	3.23	9f	Recent alluvial and lacustrine deposits
Jc12-2a	Xk	Zg		425	Morocco	6.812	8a	Recent alluvial and lacustrine deposits
Jc13-2a	Xk Zo		saline	226	Morocco	6.171, 3.24	5b	Recent alluvial deposits
Jc14-2a	Bc Lc			280	Algeria	6.161, 6.1912	5b	Recent alluvial deposits
Jc15-2/3a	Bk Vc		saline	241	Algeria	6.142	5b	Recent alluvial deposits
Jc16-2/3a	Bk Vc	Ge		158	Algeria	6.141	5b	Recent alluvial and lagoonal deposits
Jc17-3a	Vp	Bk Re So Zo		73	Tunisia	6.171	5b	Recent alluvial and lagoonal deposits
Jc18-a	Z	Bk E Vp		201	Tunisia	6.171	5b	Recent alluvial and lagoonal deposits
Jc19-a	So Zo			40	Tunisia	6.833	5b	Recent alluvial and lagoonal deposits
Jc20-ab	Bk X Z	E I		95	Tunisia	3.24	8d	Recent alluvial deposits; minor outcrops of calcareous limestone and marl
Jc21-2a	R Yy	Z		589	Algeria	3.23	9b	*Continental terminal:* limestone and marl, partly overlain with recent alluvial deposits
Jc21-3a	R Yy	Z	sodic	425	Ethiopia	3.12, 3.51	4b	Recent alluvial deposits
Jc21-3a	R Yy	Z	sodic	116	Somalia	3.12	8a	Recent alluvial deposits
Jc22-2a		Z		483	Libya	3.23	9b	Recent alluvial deposits

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION *(continued)*

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Jc23-2a	Bc Xk Z	I Rc		1 350	Libya	6.822	6c, 8d, 9f	Recent alluvial, lagoonal, marine and coastal deposits
Jc24-1/2a	Rc Z	Yk	saline	663	Lybia	3.23	9f	Recent alluvial and lacustrine deposits
Jc25-1ab	Rc	Yy Zt	stony	3 015	Egypt	3.21, 3.23	9b, 9f	Quaternary river terraces and lagoonal deposits
Jc26-2/3a	Gc Gm		saline	2 615	Egypt	3.23	9f	Recent alluvial, lacustrine and deltaic deposits
Jc26-2/3a	Gc Gm		saline	85	Sudan	3.21	9f	Recent alluvial deposits
Jc27-1a	Yy		saline	141	Egypt	3.23	9f	Recent alluvial and deltaic deposits
Jc28-2/3a	Lo Vc			28	Chad	1.917	4e	Recent alluvial deposits
Jc28-2/3a	Lo Vc			771	Sudan	1.917, 4.31, 4.32	4g	Recent alluvial deposits
Jc29-2/3a	Vc			445	Sudan	4.31, 4.32	4e, 4g	Recent alluvial deposits
Jc30-1a	Vc Zo			506	Sudan	3.11, 3.21, 3.22	9b, 9c	Recent alluvial deposits
Jc30-2/3a	Vc Zo			252	Sudan	3.21	9b	Recent alluvial deposits
Jc32-2a	Zo			125	Somalia	3.12, 3.51	4b	Recent alluvial deposits
Jc32-2a	Zo		saline	85	Sudan	3.12, 3.21	8c	Recent alluvial deposits
Jc33-2a	So Zo	Lo	saline	398	Somalia	1.534	3a, 4g	Recent alluvial and lagoonal deposits
Jc34-2a	Gc Je	V Z		508	Madagascar	1.32, 1.574, 1.583, 1.918	4e, 8a	Quaternary alluvial deposits
Jd1-a				42	Nigeria	1.77	4d	Recent alluvial deposits
Jd2-2a	G Jt	Od Z		45	Madagascar	1.123	4e	Quaternary alluvial and deltaic deposits
Jd2-2a	G Jt	Od Z		99	Equatorial Guinea	1.132	1a	Recent deltaic deposits
Jd2-2a	G Jt	Od Z		1 997	Gabon	1.132	1a	Recent alluvial, lagoonal, marine, deltaic and coastal deposits
Jd3-2a	Gp Nd			79	Cameroon	1.121	1b, 1c	Recent alluvial deposits
Jd3-2a	Gp Nd			40	Congo	1.121	1b, 1c	Recent alluvial deposits
Jd3-2a	Gp Nd			322	Nigeria	1.132, 1.46, 1.482	1a, 2a	Recent alluvial deposits
Je1	Jc			37	Upper Volta	1.533	4e	Recent alluvial deposits
Je1	Jc			6	Mali	1.533	4e	Recent alluvial deposits

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION *(continued)*

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Je1-2a	Jc			63	Angola	1.574	4e	Recent alluvial and lagoonal deposits
Je2-1a				38	Spanish Sahara	3.21, 3.34	8c	Recent alluvial deposits
Je2-2a				33	Morocco	6.1314	5b	Recent alluvial deposits
Je2-2/3a				227	Malawi	1.36. 1.741	2c. 4e	Recent alluvial and lacustrine deposits
Je2-2/3a				182	Mozambique	1.36. 1.741	4e	Recent alluvial and lacustrine deposits
Je2-2/3a				30	Zaire	1.42	4d	Recent alluvial and coastal deposits
Je2-2/3a				716	Angola	1.35. 1.574. 1.73. 1.77. 2.12. 3.37. 4.22	1a. 2d. 4c. 4e	Recent alluvial and coastal deposits
Je2-2/3a			saline	257	Angola	1.34. 1.574	4d	Recent alluvial deposits
Je7-3a	Zg			190	Malawi	1.533	4e	Recent alluvial and lacustrine deposits
Je7-3a	Zg			4 014	Mozambique	1.23. 1.485. 1.533. 1.926, 1.918	3a. 2a. 4e	Recent alluvial and coastal deposits
Je10-2/3a	R			510	Spanish Sahara	3.21	8c	Recent alluvial deposits
Je10-2/3a	R		saline	57	Angola	1.35	3a	Recent alluvial and coastal deposits
Je10-2/3a	R		saline	53	Zaire	1.35, 1.42	3a	Recent alluvial and coastal deposits
Je13-2a	Ge			438	Chad	1.917. 3.22	4e. 4g	Recent alluvial deposits
Je16	Zo			56	Spanish Sahara	3.21	8c	Recent alluvial deposits
Je19-3a	Jt			370	Mozambique	1.23. 1.31. 1.32. 1.36	3a. 4e	Recent alluvial and lagoonal deposits
Je21	G			91	Nigeria	1.532	4e	Recent alluvial deposits
Je21-2/3a	G			250	Gambia	1.484	4a. 4c	Recent alluvial deposits
Je21-2/3a	G			153	Senegal	1.483. 1.484	4a, 4c	Recent alluvial deposits
Je22	Jt Zo			132	Gambia	1.484	4a, 4c	Recent alluvial deposits
Je22	Jt Zo			12	Senegal	1.484	4a. 4c	Recent alluvial deposits
Je22-1/2a	Jt Zo		saline	165	Senegal	1.58. 1.54	4g	Recent alluvial and coastal deposits
Je22-1/2a	Jt Zo		saline	200	Mauritania	1.58. 1.54	4g	Recent alluvial and coastal deposits
Je23-a	Vc			68	Sudan	1.533	4b	Recent alluvial deposits
Je23-a	Vc			338	Ethiopia	1.42	4b	Recent alluvial deposits
Je28	Ws		sodic	62	Cameroon	1.532	4g	Quaternary alluvial and lacustrine deposits
Je29-a	Ge Gm	Vc		2 613	Sudan	1.532, 1.533	4d	Recent alluvial and lacustrine deposits

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION *(continued)*

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Je30-2/3a	Lf Vp	G Lg		1 231	Chad	1.42, 1.532, 1.533	4e, 4g	Recent alluvial deposits
Je30-2/3a	Lf Vp	G Lg		455	Cameroon	1.532, 1.533	4e, 4g	Recent alluvial deposits
Je31-2/3a	Lf	G Lg		689	Central African Empire	1.42	4a, 4c	Recent alluvial deposits
Je31-2/3a	Lf	G Lg		4 289	Chad	1.532	4d	Recent alluvial deposits
Je32-1a	Ql Vp		sodic	305	Nigeria	1.533	4e	Recent alluvial deposits
Je32-1a	Ql Vp		sodic	27	Cameroon	1.532, 1.533	4g	Recent alluvial deposits
Je33-1/3a	Ge Sg		sodic	201	Niger	1.918, 1.917	4g	Recent alluvial and lacustrine deposits
Je33-1/3a	Ge Sg		sodic	1 075	Nigeria	1.918, 1.917	4e	Recent alluvial and lacustrine deposits
Je34-1/3a	Bk Ql	Bg	sodic	921	Nigeria	1.916, 1.917, 1.918	4e	Quaternary alluvial and lagoonal deposits
Je35-2a	Re Sg	Ws	sodic	742	Nigeria	1.917, 1.532	4e	Recent alluvial deposits
Je35-2a	Re Sg	Ws	sodic	82	Cameroon	1.532	4g	Recent alluvial deposits
Je36	Gh	Ws	saline	210	Nigeria	1.532	4d, 4e	Recent alluvial deposits
Je37-2/3a	Ge Vc			19	Mali	1.533	4g	Recent alluvial deposits
Je37-2/3a	Ge Vc			477	Senegal	1.54, 1.534, 1.533	4g	Recent alluvial deposits
Je37-2/3a	Ge Vc			820	Mauritania	1.54, 1.534, 1.533	4g	Recent alluvial deposits
Je38-1/2a		Ge		89	Angola	1.73	2c	Recent alluvial deposits
Je38-1/2a		Ge		9	Namibia	4.22	4e	Recent alluvial deposits
Je38-1/2a		Ge		168	Botswana	4.22	4d	Recent alluvial deposits
Je39-2a	Xh We	G Vp		428	Angola	4.22	4e	Recent alluvial deposits
Je39-2a	Xh We	G Vp		129	Namibia	4.22	4e	Recent alluvial deposits
Je45-2a	Ge	Gh Gp		269	Ivory Coast	1.483	2a, 4a	Recent alluvial deposits
Je46-1a	Kk Lc			62	Morocco	6.1314	5b	Recent alluvial and lacustrine deposits
Je47-3a	V Zg		saline	36	Morocco	6.1912	7c	Recent alluvial and coastal deposits
Je48-2a	Lg			253	Central African Empire	1.915, 4.32	4d	Recent alluvial deposits
Je48-2a	Lg			1 122	Chad	1.915, 4.32	4d	Recent alluvial deposits
Je49-2/3a	Be Ge	W O Bk		118	Namibia	4.342	4d, 4e	Quaternary alluvial deposits

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Je49-2/3a	Be Ge	W O Bk		360	Zambia	4.342	4d. 4e	Quaternary alluvial deposits
Je49-2/3a	Be Ge	W O Bk		355	Angola	2.13	4d. 4e	Quaternary alluvial deposits
Je50-2/3a	Bg Re	V		447	Tanzania	1.32	4e	Quaternary alluvial and lacustrine deposits
Je51-2/3a	V	G		255	Tanzania	1.32	4e	Recent alluvial and lacustrine deposits
Je51-2/3a	V	G		766	Malawi	1.36. 1.53. 2.13	2c. 4e	Recent alluvial and lacustrine deposits
Je52-2/3a	Vp Zg	G		1 600	Tanzania	1.812. 1.846. 1.85	4e. 4g	Recent lacustrine deposits
Je53-1/3a	G Z	O		15	Kenya	1.33	4g	Recent alluvial deposits
Je53-1/3a	G Z	O		72	Tanzania	1.33	4g	Recent alluvial deposits
Je53-1/3a	G Z	O		148	Malawi	1.36	2c. 4e	Recent lacustrine deposits
Je54-2a	Ge	Gh V		588	Madagascar	1.144. 1.484	4e	Quaternary alluvial deposits
Je55-2a	Jc V	Re Qa		137	Madagascar	1.32. 1.574	4e	Quaternary alluvial deposits
Je56-2a	Be	Rc		13	Comoro Islands	1.121	4c	Recent alluvial deposits
Je57-2/3a	X			77	Mozambique	1.34	3a	Recent alluvial deposits
Je58-2/3a	Vp			77	Malawi	1.77	2c. 4e	Recent alluvial and lacustrine deposits
Je58-2/3a	Vp			154	Mozambique	1.36, 1.77	4e	Recent alluvial and lacustrine deposits
Je59-1a	Q Z	G	saline	3 878	Botswana	4.22	4e. 4h	Recent alluvial and lacustrine deposits: lacustrine sediments
Je60	G	V Lc		241	Namibia	4.342	4h	Recent alluvial deposits
Je60	G	V Lc		225	Botswana	4.342	4h	Recent alluvial deposits
Jt2-1/2a	Zg	Re	saline	150	Gambia	1.485. 1.484	3a	Recent alluvial. lagoonal and coastal deposits
Jt2-1/2a	Zg	Re	saline	165	Senegal	1.484	3a	Recent alluvial. lagoonal and coastal deposits
Jt2-2a	Zg	Re	saline	240	Mauritania	3.33	3a. 8e	Recent coastal and lagoonal deposits
Jt2-3a	Zg	Re	saline	294	Senegal	1.485	3a	Recent alluvial and lagoonal deposits
Jt3-2a	Zg			585	Guinea-Bissau	1.462	3a	Recent alluvial and coastal deposits
Jt3-2a	Zg		saline	194	Guinea-Bissau	1.143	3a	Recent coastal deposits
Jt4-a	Gh Zg		sodic/saline	1 225	Nigeria	1.121. 1.132. 1.123	3a	Recent deltaic deposits

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION *(continued)*

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Jt4-2a	Gh Zg		saline	307	Sierra Leone	1.141, 1.133	3a	Recent coastal and lagoonal deposits
Jt5-3a	O Zg		saline	525	Guinea	1.141, 1.142	3a	Lagoonal and marine deposits
Jt6-3a				85	Mozambique	1.31	3a	Recent alluvial and lagoonal deposits
Jt7-3a		Jd Je		32	Tanzania	1.36	3a	Recent coastal deposits
Jt8-2a	Jc Zg	Gc Z	sodic	1 287	Madagascar	1.121, 1.123, 1.142, 1.144, 1.32, 1.36, 1.484, 1.583	3a	Quaternary coastal and alluvial deposits
K2-2b	B			83	Morocco	6.922	6d, 6e	Pliocene lacustrine deposits
K3-3a	Gc Zg	Be Lc Vc		22	Tunisia	6.171	5b	Quaternary alluvial and lagoonal deposits
Kk8-2a	J Wm			158	Morocco	6.1314	5b	Quaternary lacustrine and alluvial deposits
Kk9-1ab	Bk I	Lc Rc Zg		455	Morocco	6.172	8a	Upper Cretaceous: limestone. Neogene and Quaternary: lagoonal and aeolian deposits
Kk10-3a	Kl	G Lc V		452	Morocco	6.1313	5a, 5b	Pliocene: lacustrine deposits. Quaternary: alluvial deposits
Kk11-3b	Bv V	Jc Rc Z		951	Morocco	6.131	5a	Lower Cretaceous: schist, sandstone, quartzite. Upper Cretaceous and Palaeogene: limestone
Kk12-2b	Bk	Rc		122	Morocco	6.1311	5a	Pliocene lacustrine deposits
Kk13-3b	Lc Rc			166	Morocco	6.512	5a	Lower Cretaceous schist and dolomite
Kk14-2b	Kl	Bk Jc Rc V		166	Morocco	6.1311	6d, 6e	Carboniferous: schist. Jurassic: sandy marl
Kl35-3c	E I		lithic	51	Morocco	6.1311	5a	Jurassic: sandy marl
L2	Bd			195	Cameroon	1.484	4a, 4c	Precambrian (Dahomeyan): schist, quartzite, syenite, dolerite
L3		I		686	Nigeria	1.484	2c, 4c	Basement complex (Gwarian): granitic gneiss, micaschist, amphibolite, migmatite: granitic batholiths. Palaeogene: sandstone and shale
La30-2bc	Lo			549	Algeria	6.141, 6.1912	6d, 6e	Precambrian: schist and gneiss associated with granitic intrusions

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION *(continued)*

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Lc3-2ab				804	South Africa	1.923. 2.26. 2.29. 2.14	2a. 7a. 4e	Precambrian: dolomite. quartzite. schist. conglomerate. Basement complex: granite. gneiss. schist. phyllite. amphibolite. greenstone. basalt. andesite. rhyolite
Lc3-2ab				426	Mozambique	1.929. 1.918	2a	Basement complex: granite. gneiss. schist. phyllite. amphibolite. greenstone. basalt. andesite. rhyolite
Lc3-3a				63	Mozambique	2.14	4e	Basic effusive rocks: basalt. phonolite. nephelinite
Lc5-2ab	Vc			288	Cameroon	1.8. 1.532	4e	Basement complex: granitic gneiss. mica-schist. migmatite: granitic batholiths
Lc5-2ab	Vc			49	Nigeria	1.8	4e	Basement complex: granitic gneiss. mica-schist. migmatite: granitic batholiths
Lc5-2/3bc	Vc			554	South Africa	2.27. 1.92	4e	Karroo: clayey schist and sandstone
Lc13-1a	Qc	Bc Bv		822	Sudan	4.31	4g	*Continental intercalaire:* poorly consolidated sandstone. shale. conglomerate
Lc37-1ab	Kk	Lg Rc	petrocalcic	137	Morocco	6.1912	6d. 6e	Quaternary lagoonal deposits
Lc38-2bc	Lg Re	I Lo T V		767	Morocco	6.1313. 6.75	6d. 6e	Silurian and Carboniferous metamorphic rocks associated with granite and basalt
Lc39-2c	I Lg Re		lithic	377	Morocco	6.75	6d. 6e	Silurian and Carboniferous metamorphic rocks associated with granite and basalt
Lc40-1a	Lg	Kk Lf Re We		348	Morocco	6.1912	5a. 6d. 6e	Quaternary: alluvial deposits. Pliocene: lacustrine deposits
Lc41-1ab	G V	Bk Rc Z		68	Morocco	6.1912	5a	Coastal and lagoonal deposits. partly overlain with old fixed dunes
Lc42-2c	La I	R E		666	Morocco	6.512	6d. 6e	Cretaceous: dolomite. sandstone. schist
Lc43-2c	I Kl	Jc		493	Morocco	6.171. 6.512	6d. 6e	Ordovician schist
Lc44-3c	Bk Kk	I		187	Morocco	6.1922	5b. 6d. 6e	Palaeogene: sandstone and shale. Jurassic: sandy marl and limestone
Lc44-3c	Bk Kk	I		18	Algeria	6.1922	5b. 6d. 6e	Palaeogene: sandstone and shale. Jurassic: sandy marl and limestone
Lc45-3bc	Kl	E I T	lithic	440	Morocco	6.75	6d. 6e	Carboniferous: metamorphic rocks. Jurassic: limestone and dolomite
Lc46-1a	Bc			90	Madagascar	1.574	8a	Eocene limestone

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Lc46-2a	Bc		petrocalcic	18	Morocco	6.161	6d, 6e	Jurassic sandy marl and limestone
Lc46-2a	Bc		petrocalcic	151	Algeria	6.161	6d, 6e	Jurassic sandy marl and limestone
Lc46-2ab	Bc			366	Algeria	6.142	6d. 6e	Upper Cretaceous limestone
Lc47-2c	I	X		1 367	Morocco	3.23, 3.24, 6.892	6d, 6e. 8a	Precambrian and Cambrian metamorphic rocks
Lc48-2a	Bc Bv		petrocalcic	187	Algeria	6.142	6d. 6e	Cretaceous dolomite and limestone
Lc49-2a	Qf	I		648	Rhodesia	2.14. 2.15. 4.2	2c, 2d	Precambrian: gneiss, quartzite, schist, phyllite, greenstone; granitic batholiths. Karroo: clayey schist, sandstone
Lc49-3a	Qf	I		1 027	Rhodesia	2.15. 2.26. 2.27, 3.22	4e, 4g	Precambrian: gneiss. quartzite. schist. phyllite, greenstone
Lc50-1b	I	Qf		9	Mozambique	2.14	4e	Precambrian: gneiss, quartzite, schist, phyllite
Lc50-1b	I	Qf		137	Rhodesia	2.14	4e	Precambrian: gneiss, quartzite. schist, phyllite
Lc50-1/2a	I	Qf		1 934	Rhodesia	2.15. 4.2, 4.322	2d	Precambrian: gneiss, quartzite. schist. phyllite, greenstone: granitic batholiths: partly overlain with Karroo: clayey schist. sandstone. shale. arkose
Lc50-2a	I	Qf		137	Rhodesia	2.15	4e, 4g	Karroo: clayey schist. sandstone, shale, arkose
Lc51-1/2a	So	I We		700	Rhodesia	2.14, 4.322	2c	Karroo: clayey schist. sandstone
Lc52-1a	So We	B Fo		1 481	Zambia	1.842, 4.322	2d	Karroo: clayey schist, sandstone
Lc52-1a	So We	B Fo		199	Mozambique	1.915	2d	Karroo: clayey schist. sandstone
Lc52-1a	So We	B Fo		928	Rhodesia	1.915, 4.322	2d, 4e	Karroo: clayey schist. sandstone
Lc53-2/3a	So	Bk Je		3 874	Zambia	1.842, 2.13	2c	Karroo: sandstone, conglomerate, siltstone
Lc54-2/3a		Nd		2 286	Zambia	1.842. 2.13	2c, 4e	Precambrian: graphitic schist, gneiss, amphibolite, charnockite. quartzite, crystalline limestone; granitic batholiths.
Lc55-2/3a	Bc Vp			304	Madagascar	1.484	4e	Jurassic limestone
Lc56-2b	Bc Lf	I Bk		70	Madagascar	1.121, 1.37	4e	Cretaceous sandstone, marl and limestone
Lc57-2a	Bc	I Zo		166	Somalia	1.54	2a	Neogene and Quaternary: alluvial, coastal and marine deposits, fine-grained marl, calcareous sand and clay
Lc58	Bk E	I		36	Tunisia	6.1311	5a	Cretaceous limestone

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION *(continued)*

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Lc59-2/3a	Lf Lo	V G I		832	Botswana	4.22	2d. 4e	Karroo: clayey schist. sandstone
Lc60-2bc	Lo To	I Je		206	Canary Islands	6.41. 6.892	6b	Basic and some acid effusive rocks: basalt. trachyte. rhyolite
Lc61-2b	Ao I			122	South Africa	1.92	2a	Karroo: basalt. andesite. rhyolite
Lc62-2bc	Be I Qa	We	stony	5 206	South Africa	6.183. 6.834. 6.831. 5.43	5a. 6b	Palaeozoic: sandstone. quartzite. shale
Lc64-2b	Lo Lf	I		57	Swaziland	2.21	7a	Basement complex: granite. gneiss. schist. phyllite. amphibolite. greenstone. Karroo: clayey schist. sandstone. shale. arkose: effusive rocks: basalt. dolerite. some diorite and gabbro
Lc64-2b	Lo Lf	I		2 778	South Africa	2.38. 2.21. 2.26	7a	Basement complex: granite. gneiss. schist. phyllite. amphibolite, greenstone. Karroo: clayey schist. sandstone. shale. arkose; effusive rocks: basalt. dolerite. some diorite and gabbro
Lc65-1/2ab	Be I	Lf		5 969	South Africa	2.29. 2.26. 4.41	4e. 7a	Basement complex: granite. gneiss. schist. phyllite. amphibolite, greenstone: granitic batholiths. Karroo: sandstone. clayey schist. shale. arkose
Lc65-1/2bc	Be I	Lf		106	South Africa	2.21	4e	Basement complex: granite. gneiss. schist. phyllite. amphibolite. greenstone
Lc65-1/2bc	Be I	Lf		309	Swaziland	2.21	4e	Basement complex: granite. gneiss. schist. phyllite. amphibolite. greenstone
Lc66-1a	I Lo Lf			3 370	South Africa	2.21. 2.23	7a	Precambrian: dolomite. quartzite. schist. conglomerate. phyllite. slate. ironstone
Lc67-2b	I Lo So			2 034	South Africa	2.27	4e. 7a	Karroo: sandstone. clayey schist, shale
Lc68-2/3a	Q Be	I V L		81	South Africa	2.23	4g	Basement complex: granite. gneiss. migmatite: basic intrusive rocks: diorite, gabbro
Lc68-2/3a	Q Be	I V L		1 439	Botswana	2.23. 2.29	4e	Basement complex: granite, gneiss. migmatite: basic intrusive rocks: diorite. gabbro
Lf1				2 055	Mali	1.484	4a, 4c	Basement complex: granitic gneiss. schist. quartzite: granitic batholiths
Lf1				259	Nigeria	1.482	4a. 4c	Basement complex (Gwarian): granitic gneiss. micaschist. amphibolite. migmatite: granitic batholiths

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Lf1			petric	59	Nigeria	1.482	4a. 4c	Precambrian: granitic gneiss. micaschist. migmatite. quartzite: granitic batholiths
Lf1-a				36	Ghana	1.31	2a	*Continental terminal:* poorly consolidated sandstone. shale
Lf1-1a				295	Ghana	1.42	4a. 4c	Basement complex: orthogneiss. paragneiss. granite. micaschist. quartzite. Voltaian: sandstone. shale. conglomerate. dolomitic limestone. schist
Lf1-1a				630	Nigeria	1.916	2c. 4c, 4e	Cretaceous and Palaeogene sandstone and shale
Lf1-1a				120	Cameroon	1.484	4a. 4c	Precambrian (Dahomeyan): schist. quartzite. syenite. dolerite
Lf1-1a				744	Senegal	1.532	4e	*Continental terminal:* sandstone. shale. marl. sand. clay. Quaternary: alluvial deposits
Lf1-1a			petric	1 164	Ghana	1.42	4a. 4c. 4e	Voltaian: sandstone. shale. conglomerate. dolomitic limestone. schist
Lf1-1a			petric	40	Upper Volta	1.42	4e	Basement complex: orthogneiss. paragneiss. granite. micaschist. quartzite
Lf1-1/2a				1 488	Nigeria	1.482	4a. 4c	Precambrian (Dahomeyan): schist, quartzite. syenite. dolerite
Lf7-a		G		869	Ghana	1.482. 1.481	4a. 4c	Voltaian sandstone
Lf8	Lp	I G		1 243	Nigeria	1.482. 1.483	4a. 4c	Basement complex (Gwarian): granitic gneiss. micaschist. amphibolite. migmatite: granitic batholiths
Lf8-a	Lp	I G	petroferric	1 200	Ghana	1.482. 1.411. 1.481	4a. 4c	Voltaian sandstone
Lf10-a	Ne			49	Nigeria	1.482	4a. 4c	Basement complex (Gwarian): granitic gneiss. micaschist. amphibolite. migmatite: granitic batholiths
Lf10-1a	Ne			590	Benin	1.484	4e	Cretaceous sandstone and shale
Lf10-1a	Ne			347	Nigeria	1.484	4e	Cretaceous sandstone and shale
Lf10-1a	Ne			2 978	Rhodesia	2.15. 2.26	2c. 2d	Basement complex: granite. gneiss. migmatite: basic intrusive rocks: diorite. gabbro
Lf10-1ac	Ne			114	Rhodesia	3.12	2d	Precambrian: gneiss. quartzite. schist, phyllite. greenstone

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Lf10-2a	Ne			685	Rhodesia	2.27	2c	Basement complex: granite, gneiss, migmatite: basic intrusive rocks: diorite, gabbro
Lf11	Ao			362	Mali	1.484	4a, 4c	Basement complex: granitic gneiss, schist, quartzite: granitic batholiths
Lf11	Ao			10	Ivory Coast	1.484	4a, 4c	Basement complex: granitic gneiss, schist, quartzite: granitic batholiths
Lf11	Ao			79	Guinea	1.484	4a, 4c	Basement complex: granitic gneiss, schist, quartzite: granitic batholiths
Lf12-a	I Re			56	Ghana	1.42	4e	Voltaian: sandstone, shale, conglomerate, dolomitic limestone, schist
Lf12-a	I Re		petroferric	375	Nigeria	1.482	4a, 4c	Basement complex (Gwarian): granitic gneiss, micaschist, amphibolite, migmatite; granitic batholiths
Lf12-b	I Re			557	Ghana	1.482, 1.481, 1.411, 1.42	2a, 4a, 4c	Precambrian: orthogneiss, paragneiss, granite, micaschist, quartzite, greenstone. Voltaian: sandstone, shale, conglomerate, dolomitic limestone, schist
Lf12-1a	I Re			213	Nigeria	1.484	2c, 4c	Cretaceous sandstone and shale
Lf12-1a	I Re			3	Togo	1.412	1a	Precambrian (Dahomeyan): schist, gneiss, quartzite
Lf12-1a	I Re			39	Ghana	1.412	1a	Precambrian (Dahomeyan): schist, gneiss, quartzite
Lf12-1a	I Re			217	Chad	1.42	4e	Precambrian (Dahomeyan): schist, quartzite, syenite, dolerite. *Continental terminal:* poorly consolidated sandstone, shale, conglomerate, grits, sand, clay
Lf12-1a	I Re			1 233	Cameroon	1.484	4a, 4c, 4e	Precambrian (Dahomeyan): schist, quartzite, syenite, dolerite. *Continental terminal:* poorly consolidated sandstone, shale, conglomerate, grits, sand, clay
Lf12-1a	I Re		petric	4 411	Mali	1.533, 1.534	4e, 4g	Cambrian sandstone and tillite: recent alluvial deposits
Lf13	Ao I Nd			88	Ghana	1.412, 1.482	1a	Precambrian: sandstone, conglomerate, dolomite

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION *(continued)*

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Lf15-ab	We		stony	84	Nigeria	1.482	4a, 4c	Basement complex (Gwarian): granitic gneiss, micaschist, amphibolite, migmatite; granitic batholiths
Lf17-2ab		I Zo		1 398	Somalia	1.54	2a, 4g	Neogene and Quaternary: alluvial, coastal and marine deposits, fine-grained marl, calcareous sand and clay
Lf17-2ab		I Zo		143	Uganda	1.811, 1.83	4a, 4c	Precambrian: schist, gneiss, amphibolite, charnockite, quartzite, cipolin
Lf17-2ab		I Zo		8 907	Kenya	1.33, 1.54, 1.582, 1.812, 3.12	2a, 4b, 4g	Tertiary-recent volcanics: basalt, phonolite, nephelinite, pyroclastics, tuff. Neogene and Quaternary: alluvial, coastal and marine deposits, fine-grained marl, calcareous sand and clay. Precambrian: schist, gneiss, amphibolite, charnockite, quartzite, cipolin
Lf18	Re			273	Mali	1.54	4g	Quaternary alluvial deposits
Lf18	Re			917	Upper Volta	1.532, 1.533	4e	Cambrian: sandstone, tillite, minor limestone. Basement complex: granitic gneiss, schist, quartzite; granitic batholiths. Voltaian: sandstone, shale, conglomerate, dolomitic limestone, schist. Precambrian: sandstone, conglomerate, dolomite
Lf18	Re			68	Benin	1.42	4e	Voltaian: sandstone, shale, conglomerate, dolomitic limestone, schist. Precambrian: sandstone. conglomerate, dolomite
Lf18	Re			345	Niger	1.533, 1.534	4e	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths. Precambrian (Birrimian): schist. quartzite, greenstone
Lf18-1a	Re			371	Niger	1.532	4e	Precambrian (Dahomeyan): schist, gneiss, quartzite. *Continental terminal:* poorly consolidated sandstone and marl
Lf18-1a	Re			173	Benin	1.532	4e	Precambrian (Dahomeyan): schist, gneiss, quartzite. *Continental terminal:* poorly consolidated sandstone and marl
Lf18-1a	Re		petric	1 009	Sudan	1.42, 1.533	4e	Precambrian: schist, quartzite, syenite, dolerite
Lf18-2a	Re		lithic	1 699	Sudan	1.42, 1.534, 1.811	4e	Precambrian: gneiss, schist, quartzite; granitic batholiths. Trap series: basalt, phonolite, nephelinite, trachyte, rhyolite, pyroclastics

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Lf18-2a	Re		lithic	178	Kenya	1.534	4e	Precambrian: gneiss, schist, quartzite; granitic batholiths. Trap series: basalt, phonolite, nephelinite, trachyte, rhyolite, pyroclastics
Lf18-2a	Re		lithic	93	Uganda	1.811	4e	Precambrian: gneiss, schist, quartzite; granitic batholiths. Trap series: basalt, phonolite, nephelinite, trachyte, rhyolite, pyroclastics
Lf20-1a	Lp	I Lg Qa	petroferric	626	Benin	1.42	4e	Precambrian: sandstone, conglomerate, dolomite
Lf20-1a	Lp	I Lg Qa	petroferric	673	Togo	1.42, 1.484	4a, 4c	Precambrian: sandstone, conglomerate, dolomite
Lf24-1a	Q			162	Senegal	1.483	4a, 4c	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths
Lf24-1a	Q			910	Rhodesia	2.14	4e	Basement complex: granite, gneiss, migmatite; basic intrusive rocks: diorite, gabbro
Lf24-2a	Q			659	Rhodesia	2.15, 4.2	2d	Precambrian: gneiss, quartzite, schist, phyllite, greenstone; granitic batholiths
Lf25	Nd	Lp Be	petric	252	Togo	1.411, 1.412, 1.482	4a, 4c	Precambrian: granitic gneiss, micaschist, amphibolite, quartzite; granitic batholiths
Lf25	Nd	Lp Be	petric	626	Benin	1.411, 1.412, 1.482	4a, 4c	Precambrian: granitic gneiss, micaschist, amphibolite, quartzite; granitic batholiths
Lf25	Nd	Lp Be	petroferric	28	Nigeria	1.483	2c, 4c	Basement complex (Gwarian): granitic gneiss, micaschist, amphibolite, migmatite; granitic batholiths
Lf25	Nd	Lp Be	petroferric	649	Benin	1.482, 1.483	2c, 4c	Basement complex (Gwarian): granitic gneiss, micaschist, amphibolite, migmatite; granitic batholiths
Lf26	Lp	I Lg		234	Mali	1.533	4g	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths
Lf26-a	Lp	I Lg		33	Ghana	1.482	4a, 4c	Basement complex: orthogneiss, paragneiss, granite, micaschist, quartzite
Lf26-a	Lp	I Lg	petric	5 342	Benin	1.412, 1.411, 1.482, 1.483, 1.484, 1.532	2c, 4a, 4c, 4e	Precambrian: granitic gneiss, micaschist, migmatite, quartzite; granitic batholiths
Lf26-a	Lp	I Lg	petric	5 019	Nigeria	1.482, 1.483, 1.484	2c, 4a, 4c	Precambrian: granitic gneiss, micaschist, migmatite, quartzite; granitic batholiths

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Lf26-a	Lp	I Lg	petroferric	1 835	Ghana	1.42, 1.482	1a, 2a, 4a, 4c	Precambrian: sandstone, conglomerate, dolomite. Voltaian: sandstone, shale, conglomerate, dolomitic limestone, schist
Lf26-a	Lp	I Lg	petroferric	67	Togo	1.482, 1.484, 1.42	4a, 4c	Precambrian: sandstone, conglomerate, dolomite. Voltaian: sandstone, shale, conglomerate, dolomitic limestone, schist
Lf26-1a	Lp	I Lg	petric	30	Guinea	1.483	4a, 4c	Devonian and Silurian: schist, quartzite, sandstone. Eocene and *continental terminal:* limestone, sandstone, marl, sand, clay
Lf26-1a	Lp	I Lg	petric	35	Gambia	1.484	4a, 4c	Devonian and Silurian: schist, quartzite, sandstone. Eocene and *continental terminal:* limestone, sandstone, marl, sand, clay
Lf26-1a	Lp	I Lg	petric	320	Guinea-Bissau	1.484	4a, 4c	Devonian and Silurian: schist, quartzite, sandstone. Eocene and *continental terminal:* limestone, sandstone, marl, sand, clay
Lf26-1a	Lp	I Lg	petric	542	Senegal	1.483, 1.484	4a, 4c	*Continental terminal:* sandstone, shale, marl, sand, clay. Pliocene and Quaternary: alluvial and coastal deposits
Lf27	I Ne		petric	108	Benin	1.484	4e	Cretaceous sandstone and shale
Lf27-a	I Ne		petric	231	Nigeria	1.482	4a, 4c	Precambrian (Dahomeyan): schist, quartzite, syenite, dolerite
Lf27-1/2a	I Ne			1 232	Guinea-Bissau	1.484, 1.462, 1.143	2a, 4c	Devonian and Silurian: schist, quartzite, sandstone. Eocene: nummuliticlimestone; *continental terminal:* sandstone, sand and clay, mostly overlain with recent alluvial, lagoonal and deltaic deposits
Lf27-1/2a	I Ne			235	Senegal	1.484	2a, 4c	Devonian and Silurian: schist, quartzite, sandstone. Eocene and *continental terminal:* limestone, sandstone, marl, sand, clay
Lf27-1/2b	I Ne			189	Nigeria	1.482, 1.484	2c, 4c	Precambrian (Dahomeyan): schist, quartzite, syenite, dolerite
Lf28-2/3b	Af Lg	Bc		496	Sudan	1.532, 1.533	4g	*Continental terminal:* clay and sand. Precambrian: gneiss, quartzite, cipolin, conglomerate, argillite, andesite, rhyolite; granitic batholiths
Lf29-1a		Ge Re Vp		20	Zaire	1.34	4e	Quaternary alluvial and lagoonal deposits
Lf29-1a		Ge Re Vp		453	Angola	1.574	4d, 4e	Quaternary deltaic and lagoonal deposits
Lf29-1a		Ge Re Vp		51	Angola (Cabinda dist.)	1.34	4e	Quaternary alluvial and lagoonal deposits
Lf30	Lg			1 119	Chad	1.532	4e	Quaternary alluvial and lacustrine deposits

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Lf30	Lg			101	Upper Volta	1.484	4a. 4c	Basement complex: granitic gneiss. schist. quartzite: granitic batholiths
Lf30-1a	Lg			545	Senegal	1.532	4e	Recent alluvial deposits. overlying *continental terminal:* sandstone. shale. marl. sand. clay
Lf30-1a	Lg		petric	326	Upper Volta	1.532	4e	Cambrian: sandstone. tillite. minor limestone
Lf30-1a	Lg		petroferric	109	Gambia	1.532	4e	*Continental terminal.* Plio-Pleistocene: sandstone. sand and clay. recent alluvial deposits
Lf30-1a	Lg		petroferric	1 095	Senegal	1.532	4e	*Continental terminal.* Plio-Pleistocene: sandstone. sand and clay. recent alluvial deposits
Lf30-2a	Lg			1 054	Sudan	1.532	4e	*Continental terminal:* sand and clay
Lf31-a		Be I	petric	2 668	Ghana	1.42. 1.411	2a, 4a. 4c	Basement complex: granite. micaschist. quartzite. Precambrian: orthogneiss. paragneiss. granite. micaschist. quartzite. greenstone. shale. dolomitic limestone. schist. phyllite. grauwacke. sandstone. conglomerate: granitic batholiths
Lf31-a		Be I	petric	424	Ivory Coast	1.411. 1.412	4a. 4c	Basement complex: granite. micaschist. quartzite. Precambrian (Birrimian): schist. phyllite. grauwacke. sandstone. greenstone
Lf32		I	petric	2 209	Nigeria	1.484. 1.532. 1.483	2c. 4c	Basement complex (Gwarian): granitic gneiss. micaschist. amphibolite. migmatite: granitic batholiths
Lf32-a		I	petric	7	Ghana	1.412	4a. 4c	Precambrian: granitic gneiss. micaschist. amphibolite. quartzite: granitic batholiths
Lf32-a		I	petric	1 682	Togo	1.411. 1.412. 1.482	4a. 4c	Precambrian: granitic gneiss. micaschist. amphibolite. quartzite: granitic batholiths
Lf32-1a		I		111	Upper Volta	1.484	4a. 4c	Precambrian (Tarkwaian): schist. quartzite. conglomerate. sandstone: granitic batholiths
Lf32-1/2a		I		473	Nigeria	1.482	4a. 4c	Precambrian (Dahomeyan): schist. quartzite. syenite, dolerite
Lf32-1/2ab		I	petroferric	2 697	Chad	1.42. 1.916. 4.32	4e	Precambrian: granitic gneiss, migmatite. schist. quartzite. syenite. dolerite: granitic batholiths. Quaternary: alluvial and lacustrine deposits

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Lf32-1/2ab		I	petroferric	901	Sudan	4.32	4e	Precambrian: granitic gneiss, migmatite, schist, quartzite, syenite, dolerite; granitic batholiths. Quaternary: alluvial and lacustrine deposits
Lf32-2c		I	stony	860	Tanzania	1.812	2c	Precambrian: sandstone, quartzite, arkose, mudstone, siltstone, clay, shale, coal
Lf33-1a		Ao Be		33	Zaire	1.42	4e	Cretaceous: sandstone, marl, limestone
Lf33-1a		Ao Be		206	Angola	1.35, 1.42	4e	Cretaceous: sandstone, marl, limestone. Quaternary: coastal deposits
Lf34-a	Lg	Re		524	Upper Volta	1.532	4e	Basement complex: granitic gneiss, schist, quartzite: granitic batholiths
Lf35	Re	Vc		437	Upper Volta	1.532	4e	Basement complex: granitic gneiss, schist, quartzite: granitic batholiths
Lf36	Bv Re			24	Upper Volta	1.534	4g	Basement complex: granitic gneiss, schist, quartzite: granitic batholiths
Lf36-1a	Bv Re			107	Upper Volta	1.533	4e	Basement complex: granitic gneiss, schist, quartzite: granitic batholiths: greenstone
Lf37	Re	Bv I Vc		658	Upper Volta	1.532	4e	Precambrian (Birrimian): schist, quartzite, greenstone. Basement complex: granitic gneiss, schist, quartzite: granitic batholiths
Lf38	Lg Rd	Be		269	Upper Volta	1.483, 1.484	4a, 4c	Precambrian (Birrimian): schist, quartzite, greenstone
Lf39	Lg Rd		petric	316	Ivory Coast	1.483	4a, 4c	Basement complex: granitic gneiss, schist, quartzite, biotite, apatite, norite: granitic batholiths
Lf39	Lg Rd		petric	255	Upper Volta	1.484	4a, 4c	Basement complex: granitic gneiss, schist, quartzite, biotite, apatite, norite: granitic batholiths
Lf39	Lg Rd		petric	353	Mali	1.484	4a, 4c	Basement complex: granitic gneiss, schist, quartzite, biotite, apatite, norite: granitic batholiths
Lf40	Rd			2 449	Mali	1.532, 1.533	4g	Cambrian: calcareous schist, quartzite, pelites, sandstone, tillite

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Lf40	Rd			80	Mauritania	1.533	4g	Cambrian: calcareous schist, quartzite, pelites, sandstone, tillite
Lf40-1a	Rd			865	Niger	1.533, 1.534	4e, 4g	*Continental terminal* and *continental intercalaire:* poorly consolidated sandstone, sandstone, shale and conglomerate, grits, sand and clay
Lf41-1/2a	Lg I			966	Nigeria	1.483, 1.484	2c, 4c	Basement complex (Gwarian): granitic gneiss, micaschist, amphibolite, migmatite; granitic batholiths
Lf41-1/2ab	Lg I		petric	1 619	Central African Empire	4.32	4e	Quaternary alluvial and lacustrine deposits
Lf41-1/2ab	Lg I		petric	316	Sudan	4.32	4e	Quaternary alluvial and lacustrine deposits
Lf41-2a	Lg I		petric	27	Upper Volta	1.533	4e	Cambrian sandstone and tillite
Lf41-2a	Lg I		petric	5 914	Mali	1.484, 1.532, 1.533, 1.534	4e	Cambrian sandstone and tillite
Lf42-1a	Lg Ql	I		987	Nigeria	1.483, 1.484	2c, 4c	Basement complex (Gwarian): granitic gneiss, micaschist, amphibolite, migmatite; granitic batholiths. Cambrian: sandstone and shale
Lf43-1a	Lg Ql	J		1 218	Nigeria	1.482	4a, 4c	Cretaceous dolomitic limestone, shale and sandstone
Lf44-1/2bc	I	Fo		1 965	Angola	1.35, 1.73	2c, 4a, 4c, 4e	Precambrian: calcareous schist, gneiss, schist, dolomite, quartzite, syenite, dolerite, conglomerate, tillite; polymorphic sandstone
Lf45-2ab	Lp			27	Guinea	1.484	4a, 4c	Basement complex: granitic gneiss, schist, quartzite: granitic batholiths
Lf46	Af	I		21	Nigeria	1.532	4e	Cretaceous sandstone and marl
Lf47-1/2ab	Lg Lp	I Vc		380	Angola	1.34, 1.35	4e	Precambrian: granitic gneiss, migmatite, schist, quartzite, dolerite, syenite; granitic batholiths
Lf48-1a	I Lp Lv	Je		294	Nigeria	1.916	4e	Cretaceous sandstone and shale
Lf49	Af I	Ge Lp	petric	721	Nigeria	1.482	2a	Basement complex (Gwarian): granitic gneiss, micaschist, amphibolite, migmatite: granitic batholiths

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION *(continued)*

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Lf49-1a	Af I	Ge Lp		1 460	Nigeria	1.483. 1.484	2c. 4c	Basement complex (Gwarian): granitic gneiss. micaschist. amphibolite. migmatite: granitic batholiths
Lf50	Re We	I		143	Nigeria	1.482	4a. 4c	Basement complex (Gwarian): granitic gneiss. micaschist. amphibolite. migmatite: granitic batholiths
Lf51-2a	Lg Lp	Fo Fp		380	Angola	1.73	4a. 4c	Precambrian: gneiss. schist. quartzite. dolerite. syenite. calcareous schist. dolomite. conglomerate. tillite
Lf52	Lg We	I Vc		935	Nigeria	1.532. 1.484	2c. 4c. 4e	Basement complex (Gwarian): granitic gneiss. micaschist. amphibolite. migmatite: granitic batholiths. Cretaceous: sandstone and marl
Lf52	Lg We	I Vc	petric	231	Nigeria	1.482	4a. 4c	Basement complex (Gwarian): granitic gneiss. micaschist. amphibolite. migmatite: granitic batholiths
Lf53	Lg	I Sg		606	Nigeria	1.532. 1.484	2c. 4c	Basement complex (Gwarian): granitic gneiss. micaschist. amphibolite. migmatite: granitic batholiths
Lf54-1a	Af Lg		petric	668	Ivory Coast	1.412	2a	Basement complex: granitic gneiss. schist. quartzite; granitic batholiths
Lf55-a	Ao Lg	Ag	petric	424	Ivory Coast	1.411	2a	Basement complex: orthogneiss. paragneiss. granite. micaschist. quartzite. Precambrian (Birrimian): schist. phyllite. grauwacke. sandstone. greenstone
Lf60-2b	Ne	Ql	petric	1 001	Nigeria	1.131	1a	Basement complex (Gwarian): granitic gneiss. micaschist. amphibolite, migmatite: granitic batholiths
Lf61-2a	Ne	I Ql		290	Nigeria	1.131	1a	Basement complex (Gwarian): granitic gneiss. micaschist. amphibolite. migmatite: granitic batholiths
Lf61-2a	Ne	I Ql	lithic	494	Nigeria	1.482	2a	Basement complex (Gwarian): granitic gneiss. micaschist, amphibolite, migmatite: granitic batholiths
Lf61-3a	Ne	I Ql	petric	536	Nigeria	1.131	1a	Basement complex (Gwarian): granitic gneiss. micaschist. amphibolite. migmatite: granitic batholiths
Lf62-3a	Ne Ql			406	Nigeria	1.131	1a	Basement complex (Gwarian): granitic gneiss, micaschist. migmatite. amphibolite: granitic batholiths

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION *(continued)*

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Lf63-2a	Lp Nd	Ao		417	Nigeria	1.482	2a	Basement complex (Gwarian): granitic gneiss, micaschist, amphibolite, migmatite; granitic batholiths
Lf64	I	Ql		476	Nigeria	1.131	2a	Basement complex (Gwarian): granitic gneiss, micaschist, amphibolite, migmatite; granitic batholiths
Lf64-1a	I	Ql	petric	80	Nigeria	1.482	2a	Basement complex (Gwarian): granitic gneiss, micaschist, amphibolite, migmatite; granitic batholiths
Lf65-1/2ab	Vp	I	petroferric	3 019	Chad	1.915, 1.916	4e	Quaternary alluvial and lacustrine deposits
Lf66-2ab	I	F Gp		304	Angola	1.73	2c	*Continental intercalaire:* sandstone, shale, conglomerate
Lf67-2b		Fx I		1 230	Angola	1.77	4e, 7b	Basement complex: granitic gneiss, migmatite, schist, quartzite; granitic batholiths
Lf68-2b	Ao	Fx I		476	Angola	1.77	4e	Basement complex: granitic gneiss, migmatite, schist, quartzite; granitic batholiths
Lf69-ac	F I	Ao		63	Angola	1.77	7b	Basement complex: granitic gneiss, migmatite, schist, quartzite; granitic batholiths
Lf70-1/2ab	X	I		688	Angola	1.77	7b	Basement complex: granitic gneiss, migmatite, schist, quartzite; granitic batholiths
Lf71-2ab	Gp	Fx I		89	Angola	2.27	2c	Basement complex: granitic gneiss, migmatite, schist, quartzite; granitic batholiths
Lf72-3a	Vp	Fo		89	Angola	2.13, 2.27	2c	Basic intrusive rocks: dolerite, gabbro, peridotite
Lf73-1a	Qf Re	G		289	Angola	4.22	2d	Precambrian: gneiss, schist, quartzite, diorite, syenite
Lf74-1a	Q	X Be Bk		1 591	Angola	4.22	2d, 4e	Kalahari: sand, ironstone, chalcedony. Quaternary: lacustrine sediments
Lf74-1a	Q	X Be Bk		79	Namibia	4.22	2d	Kalahari: sand, ironstone, chalcedony. Quaternary: lacustrine sediments
Lf75-1/2a	Ne	Bk Vp		2 293	Tanzania	1.85	4g	Precambrian: schist, gneiss, charnockite, quartzite, cipolin
Lf76-1/2a	Lp	Gc I		1 361	Tanzania	1.812	2c	Neogene and Quaternary alluvial deposits

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION *(continued)*

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Lf77-1/2a		Gp Vp		704	Tanzania	1.812	2c	Precambrian: sandstone. quartzite. arkose. mudstone. siltstone. clay. shale and coal. mostly overlain with Neogene and Quaternary alluvial deposits
Lf78-1/2ab	Af	Gp		728	Tanzania	1.32. 1.36	2a. 4e	Cretaceous and Tertiary: sandstone. marl. clay. sand. Quaternary: coastal deposits
Lf79-2ab	Af	Ge I	stony	866	Tanzania	1.72. 1.811. 1.812	2c. 4a. 4c	Precambrian: sandstone. quartzite. arkose. mudstone. siltstone. clay. shale. coal
Lf80-2bc	Be Ne	I	stony	636	Tanzania	1.811	2c. 4a. 4c	Precambrian: shale. sandstone. conglomerate. phyllite. schist. quartzite
Lf81-1a		Qf		1 050	Rhodesia	2.14. 2.15. 2.26. 2.27	2c	Basement complex: granite. gneiss.. migmatite: basic intrusive rocks: diorite. gabbro
Lf81-2a		Qf		4 804	Rhodesia	2.14. 2.26. 2.27	2c. 4e. 4g	Basement complex: granite. gneiss. migmatite: basic intrusive rocks: diorite. gabbro
Lf81-2ac		Qf		353	Rhodesia	2.27	2c	Precambrian: gneiss. quartzite. schist. phyllite. greenstone
Lf82-1a	So	We		1 616	Rhodesia	2.15. 2.26. 2.27	2c. 4e. 4g	Basement complex: granite. gneiss. migmatite. Basic intrusive rocks: diorite. gabbro. Karroo: clayey schist. sandstone. shale. arkose
Lf83-1a	I L	Qf		621	Rhodesia	2.14. 4.322	2c	Karroo: clayey schist. sandstone. shale. arkose
Lf84-1a	So	Re		300	Rhodesia	2.14. 4.322	2c	Karroo: clayey schist. tillite. sandstone. shale. arkose
Lf85-2ab	Lc Ne	Ao		4 979	Madagascar	1.142. 1.484. 1.574. 1.918. 2.14	2c. 4c. 4e. 8a	Pliocene: sandstone. sand. clay. Triassic. Jurassic. Cretaceous: sandstone. Permian: schist. migmatite. gneiss
Lf86-2a	Vp			1 751	Kenya	1.36. 1.54	2a. 4g	Karroo: tillite. grits. sandstone. conglomerate. siltstone. some carbonaceous shale and thin limestone
Lf86-2a	Vp			16	Tanzania	1.134	2a	Karroo: tillite. grits. sandstone. conglomerate. siltstone. some carbonaceous shale and thin limestone
Lf87-2/3b	Lc			18 235	Mozambique	1.23. 1.31. 1.32. 1.485. 1.741. 1.918. 2.14	2c. 4e	Precambrian: graphitic schist. gneiss. amphibolite, charnockite, quartzite and crystalline limestone: granitic batholiths. Cretaceous: limestone and marl

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Lf87-2/3b	Lc			1 143	Tanzania	1.741	2c, 4e	Karroo: conglomerate, tillite, sandstone, siltstone, clay, shale
Lf88-1/2bc	I			474	Malawi	1.533	4e	Precambrian: granitic gneiss, schist, amphibolite, charnockite, quartzite, cipolin; granitic batholiths; greenstone
Lf88-1/2bc	I			140	Zambia	1.842	2c	Precambrian: granitic gneiss, schist, amphibolite, charnockite. quartzite, cipolin; granitic batholiths; greenstone
Lf88-1/2bc	I			3 471	Mozambique	1.915, 2.13	2c, 2d, 4e	Precambrian: granitic gneiss, schist, amphibolite, charnockite, quartzite, cipolin; granitic batholiths; greenstone
Lf88-3b	I			11	Mozambique	2.13	2c	Precambrian: graphitic schist, gneiss. amphibolite, charnockite, quartzite, cipolin; granitic batholiths
Lf88-3b	I			358	Malawi	2.13	2c	Precambrian: graphitic schist, gneiss, amphibolite, charnockite, quartzite, cipolin; granitic batholiths
Lf89-1/2b	I	Bc F		93	Rhodesia	2.14	4e	Precambrian: gneiss, quartzite, schist, phyllite. Jurassic and Cretaceous sandstone and shale
Lf89-1/2b	I	B; F		1 478	Mozambique	2.14, 1.534	4e	Precambrian: gneiss, quartzite, schist, phyllite. Jurassic and Cretaceous: sandstone and shale
Lf90-2/3bc	Fh I			65	Malawi	2.13	2c	Precambrian: schist, quartzite, syenite, dolerite
Lf91-3ab	Lc	I		173	Mozambique	2.13	2c	Precambrian: graphitic schist, gneiss, amphibolite, charnockite, quartzite, crystalline limestone; granitic batholiths
Lf91-3ab	Lc	I		474	Malawi	2.13	2c	Precambrian: schist, quartzite, graphitic schist, gneiss, amphibolite. charnockite, syenite, dolerite, crystalline limestone; granitic batholiths
Lf93-1/2a	Lc Qc			538	South Africa	2.23, 2.21	7a	Precambrian: quartzite, phyllite, slate, schist, ironstone, andesite. dolomite, conglomerate

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION *(continued)*

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Lg1				67	Upper Volta	1.532. 1.533	4d	Basement complex: granitic gneiss. schist. quartzite: granitic batholiths. Cambrian: sandstone. tillite. minor limestone: recent alluvial deposits
Lg1-3a				22	Ivory Coast	1.41. 1.42. 1.48	4d	Recent alluvial deposits
Lg1-3a				191	Upper Volta	1.532	4d	Recent alluvial deposits
Lg1-3a				256	Ghana	1.41. 1.42. 1.48	4d	Recent alluvial deposits
Lg2-1a	Lf			729	Rhodesia	2.26. 2.27	2c	Basement complex: granite. gneiss. migmatite: basic intrusive rocks: diorite. gabbro
Lg2-1/2a	Lf			168	Chad	1.915	4e	Quaternary alluvial and lacustrine deposits
Lg3-1a	Re			141	Upper Volta	1.532	4e	Voltaian: sandstone. shale. conglomerate. dolomitic limestone. schist
Lg3-1a	Re			408	Rhodesia	2.26	2c	Precambrian: gneiss. quartzite. schist. phyllite. greenstone. Karroo: clayey schist. sandstone. shale. arkose. Kalahari: sand. ironstone. chalcedony
Lg3-2a	Re			440	Upper Volta	1.532	4e	Cambrian: sandstone. tillite. minor limestone. Quaternary: alluvial deposits
Lg4-1a	Ge			959	Central African Empire	1.915. 4.32	4d	Quaternary alluvial and lacustrine deposits
Lg5-2a	Lf Re		petroferric	991	Upper Volta	1.533. 1.532. 1.484	4a. 4c. 4e	Cambrian: sandstone. tillite. minor limestone. Basement complex: granitic gneiss. schist. quartzite: granitic batholiths
Lg5-2a	Lf Re		petroferric	160	Mali	1.484	4a. 4c	Cambrian: sandstone. tillite, minor limestone
Lg5-3a	Lf Re			168	Upper Volta	1.532	4e	Voltaian: sandstone, shale. conglomerate. dolomitic limestone. schist
Lg6-2/3a	Lf Vc	Ge Oe		758	Sudan	1.42. 1.533	4d	*Continental terminal:* clay and sand. Precambrian: schist. quartzite. syenite. dolerite
Lg7	Vp			107	Upper Volta	1.484. 1.532	4a. 4c	Recent alluvial deposits
Lg7	Vp			51	Mali	1.54	4h	Quaternary alluvial deposits overlying Cambrian sandstone, tillite and minor limestone
Lg7-2/3a	Vp			65	Senegal	1.484	4a. 4c	*Continental terminal:* sandstone. shale. marl. sand and clay. Pliocene and Quaternary alluvial and coastal deposits

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Lg7-3a	Vp			10	Mali	1.532	4c	Quaternary alluvial deposits overlying Cambrian *sandstone, tillite and minor* limestone
Lg7-3a	Vp			10	Upper Volta	1.532	4c	Recent alluvial deposits
Lg8	Lf Lp	I		138	Upper Volta	1.484	4a, 4c	Precambrian (Birrimian): schist, quartzite, greenstone. Basement complex: granitic gneiss, schist, quartzite; granitic batholiths
Lg8-1a	Lf Lp	I		777	Senegal	1.484	4a, 4c	*Continental terminal:* sandstone, shale, marl, sand, clay. Pliocene and Quaternary: alluvial and coastal deposits
Lg8-1a	Lf Lp	I		53	Gambia	1.484	4a, 4c	*Continental terminal:* sandstone, shale, marl, sand, clay. Pliocene and Quaternary: alluvial and coastal deposits
Lg9	Bv Ql	Re		282	Upper Volta	1.533	4e	Precambrian (Birrimian): schist, quartzite, greenstone
Lg9-1a	Bv Ql	Re		81	Upper Volta	1.533	4e	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths. Precambrian (Birrimian): schist, quartzite, greenstone
Lg10	Bv Re			114	Upper Volta	1.534	4g	Precambrian (Birrimian): schist, quartzite, greenstone
Lg10	Bv Re		petroferric	262	Upper Volta	1.484, 1.532, 1.534	4e	Cambrian: sandstone, tillite, minor limestone
Lg11		Gh		10	Upper Volta	1.484	4d	Cambrian: sandstone, tillite, minor limestone
Lg12	Ne Re			138	Upper Volta	1.484, 1.532	4e	Quaternary alluvial deposits overlying Cambrian sandstone, tillite and minor limestone
Lg13	Nd Rd			96	Mali	1.484	4a, 4c	Cambrian sandstone, *tillite* and minor limestone
Lg13	Nd Rd			161	Upper Volta	1.484	4a, 4c	Cambrian sandstone, tillite and minor limestone
Lg14	Gd Lf			61	Upper Volta	1.484	4a, 4c	Basement complex: granitic gneiss, schist, quartzite, biotite, apatite, norite; granitic batholiths
Lg15-1/2a	We			1 329	Cameroon	1.484	4a, 4c	Precambrian (Dahomeyan): schist, quartzite, syenite, dolerite; acid and basic effusive rocks: rhyolite, basalt, andesite. Basement complex: granitic gneiss, micaschist, migmatite; granitic batholiths

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Lg15-1/2a	We			157	Nigeria	1.482	4a. 4c	Precambrian (Dahomeyan): schist. quartzite. syenite. dolerite. Acid and basic effusive rocks: rhyolite. basalt. andesite
Lg16-1a	Sg	Re		64	Rhodesia	2.26	4g	Karroo: clayey schist. sandstone. shale. arkose
Lg20	Sg Ws			49	Nigeria	1.916	4e	Basement complex (Gwarian): granitic gneiss. micaschist. amphibolite. migmatite: granitic batholiths: recent alluvial deposits
Lg20-2a	Sg Ws		sodic	480	Nigeria	1.916. 1.917	4e	Quaternary alluvial and lacustrine deposits
Lg21	Lv	I We		112	Nigeria	1.916	4e	Basement complex (Gwarian): granitic gneiss. micaschist. amphibolite. migmatite: granitic batholiths: recent alluvial deposits
Lg23-a	Lf We	Ws	petric	75	Ghana	1.412	2a	Precambrian (Dahomeyan): schist, gneiss. quartzite
Lg23-a	Lf We	Ws	petric	276	Togo	1.412	2a	Precambrian (Dahomeyan): schist, gneiss. quartzite
Lg23-a	Lf We	Ws	petric	528	Benin	1.411. 1.412	4a. 4c	Precambrian (Dahomeyan): schist. gneiss. quartzite
Lg24	Ql	Sg		206	Nigeria	1.916. 1.484	4e	Basement complex (Gwarian): granitic gneiss. micaschist. amphibolite, migmatite: granitic batholiths
Lg25-2a	Qc	Je		319	Nigeria	1.916. 1.484	2c. 4c	Basement complex (Gwarian): granitic gneiss. micaschist. amphibolite. migmatite: granitic batholiths
Lg26-2a	Bg			704	Nigeria	1.483	2c. 4c	Basement complex (Gwarian): granitic gneiss. micaschist. amphibolite. migmatite: granitic batholiths
Lg27	I			49	Nigeria	1.532	2c. 4c	Basement complex (Gwarian): granitic gneiss. micaschist. amphibolite. migmatite: granitic batholiths
Lg28-1a	Lf Lp	Ql	petric	16	Ghana	1.484	4a. 4c	Basement complex: granitic gneiss. schist. quartzite: granitic batholiths
Lg28-1a	Lf Lp	Ql	petric	111	Upper Volta	1.484	4a. 4c	Basement complex: granitic gneiss. schist. quartzite: granitic batholiths
Lg28-1a	Lf Lp	Ql	petric	848	Ivory Coast	1.483	4a. 4c	Basement complex: granitic gneiss. schist. quartzite: granitic batholiths

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION *(continued)*

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Lg32-2c	I Jc	La Re V Zo		14	Algeria	6.151. 6.741	6d, 6e	Oligocene: sandstone. Quaternary: alluvial and lagoonal deposits
Lg32-2c	I Jc	La Re V Zo		204	Tunisia	6.741. 6.151. 6.1912	6d. 6e	Oligocene: sandstone. Quaternary: alluvial and lagoonal deposits
Lg33-1/2a	Je Lf			403	Chad	1.42. 1.915	4e	Quaternary alluvial and lacustrine deposits
Lg34-1/2a	Vp We			754	Chad	1.42. 1.915	4e	Quaternary alluvial and lacustrine deposits
Lg35-1a	Lf	G		492	Central African Empire	1.915	4a. 4c	Quaternary alluvial and lacustrine deposits
Lg36-1a	Je Lf	Nd Z		2 269	Chad	1.42	4a. 4c	*Continental terminal:* poorly consolidated sandstone. shalc. marl
Lg36-1a	Je Lf	Nd Z		439	Central African Empire	1.42	4a. 4c	*Continental terminal:* poorly consolidated sandstone. shale. marl
Lk4-2ab	Be I	Lc Bk	stony	1 896	Rhodesia	2.29. 3.22. 2.15	2d	Basement complex: granite. gneiss. migmatite. Basic intrusive rocks: diorite. gabbro. greenstone. basalt. rhyolite
Lk4-2ab	Be I	Lc Bk	stony	1 494	South Africa	2.29. 3.22	2d. 4e	Basement complex: granite. gneiss. migmatite. Basic intrusive rocks: diorite. gabbro. greenstone. basalt. rhyolite
Lk4-2ab	Be I	Lc Bk	stony	2 429	Botswana	2.29	2d	Basement complex: granite. gneiss. migmatite. Basic intrusive rocks: diorite. gabbro. greenstone. basalt. rhyolite
Lo38-bc	Bk I			467	Algeria	6.141. 6.142	6d. 6e	Upper Cretaceous: limestone. Eocene: flysch deposits. Pliocene and Quaternary: alluvial. lagoonal and lacustrine deposits
Lo39-2/3a	Vc			72	Algeria	6.142	5a	Eocene: flysch deposits. Pliocene and Quaternary: alluvial and lagoonal deposits
Lo40-ab	Bk			75	Algeria	6.142	6d. 6e	Upper Cretaceous: limestone. Eocene: flysch deposits. Pliocene and Quaternary: alluvial and lagoonal deposits
Lo41-1/2a	Xh			82	Angola	4.22	2d	Quaternary alluvial and aeolian deposits
Lo42-1a	Lc	So		125	Rhodesia	2.14	2d	Karroo clayey schist and sandstone
Lo43-2b	Lc	I		4 837	South Africa	2.27. 4.45. 2.38. 2.14	1d. 4e. 7a	Karroo clayey schist, sandstone. shale arkose. mudstone

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Lp2	Lg	I		1 029	Nigeria	1.482	4a. 4c	Basement complex (Gwarian): granitic gneiss. micaschist. amphibolite. migmatite: granitic batholiths
Lp2	Lg	I	petroferric	306	Togo	1.42	4e	Voltaian: sandstone. shale. conglomerate. dolomitic limestone, schist
Lp2	Lg	I	petroferric	27	Upper Volta	1.42	4e	Voltaian: sandstone. shale. conglomerate. dolomitic limestone. schist
Lp2-a	Lg	I	petroferric	2 219	Ghana	1.411. 1.42. 1.482	4a, 4c	Voltaian: sandstone. shale. conglomerate. dolomitic limestone. schist
Lp3-a	Lf	Ne	petroferric	499	Benin	1.482. 1.483. 1.484	4a. 4c	Precambrian: granitic gneiss. micaschist. amphibolite. quartzite: granitic batholiths
Lp3-a	Lf	Ne	petroferric	3	Togo	1.482	4a. 4c	Precambrian: granitic gneiss. micaschist. amphibolite. quartzite: granitic batholiths
Lp3-c	Lf	Ne	petric	34	Togo	1.484	4a. 4c	Precambrian (Dahomeyan): schist. gneiss. quartzite
Lp3-c	Lf	Ne	petric	33	Benin	1.484	4a. 4c	Precambrian (Dahomeyan): schist. gneiss. quartzite
Lp4	Re	I		275	Upper Volta	1.532	4e	Basement complex: granitic gneiss. schist. quartzite: granitic batholiths
Lp4	Re	I	petric	823	Upper Volta	1.532	4e	Basement complex: granitic gneiss. schist. quartzite: granitic batholiths
Lp4	Re	I	petric	75	Ghana	1.42	4e	Basement complex: granitic gneiss. schist. quartzite: granitic batholiths
Lp4	Re	I	petric	613	Nigeria	1.916	2c. 4c	Precambrian (Dahomeyan): schist. quartzite. syenite. dolerite. Quaternary: alluvial and lacustrine deposits
Lp4	Re	I	petric	94	Togo	1.42	4e	Basement complex: granitic gneiss. schist. quartzite: granitic batholiths
Lp5	I Lf			57	Upper Volta	1.484	4a. 4c	Precambrian (Birrimian): schist. quartzite. greenstone
Lp5-1a	I Lf		petric	1 477	Upper Volta	1.532	4e	Basement complex: granitic gneiss. schist. quartzite: granitic batholiths

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Lp6	Lf		petric	2 422	Nigeria	1.482, 1.484	4a, 4c	Basement complex (Gwarian): granitic gneiss, micaschist, amphibolite, migmatite; granitic batholiths. Cretaceous: sandstone and shale
Lp6-1a	Lf		petric	400	Ghana	1.42	4e	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths
Lp6-1a	Lf		petric	1 024	Upper Volta	1.532	4e	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths
Lp6-1a	Lf		lithic	441	Nigeria	1.916	2c, 4c, 4e	Basement complex (Gwarian): granitic gneiss, micaschist, amphibolite, migmatite; granitic batholiths
Lp7	Lf Lg		petroferric	376	Upper Volta	1.532	4e	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths
Lp8	Ap		petroferric	678	Upper Volta	1.484	4a, 4c	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths
Lp9	Rd	I	petroferric	309	Upper Volta	1.484	4a, 4c	Precambrian (Birrimian): schist, quartzite, greenstone
Lp10-1a	Lg Nd		petric	934	Ivory Coast	1.483	4a, 4c	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths
Lp10-1a	Lg Nd		petric	366	Upper Volta	1.483, 1.484	4a, 4c	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths
Lp12-1a	Lg	Fo Ao I		19	Angola	2.13	2c	Precambrian: gneiss, schist, quartzite, dolerite, syenite; acid intrusive rocks: granite, diorite
Nd1				84	Nigeria	1.484	2c, 4c	Basement complex (Gwarian): granitic gneiss, micaschist, amphibolite, migmatite; granitic batholiths
Nd1				2 109	Cameroon	1.73, 1.484, 1.483	2a, 4a, 4c	Basement complex: granitic gneiss, micaschist, migmatite; granitic batholiths. Precambrian: schist, quartzite, syenite, dolerite
Nd1				305	Mali	1.484	4a, 4c	Cambrian: sandstone, tillite, minor limestone

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Nd1				282	Upper Volta	1.484	4a, 4c	Cambrian: sandstone, tillite, minor limestone
Nd1-2a				267	Central African Empire	1.72, 1.121	1a	Basic intrusive rocks: diorite, gabbro, peridotite
Nd1-2a				339	Cameroon	1.72	1a	Precambrian (Birrimian): gneiss, quartzite, micaschist. Basic intrusive rocks: diorite, gabbro, peridotite
Nd1-2b			petric	17	Nigeria	1.46	1a	*Continental terminal:* poorly consolidated sandstone, marl, shale, sand, clay
Nd1-3a				1 627	Zaire	1.72	1a	Jurassic sandstone
Nd3	I			980	Nigeria	1.484, 1.482, 1.483	2c, 4a, 4c	Cretaceous sandstone and shale
Nd3	I			27	Upper Volta	1.484	4a, 4c	Precambrian (Birrimian): schist, quartzite, greenstone
Nd3	I		petroferric	10	Ivory Coast	1.483	4a, 4c	Precambrian (Birrimian): schist, quartzite, greenstone
Nd3	I		petroferric	398	Mali	1.484	4a, 4c	Precambrian (Birrimian): schist, quartzite, greenstone
Nd5-1a	Ao I		petric	973	Nigeria	1.132, 1.46, 1.482	2a	Cretaceous sandstone and shale
Nd6-3a	Fr	Fp I	petric	818	Cameroon	1.73	2a	Basement complex: granitic gneiss, micaschist, migmatite; granitic batholiths
Nd6-3a	Fr	Fp I	petric	1 595	Central African Empire	1.73	2a, 4a, 4c	Basement complex: granitic gneiss, micaschist, migmatite; granitic batholiths
Nd6-3ab	Fr	Fp I	petric	1 603	Cameroon	1.77	4a, 4c	Precambrian: granitic gneiss, micaschist, migmatite, quartzite, syenite, dolerite; granitic batholiths
Nd7	I	Nh		178	Togo	1.471	1a	Precambrian: sandstone, conglomerate, dolomite, schist, phyllite, grauwacke, greenstone
Nd7	I	Nh		180	Ghana	1.471	1a	Precambrian: sandstone, conglomerate, dolomite, schist, phyllite, grauwacke, greenstone
Nd8	Ao	I		366	Cameroon	1.73	2a	Basement complex: granitic gneiss, micaschist, migmatite; granitic batholiths

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION *(continued)*

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Nd8-b	Ao	I		66	Ghana	1.134	1a	Basic intrusive rocks: dolerite. diorite. gabbro
Nd8-1a	Ao	I		1 740	Nigeria	1.482. 1.483	4a. 4c	Cretaceous sandstone and marl
Nd8-2bc	Ao	I		261	Malawi	1.36. 2.13	2c	Precambrian: schist. quartzite, syenite. dolerite
Nd8-2bc	Ao	I		809	Tanzania	1.741. 1.812. 2.32	2b	Basement complex: orthogneiss. granite. migmatite. amphibolite. schist. quartzite
Nd9		Lf		574	Benin	1.412. 1.35. 1.135	2a	Cretaceous limestone and marl
Nd9		Lf		38	Nigeria	1.135, 1.412	2a	Cretaceous limestone and marl
Nd9		Lf		111	Ghana	1.35	2a	*Continental terminal:* poorly consolidated sandstone and marl. Pliocene: alluvial and deltaic deposits
Nd9		Lf		182	Togo	1.35. 1.412	2a	*Continental terminal:* poorly consolidated sandstone and marl. Pliocene: alluvial and deltaic deposits
Nd9-1a		Lf		98	Benin	1.135	2a	*Continental terminal:* poorly consolidated sandstone. marl. shale. sand. clay
Nd9-1a		Lf		213	Nigeria	1.135	1a. 2a	*Continental terminal:* poorly consolidated sandstone. marl. shale. sand. clay
Nd10-b	Fo Fr			69	Cameroon	1.73	4a, 4c	Precambrian (Dahomeyan): schist. quartzite. syenite. dolerite
Nd10-3b	Fo Fr			438	Cameroon	1.73	4a	Basic effusive rocks: basalt. andesite
Nd11	Lf			3 240	Chad	1.42	4a. 4c. 4e	*Continental terminal:* poorly consolidated sandstone. shale. conglomerate. grits. sand. clay
Nd12-2b	Bf I			10	Liberia	1.476	1a	Basement complex: granitic gneiss, schist. quartzite: granitic batholiths
Nd12-2b	Bf I			69	Sierra Leone	1.476	1a	Basement complex: granitic gneiss. schist. quartzite: granitic batholiths.
Nd13-3bc	Ne	I		342	Uganda	1.42, 1.72	4e, 4a. 4c	Basement complex: orthogneiss. granite. migmatite. amphibolite. schist. quartzite. cipolin
Nd13-3bc	Ne	I		331	Zaire	1.42. 1.72	2a	Basement complex: orthogneiss. granite. migmatite. amphibolite. schist. quartzite. cipolin
Nd14-1a	Ao	Ne		52	Nigeria	1.482	2a	Cretaceous sandstone and shale
Nd15	Af Ap	I		108	Nigeria	1.412	2a	Cretaceous limestone and marl
Nd15-1a	Af Ap	I	petric	809	Nigeria	1.131. 1.482	1a. 2a	Cretaceous and Palaeogene: limestone. marl. sandstone and shale
Nd16-2/3a	Ag Ao			1 960	Nigeria	1.482. 1.46. 1.132	1a. 2a	Cretaceous dolomitic limestone. shale and sandstone

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Nd16-2/3a	Ag Ao			212	Cameroon	1.123	1a	Cretaceous dolomitic limestone. shale and sandstone
Nd17-1a		G		525	Nigeria	1.135. 1.131. 1.132	1a	*Continental terminal:* poorly consolidated sandstone. marl. shale. sand. clay
Nd17-1ab		G		396	Nigeria	1.132	1a	*Continental terminal:* poorly consolidated sandstone. marl. shale. sand. clay
Nd18	G			175	Nigeria	1.132	1a	*Continental terminal:* poorly consolidated sandstone. marl. shale. sand. clay
Nd18-1a	G			406	Nigeria	1.132	1a	*Continental terminal:* poorly consolidated sandstone. marl. shale. sand. clay
Nd19-1a	Fo G			49	Nigeria	1.132	1a	*Continental terminal:* poorly consolidated sandstone. marl, shale. sand. clay
Nd20-1a	Jd			220	Nigeria	1.131	1a	Palaeogene limestone and marl
Nd21	Fo			795	Nigeria	1.132	1a	*Continental terminal:* poorly consolidated sandstone. marl. shale. sand. clay
Nd21-1a	Fo			532	Nigeria	1.132	1a	*Continental terminal:* poorly consolidated sandstone. shale. conglomerate. grits, sand and clay. Quaternary: lagoonal and aeolian deposits
Nd22-1a		I		1 575	Nigeria	1.916. 1.484	2c. 4c. 4e	Palaeogene sandstone and shale
Nd23-3c	Fo	Ah		98	Angola (Cabinda dist.)	1.132	1a	Precambrian: crystalline schist. quartzite. greenstone: granite and diorite intrusives
Nd23-3c	Fo	Ah		215	Zaire	1.73	1a	Precambrian: crystalline schist. quartzite. greenstone: granite and diorite intrusives
Nd23-3c	Fo	Ah		40	Congo	1.132	1a	Precambrian: crystalline schist, quartzite. greenstone: granite and diorite intrusives
Nd24-2c	Lp	I V		535	Tanzania	1.812	7	Basement complex: orthogneiss. granite. migmatite. amphibolite. schist. quartzite. Precambrian: acid and basic volcanic rocks and minor clastic sediments
Nd25-2b	Bf	I		28	Ivory Coast	1.122	1a	Basement complex: granitic gneiss. schist. quartzite: granitic batholiths.
Nd27	Ap I		petroferric	9	Guinea	1.483	4a. 4c	Precambrian (Birrimian): schist. quartzite. greenstone
Nd27	Ap I		petroferric	424	Ivory Coast	1.483	4a. 4c	Precambrian (Birrimian): schist. quartzite. greenstone
Nd28-2a	Lf	G		327	Gambia	1.484	4a. 4c	*Continental terminal:* sandstone. shale. marl. sand. clay. Pliocene and Quaternary: alluvial. lagoonal and marine deposits
Nd28-2a	Lf	G		120	Guinea-Bissau	1.484. 1.485	2a. 4c	*Continental terminal:* sandstone. shale. marl. sand. clay. Pliocene and Quaternary: alluvial. lagoonal and marine deposits

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Nd28-2a	Lf	G		1 395	Senegal	1.485. 1.532	2a. 4a. 4c	*Continental terminal:* sandstone. shale. marl. sand. clay. Pliocene and Quaternary: alluvial. lagoonal and marine deposits
Nd34-2bc	Ap	I Vp	stony	328	Tanzania	1.812	2b	Precambrian: schist. gneiss. charnockite. quartzite. cipolin: acid and basic intrusive rocks
Nd37-2/3ab	Fo Lf	I		37	Kenya	1.812	4a. 4c	Precambrian: schist. gneiss. charnockite. quartzite. cipolin: acid and basic volcanic rocks and minor clastic sediments: basalt
Nd37-2/3ab	Fo Lf	I		649	Tanzania	1.811. 1.812	2c. 4a. 4c	Precambrian: schist. gneiss. charnockite. quartzite. cipolin: acid and basic volcanic rocks and minor clastic sediments
Nd38-2bc	Ao	Gh Vp		224	Tanzania	1.812. 1.846. 2.32	4g	Basement complex: orthogneiss. granite. migmatite. amphibolite. schist. quartzite. charnockite. cipolin
Nd39-3bc		I Ge		90	Burundi	1.811	4f	Precambrian: shale. sandstone. conglomerate. phyllite. schist, quartzite
Nd39-3bc		I Ge		118	Rwanda	1.811	4f	Effusive rocks: basalt. rhyolite. dacite. trachyte. pyroclastics. tuff. Precambrian: shale. sandstone. conglomerate. phyllite. schist. quartzite
Nd39-3bc		I Ge		335	Zaire	1.72. 1.76	4f	Effusive rocks: basalt. rhyolite. dacite. trachyte. pyroclastics. tuff
Nd40-3b		Ge Gp		4 536	Zaire	1.482. 1.72	2a. 2c	Precambrian: sandstone. quartzite, calcareous schist. Carboniferous: tillite. shale. slate. sandstone
Nd41-3b	Fo	G		729	Zaire	1.72	1a	Jurassic sandstone
Nd42-3b	Fo	Bd G		6 109	Zaire	1.72	1a	Precambrian: gneiss. amphibolite. quartzite. micaschist. sandstone. calcareous schist: granitic batholiths
Nd43-2/3a	Fo Gd	Jd		2 286	Zaire	1.121. 1.72	1a	Jurassic: sandstone. Karroo: sandstone. conglomerate and siltstone
Nd44-2/3a	Fo Q			31	Angola	1.73	1a	*Continental intercalaire:* sandstone. shale. conglomerate
Nd44-2/3a	Fo Q			15 876	Zaire	1.121. 1.23. 1.482. 1.72. 1.73	1a. 2c. 4c	Carboniferous: tillite. shale. slate. sandstone. Karroo: sandstone. conglomerate and siltstone partly covered with *continental intercalaire:* sandstone. shale. conglomerate
Nd45-2b	Fp Fx		petric	268	Congo	1.121	1a	Precambrian gneiss. quartzite. micaschist
Ne1				28	Nigeria	1.132	1a	Basalt. trachyte, dolerite
Ne1.				27	Cameroon	1.123	1a	Basalt. trachyte. dolerite
Ne1				26	Ghana	1.131	1a. 2a	Greenstone
Ne1				37	Togo	1.412	2a	Precambrian (Dahomeyan): schist. gneiss. quartzite

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Ne1-a				34	Togo	1.484	4a, 4c	Precambrian (Dahomeyan): schist, gneiss, quartzite
Ne1-ab				442	Ghana	1.131	1a	Basement complex: orthogneiss, paragneiss, granite, micaschist, quartzite, greenstone
Ne1-3a				298	Rhodesia	2.26	2c	Precambrian: gneiss, quartzite, schist, phyllite, greenstone
Ne1-3b				145	Mozambique	1.77	2c	Precambrian: graphitic schist, gneiss, amphibolite, charnockite, quartzite, crystalline limestone; granitic batholiths
Ne1-3b				210	Malawi	1.77	2c	Precambrian: graphitic schist, gneiss, amphibolite, charnockite, quartzite, crystalline limestone; granitic batholiths
Ne3-b	Fo I			171	Nigeria	1.123	2a	Precambrian (Dahomeyan): schist, quartzite, syenite, dolerite
Ne3-b	Fo I			301	Cameroon	1.123	1a	Precambrian (Dahomeyan): schist, quartzite, syenite, dolerite
Ne6-2b	Ao I	Be		118	Togo	1.471	4a, 4c	Precambrian (Dahomeyan): schist, gneiss, quartzite
Ne6-2b	Ao I	Be		46	Ghana	1.412	1a	Precambrian (Dahomeyan): schist, gneiss, quartzite
Ne6-3a	Ao I	Be		20	Togo	1.412	1a	Precambrian (Dahomeyan): schist, gneiss, quartzite
Ne7-2/3b	Nh Re	I	petroferric	351	Central African Empire	1.482	2a	Precambrian: schist, quartzite, syenite, dolerite
Ne10-3b	Be Vp	I Lp		3 281	Ethiopia	2.32, 2.37, 1.843	1d, 4f	Trap series: basalt, phonolite, nephelinite, trachyte, rhyolite, pyroclastics
Ne12-2c	Be	I Vp		439	Kenya	1.534	8a, 4g	Tertiary-recent volcanics: basalt, phonolite, nephelinite, pyroclastics, tuff
Ne12-2c	Be	I Vp		1 597	Ethiopia	1.77, 1.85, 2.32	1d, 4b	Trap series: basalt, phonolite, nephelinite, trachyte, rhyolite, pyroclastics
Ne12-3b	Be	I Vp		3 743	Ethiopia	1.77, 2.32, 2.37	4b, 4f	Trap series and Aden volcanic series: basalt, basaltic breccias, tuff, phonolite, trachyte, rhyolite
Ne13-3b	Vp	Be I Lp		7 561	Ethiopia	1.42, 1.77, 2.32	4b, 4f, 5a	Trap series: basalt, phonolite, nephelinite, trachyte, rhyolite, pyroclastics
Ne13-3b	Vp	Be I Lp		534	Sudan	1.532, 1.77	4b	Trap series: basalt, phonolite, nephelinite, trachyte, rhyolite, pyroclastics. Jurassic: limestone, marl, gypsum
Ne14-3	Bf		lithic	580	Mali	1.484	4a, 4c	Precambrian (Birrimian): schist, quartzite, greenstone
Ne14-3	Bf		lithic	32	Ivory Coast	1.483	4a, 4c	Precambrian (Birrimian): schist, quartzite, greenstone
Ne14-3	Bf		lithic	36	Guinea	1.483	4a, 4c	Precambrian (Birrimian): schist, quartzite greenstone

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION *(continued)*

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Ne15-3c	Bk	I	lithic	834	Ethiopia	1.77, 1.843, 1.85, 2.21, 2.35	1d, 4f	Jurassic: dolomitic limestone, marl, minor limestone, gypsum. Precambrian: gneiss, schist, quartzite; granitic batholiths
Ne16-a	Fo Nd			364	Nigeria	1.123	1a	Precambrian (Dahomeyan): schist, quartzite, syenite, dolerite
Ne16-a	Fo Nd			103	Cameroon	1.123	1a	Precambrian (Dahomeyan): schist, quartzite, syenite, dolerite
Ne17	Nd	I		245	Nigeria	1.132	1a	Precambrian (Dahomeyan): schist, quartzite, syenite, dolerite; acid and basic effusive rocks: rhyolite, basalt, andesite
Ne17	Nd	I		757	Cameroon	1.123	1a	Precambrian (Dahomeyan): schist, quartzite, syenite, dolerite; acid and basic effusive rocks: rhyolite, basalt, andesite
Ne17-2/3c	Nd	I		665	Tanzania	1.134, 1.85, 1.811, 2.11	2a, 2c	Basement complex: orthogneiss, granite, migmatite, amphibolite, schist, quartzite. Precambrian: schist, gneiss, charnockite, quartzite, cipolin
Ne18	I Nd			262	Nigeria	1.482, 1.131	1a, 2a	Basement complex (Gwarian): granitic gneiss, micaschist, amphibolite, migmatite; granitic batholiths
Ne18	I Nd		petroferric	85	Ivory Coast	1.484	4a, 4c	Precambrian (Birrimian): schist, quartzite, greenstone
Ne18	I Nd		petroferric	718	Mali	1.484	4a, 4c	Precambrian (Birrimian): schist, quartzite, greenstone
Ne18-2b	I Nd			12	São Tomé and Principe	1.131	4a	Basic effusive rocks: basalt, andesite, pyroclastics
Ne19-1a	Nd			115	Nigeria	1.131	1a, 3a	Basement complex (Gwarian): granitic gneiss, micaschist, amphibolite; granitic batholiths
Ne19-2a	Nd		lithic	340	Nigeria	1.482	2a	Basement complex (Gwarian): granitic gneiss, micaschist, amphibolite, migmatite; granitic batholiths
Ne20-3b	Vp	Be Lp		581	Ethiopia	2.32, 2.35	4f	Trap series: basalt, phonolite, nephelinite, trachyte, rhyolite, pyroclastics
Ne21	Be	I		21	Nigeria	1.131	1a	Basement complex (Gwarian): granitic gneiss, micaschist, amphibolite, migmatite; granitic batholiths
Ne21-b	Be	I		64	Togo	1.484	4a, 4c	Precambrian (Dahomeyan): schist, gneiss, quartzite
Ne21-b	Be	I		10	Benin	1.484	4a, 4c	Precambrian (Dahomeyan): schist, gneiss, quartzite
Ne21-3b	Be	I		119	Nigeria	1.131	1a	Basement complex (Gwarian): granitic gneiss, micaschist, amphibolite, migmatite; granitic batholiths

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION *(continued)*

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Ne21-3b	Be	I	stony	15	Comoro Islands	1.121	4c	Basalt and rhyolite
Ne26-2/3b	Fr Nh			256	Central African Empire	1.482	2a, 4a, 4c	Precambrian: granitic gneiss, migmatite, schist, quartzite, syenite, dolerite: granitic batholiths; sandstone, calcareous schist
Ne27-2b	Nh Rd	I		833	Sudan	1.42, 1.72	4e	Precambrian: gneiss, schist, quartzite; granitic batholiths
Ne27-2b	Nh Rd	I		630	Zaire	1.72, 1.73	4a, 4c	Precambrian: schist, gneiss, amphibolite, charnockite, quartzite, cipolin
Ne27-2b	Nh Rd	I		283	Uganda	1.42, 1.72	4a, 4c	Precambrian: gneiss, schist, quartzite, amphibolite, charnockite, cipolin; granitic batholiths
Ne28-2a	Ao Fr			1 805	Somalia	1.534	4b	Precambrian: gneiss, schist, quartzite; granitic batholiths
Ne29-2bc		We		200	Kenya	2.31	2b	Tertiary-recent volcanics: basalt, phonolite, nephelinite, pyroclastics, tuff
Ne30-2ab	Fo	Ap Gp		276	Kenya	1.33	4a, 4c	Precambrian: schist, gneiss, amphibolite, charnockite, quartzite, cipolin
Ne31-2ab		Vp I		120	Tanzania	1.33, 1.846	4g	Precambrian: schist, gneiss, charnockite, quartzite, cipolin
Ne31-2ab		Vp I		719	Kenya	1.33, 1.582	4a, 4c	Precambrian: schist, gneiss, charnockite, quartzite, cipolin
Ne33-2/3bc	Fo	Ah		209	Angola	1.73	1a	Precambrian: sandstone, quartzite, calcareous schist
Ne34-3c		Nh		82	Angola	1.73	4a, 4c	Precambrian: sandstone, quartzite, calcareous schist
Ne35-2/3ab	Fo	Ap Fp		418	Zaire	1.23, 1.42, 1.73	1a, 2a	Precambrian: sandstone, quartzite, calcareous schist
Ne35-2/3ab	Fo	Ap Fp		266	Angola	1.23, 1.35	2a	Precambrian: sandstone, quartzite, calcareous schist
Ne35-2/3ab	Fo	Ap Fp		86	Angola (Cabinda dist.)	1.42	1a	Precambrian: sandstone, quartzite, calcareous schist
Ne36-2/3bc	Fo	Fr Nh		67	Angola	1.73	1a	Precambrian: sandstone, quartzite, calcareous schist
Ne37-1/2a	Je Vp			312	Tanzania	1.846, 1.85	4g	Precambrian: schist, gneiss, charnockite, quartzite, cipolin
Ne38-2ab	Bc	I Vp		181	Kenya	1.36, 1.582	4g, 2a	Basement complex: orthogneiss, migmatite, amphibolite, schist, quartzite, charnockite, cipolin
Ne38-2ab	Bc	I Vp		1 389	Tanzania	1.32, 1.34, 1.36, 1.582 1.812, 1.846	2a, 4g	Basement complex: orthogneiss, granite, migmatite, amphibolite, schist, quartzite, charnockite, cipolin

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Ne39-2a	Bk	E I	petrocalcic	372	Tanzania	1.846, 1.85	4g	Precambrian: schist, gneiss, charnockite, quartzite, cipolin
Ne40-1/2a	Bc	Lf Vp		233	Tanzania	1.85	4g	Precambrian: schist, gneiss, charnockite, quartzite, cipolin
Ne41-2ab	Lf			309	Tanzania	1.74, 1.812	2c	Precambrian basalt
Ne41-3a	Lf			385	Rhodesia	2.15, 2.26, 2.27	2c	Precambrian: gneiss, quartzite, schist, phyllite, greenstone
Ne42-2c	To	V		255	Tanzania	1.846	4g	Precambrian: schist, gneiss, charnockite, quartzite, cipolin
Ne43-2/3ab	Ap	Vp	duripan	82	Tanzania	1.812	2c	Carbonatite and basic intrusive rocks
Ne43-2/3ab	Ap	Vp	duripan	9	Zambia	1.812	2c	Carbonatite and basic intrusive rocks
Ne44-2/3ab		Gh I		32	Tanzania	1.843	2c	Granite and basic intrusive rocks
Ne45-3a	V	I		394	Rhodesia	2.26	2c	Basic and ultrabasic igneous rocks: diorite, gabbro, peridotite, serpentinite
Ne45-3a	V	I		230	Botswana	2.29	2d	Basic and ultrabasic igneous rocks: diorite, gabbro, peridotite, serpentinite
Ne46-2ab	I			239	Rhodesia	2.27	2c	Precambrian: gneiss, quartzite, schist, phyllite, greenstone
Ne46-2ab	I			104	Zambia	1.741	2c	Precambrian: limestone, dolomitic shale, schist, quartzite, sandstone, shale, arkose
Ne46-2/3ab	I			227	Swaziland	2.21	7a	Basement complex: granite, gneiss, schist, phyllite, amphibolite, greenstone
Ne47-2b	Af Ao	Bf I U		2 659	Madagascar	1.121, 1.484, 1.73, 1.74, 2.14, 2.25, 4.32	1a, 4a, 4c, 4e	Precambrian: amphibolite, pyroxenite, cipolin, gneiss, migmatite. Triassic: sandstone
Ne48-3a	I Lc			446	Madagascar	1.142, 1.144, 1.484	2c	Cretaceous basalt
Ne48-3b	I Lc			540	Madagascar	1.36, 1.484	2c, 4e	Cretaceous basalt
Ne49-3b	Fh Fp	I	stony	22	Madagascar	1.121	2c	Quaternary basalt
Ne50-3b	Fr Lc	I Rc Vp	stony	81	Mauritius	1.22	4e	Pleistocene basalt
Ne51-2/3b	Fr Lc	I		28	Comoro Islands	1.121	4c	Basalt and rhyolite
Ne52-2a	Jc			115	Algeria	6.1912	6d, 6e	Quaternary alluvial deposits
Ne54-2/3b	I	Ge		292	Malawi	1.77	2c	Precambrian: graphitic schist, gneiss, amphibolite, charnockite, quartzite, crystalline limestone; granitic batholiths

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION *(continued)*

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Nh2-2c	Th	I O		1 935	Kenya	1.77, 1.811, 2.31	2b, 4a, 4c	Tertiary-recent volcanics: basalt, phonolite, nephelinite, pyroclastics, tuff. Precambrian: schist, gneiss, amphibolite, charnockite, quartzite, cipolin. Trap series: basalt, phonolite, nephelinite, trachyte, rhyolite, pyroclastics
Nh2-2c	Th	I O		750	Uganda	1.72, 1.76, 1.811	2a, 4a, 4c	Precambrian: schist, gneiss, amphibolite, charnockite, quartzite, cipolin; granitic intrusions. Basement complex: orthogneiss, granite, migmatite, amphibolite, schist, quartzite, cipolin. Acid and basic volcanic rocks; argillaceous and arenaceous sediments
Nh2-2/3c	Th	I O		630	Tanzania	1.72, 2.32	4g	Tertiary-recent volcanics: basalt, phonolite, nephelinite, pyroclastics, tuff
Nh3	Fh I			171	Cameroon	1.73	4a	Precambrian (Dahomeyan): schist, quartzite, syenite, dolerite; acid and basic effusive rocks: rhyolite, basalt, andesite
Nh3	Fh I			326	Nigeria	1.77, 1.482	2a, 4a, 4c	Precambrian (Dahomeyan): schist, quartzite, syenite, dolerite
Nh3-ab	Fh I			38	Nigeria	1.482	4a, 4c	Precambrian (Dahomeyan): schist, quartzite, syenite, dolerite
Nh3-ac	Fh I			41	Cameroon	1.77	4a	Precambrian (Dahomeyan): schist, quartzite, dolerite
Nh3-ac	Fh I			45	Nigeria	1.77	4a	Precambrian (Dahomeyan): schist, quartzite, syenite, dolerite
Nh4-c	I Th			24	São Tomé and Principe	1.131	1a, 4a	Basic effusive rocks: basalt, andesite, pyroclastics
Nh5-2/3c	Bh	I		3 472	Zaire	1.72, 1.73, 1.76	2b, 4f	Precambrian: schist, gneiss, amphibolite, charnockite, quartzite, cipolin, sandstone, calcareous schist
Nh5-2/3c	Bh	I		110	Burundi	1.812	4f	Precambrian: schist, gneiss, amphibolite, charnockite, quartzite, cipolin, sandstone, calcareous schist
Nh5-2/3c	Bh	I		532	Rwanda	1.811	4a, 4c	Precambrian: schist, gneiss, amphibolite, charnockite, quartzite, cipolin, sandstone, calcareous schist
Nh6-2/3c	Fo	Bd		828	Zaire	1.72	2b, 4f	Basement complex: orthogneiss, granite, migmatite, amphibolite, schist, quartzite, sandstone, calcareous schist
Nh7-2/3c	Fh Fo	I		184	Burundi	1.74, 1.812	4f	Precambrian: schist, gneiss, charnockite, quartzite, cipolin
Nh7-2/3c	Fh Fo	I		9	Tanzania	1.74	2c	Precambrian: schist, gneiss, charnockite, quartzite, cipolin
Nh7-2/3c	Fh Fo	I		112	Uganda	1.76	4a, 4c	Precambrian: shale, sandstone, conglomerate, phyllite, schist, quartzite

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Nh7-2/3c	Fh Fo	I		187	Rwanda	1.811	4a, 4c	Precambrian: shale, sandstone, conglomerate, phyllite, schist, quartzite
Nh7-2/3c	Fh Fo	I		40	Zambia	1.74	2c	Precambrian: gneiss, amphibolite, quartzite, micaschist
Nh7-2/3c	Fh Fo	I		2 147	Zaire	1.482, 1.74, 1.76, 1.812	2b, 4f, 2c	Precambrian: shale, sandstone, conglomerate, phyllite, schist, quartzite, gneiss, amphibolite, micaschist
Od10-1/2a	Gh Jd			32	Ivory Coast	1.122	4h	Recent alluvial and lagoonal deposits
Od11-2a	Gd Gh			297	Congo	1.121	1b, 1c	Recent alluvial deposits
Od12-2a	Gd Gh	Jd		179	Madagascar	1.72		Quaternary alluvial and lacustrine deposits
Oe3-a	G	Je		40	Zaire	1.77	4h	Quaternary lacustrine deposits
Oe3-a	G	Je		1 106	Zambia	1.77, 2.26	4h	Quaternary lacustrine deposits
Oe4-a	Gh	Je		91	Malawi	1.533	4e	Recent alluvial and lacustrine deposits
Ph5-1a		G Qc Od		1 192	Angola	2.13, 4.22	4d, 4e	Kalahari: sand, ironstone, chalcedony. Quaternary: lacustrine sediments
Ph5-1a		G Qc Od		1 127	Zambia	2.13	2c	Kalahari: sand, ironstone, chalcedony
Qa5-1a	Ql	Ge V	duripan	901	Botswana	2.23	4g	Karroo: clayey schist, tillite, sandstone, shale, arkose; effusive rocks: basalt and rhyolite, partly overlain with Kalahari sand, ironstone and chalcedony
Qa6-1a	Ql	Qc Jc		3 575	Botswana	4.22	4e, 4g	Kalahari: sand, ironstone, chalcedony
Qa6-1a	Ql	Qc Jc		182	Namibia	4.22	4e	Kalahari: sand, ironstone, chalcedony
Qa7-1a	So	Zo		270	Mozambique	1.923	2a	Quaternary alluvial and coastal deposits
Qa7-1a	So	Zo		235	Namibia	3.43, 3.45	8b	Quaternary alluvial and coastal deposits
Qa7-1a	So	Zo		2 580	South Africa	6.21, 6.831, 3.45, 6.183, 1.923	5a, 8b, 2a	Quaternary alluvial and coastal deposits
Qa8-1ab	Be I So	Qc	stony	769	South Africa	6.1923, 6.183	5a	Precambrian: quartzite, shale, slate
Qc1				1 154	Mali	1.54, 1.534	4g	Recent dunes
Qc1				50	Upper Volta	1.534	4g	*Continental terminal:* poorly consolidated sandstone, mudstone, conglomerate, grits
Qc1				28	Nigeria	1.918	4g	*Continental intercalaire:* sandstone, arkose, shale, conglomerate
Qc1				79	Cameroon	1.532	4e	Quaternary alluvial and lacustrine deposits

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION *(continued)*

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Qc1				995	Niger	1.534. 1.54. 1.918. 1.919	4g	Recent dunes. *Continental intercalaire:* sandstone, arkose. shale. conglomerate
Qc1-1a				5 890	Mauritania	3.11. 3.12. 1.543	4g. 8c. 9c	*Continental terminal:* sandstone. shale. marl. sand. clay. Quaternary: coastal and lagoonal deposits
Qc1-1a				5 618	Chad	1.534. 3.22	4g. 8c	Quaternary alluvial and lacustrine deposits: granite outcrops
Qc1-1a				506	Senegal	1.54	4g	*Continental terminal:* sandstone. shale. marl. sand. clay. Quaternary: coastal and lagoonal deposits
Qc1-1a				2 287	Niger	1.534. 3.22	4g	Recent dunes. *Continental intercalaire:* sandstone. arkose. shale. conglomerate
Qc2-1bc	Bh	Je	lithic	1 531	Ethiopia	1.77. 2.21. 2.35	4f. 8c. 8a	Jurassic dolomite. limestone. marl. minor sandstone
Qc3-1a	Bk			1 157	Senegal	1.534	4g	*Continental terminal:* sandstone. shale. marl. sand. clay
Qc4	Ql			1 040	Mauritania	1.534. 1.544	4g	Cambrian: calcareous schist. quartzite. pelites. *Continental terminal:* sandstone. shale. marl. sand. clay
Qc4-1a	Ql			14 001	Sudan	1.533. 4.31	4e. 4g	*Continental terminal:* clay. sand. Precambrian: schist. quartzite. syenite. dolerite
Qc4-1a	Ql			1 113	Nigeria	1.916. 1.917. 1.918	4e	Quaternary alluvial and lagoonal deposits overlain with aeolian sand
Qc4-1b	Ql			182	Nigeria	1.8	4e	Precambrian (Dahomeyan): schist. quartzite. syenite. dolerite
Qc5-1c	Bh I	Je	lithic	1 509	Ethiopia	1.77. 2.32. 2.35	5a	Jurassic dolomite. limestone. marl and minor sandstone
Qc6	Ql Ws			91	Upper Volta	1.534	4g	Recent dunes
Qc7-1a	Ge Zg			2 170	Nigeria	1.918. 1.917	4e. 4g	Quaternary alluvial and lacustrine deposits overlain with aeolian sand: granite outcrops
Qc7-1a	Ge Zg			193	Chad	3.22	4g	Quaternary alluvial and lacustrine deposits: granite outcrops
Qc7-1a	Ge Zg			4 868	Niger	1.917. 1.918. 1.919. 3.22	4e. 4g	Quaternary alluvial and lacustrine deposits; granite outcrops
Qc8-1a	Ge			930	Somalia	3.12	4b	Cretaceous: limestone. marl and sandstone. Quaternary: alluvial. lacustrine and aeolian deposits
Qc8-1a	Ge			783	Kenya	3.12	4b	Cretaceous limestone.' marl and sandstone
Qc9-1b	I Ge			17	Somalia	3.12	4b	Jurassic: limestone. marl. gypsum. Trap series: basalt, phonolite, nephelinite, trachyte. rhyolite. pyroclastics

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION *(continued)*

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Qc9-1b	I Ge			43	Kenya	3.12	4b	Jurassic: limestone, marl, gypsum. Trap series: basalt, phonolite, nephelinite, trachyte, rhyolite, pyroclastics
Qc10-1a	I			13 231	South Africa	3.271, 3.53, 2.23	8c	Basement complex: granite, gneiss, schist, phyllite. Kalahari: sand, ironstone, chalcedony. Quaternary: lacustrine sediments
Qc10-1a	I			327	Namibia	3.26	4g	Kalahari: sand, ironstone, chalcedony. Quaternary: lacustrine sediments
Qc10-1a	I			110	Cameroon	1.484	4e	Basement complex: granitic gneiss, mica-schist, migmatite; granitic batholiths
Qc10-1c	I		lithic	438	Ethiopia	1.77, 1.85	4f	Jurassic limestone, marl and gypsum
Qc11	Ws			852	Chad	1.533, 1.534	4e, 4g	Quaternary alluvial and lacustrine deposits
Qc12	Vp			175	Chad	1.534	4g	Quaternary alluvial and lacustrine deposits
Qc13-1a		Z		6 372	Chad	1.534, 3.22	4e, 4g, 8c	Recent lacustrine and aeolian deposits
Qc14	Bk I		petroferric	354	Nigeria	1.532	4e	Palaeogene: limestone, marl, shale
Qc15-1a	Re	S Z		3 486	Chad	1.534, 1.917, 3.22	4e, 4g, 8c	Recent aeolian deposits
Qc15-1a	Re	S Z		258	Sudan	3.22	8c	Recent aeolian deposits
Qc16-1a	S V Z			614	Chad	1.534, 3.22	4g, 8c	Quaternary alluvial, lacustrine and aeolian deposits
Qc17-1a	S Ws			54	Sudan	3.22	4g	Recent aeolian deposits
Qc17-1a	S Ws			130	Chad	3.22	4g	Recent aeolian deposits
Qc18-1a	Bg Z			2 052	Chad	1.534, 3.22	4e, 4g, 9c	Quaternary alluvial, lacustrine and aeolian deposits
Qc19-1c		Re Qa	lithic	474	Somolia	3.12	8a	Cretaceous limestone, marl, sandstone
Qc19-1c		Re Qa	lithic	46	Kenya	3.12	4b	Cretaceous limestone, marl, sandstone
Qc20-1a	Re		shifting sands	135	Kenya	1.534, 3.12	4g	Recent alluvial and aeolian deposits
Qc20-1a	Re			20	Zanzibar Island (Tanzania)	1.12	2a	Neogene terrestrial sediments
Qc21-1a	Ql Re	Gc Lk So		6 742	Sudan	1.534, 1.544, 4.31	4g	Aeolian sand. Precambrian: gneiss, quartzite, schist, cipolin, conglomerate, argillite, andesite, rhyolite; granitic batholiths
Qc22-1b	Lc Re			2 918	Somalia	1.543, 1.574	4b, 8c	Quaternary terrestrial and coastal deposits
Qc22-1b	Lc Re		shifting sands	195	Somalia	1.534, 1.543	8c	Recent alluvial and lacustrine deposits
Qc23-1a		Rd Lf F		5 630	Angola	1.73, 4.22	2c, 4e	Polymorphic sandstone; consolidated and unconsolidated sand, shale, conglomerate. Kalahari: sand, ironstone, chalcedony. Quaternary: lacustrine sediments

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION *(continued)*

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Qc24-1a	R	G P		806	Zaire	1.482. 1.73	2c. 4e	Precambrian: limestone. dolomitic shale. schist, quartzite, sandstone. shale. arkose. Polymorphic sandstone: consolidated and unconsolidated sands
Qc24-1a	R	G P		2 473	Angola	2.13. 4.22	2c. 4e. 5a	Polymorphic sandstone: consolidated and unconsolidated sands. Kalahari: sand. ironstone. chalcedony. Quaternary: lacustrine deposits
Qc24-1a	R	G P		1 971	Zambia	2.13	2c. 4e	Polymorphic sandstone: consolidated and unconsolidated sands
Qc25-1a	G	P A Fo		1 246	Angola	1.77. 2.13	2c	Polymorphic sandstone: consolidated and unconsolidated sands
Qc26-1a	Ge	Fo		1 741	Botswana	4.22. 2.16	4g	Kalahari: sand. ironstone. chalcedony. greenstone: granite outcrops
Qc26-1a	Ge	Fo		221	Namibia	2.16. 4.22	2d	Kalahari: sand. ironstone. chalcedony. greenstone: granite outcrops. Quaternary: lacustrine sediments
Qc26-1a	Ge	Fo		2 019	Angola	2.13. 4.22	2c. 2d	Precambrian: limestone. dolomitic shale. schist. quartzite. sandstone. shale. arkose. Polymorphic sandstone: consolidated and unconsolidated sands. Kalahari: sand. ironstone. chalcedony. Quaternary: lacustrine sediments
Qc26-1a	Ge	Fo		24	Zambia	2.13	2c	Precambrian: limestone. dolomitic shale. schist. quartzite. sandstone. shale. arkose. Polymorphic sandstone: consolidated and unconsolidated sands
Qc27-1a	Ph	G		2 165	Angola	4.22	4d. 4e	Kalahari: sand. ironstone. chalcedony. Quaternary: lacustrine sediments
Qc28-1a	Ge Lf	Xh Be W		1 167	Angola	4.22	4e	Kalahari: sand. ironstone. chalcedony. Quaternary: lacustrine sediments
Qc29-1a	Ge P	V Sg		4 664	Botswana	4.22. 4.342	2d. 4e	Kalahari: sand. ironstone. chalcedony
Qc29-1a	Ge P	V Sg		1 371	Namibia	4.342. 4.22	4e	Kalahari: sand. ironstone. chalcedony
Qc29-1a	Ge P	V Sg		219	Rhodesia	4.2214	2d	Kalahari: sand. ironstone. chalcedony
Qc29-1a	Ge P	V Sg		7 754	Zambia	2.13. 2.26. 4.342	2c. 4e. 2d	Kalahari: sand. ironstone. chalcedony
Qc29-1a	Ge P	V Sg		621	Angola	2.13	4e	Kalahari: sand. ironstone. chalcedony
Qc30-1a	Af Qf	Vp Je I		70	Zanzibar Island (Tanzania)	1.12	2a	Neogene terrestrial sediments
Qc30-1/2a	Af Qf	Vp Je I		1 021	Tanzania	1.134. 1.36	2a	Neogene and Quaternary: coastal deposits. marl. calcareous sand. clay
Qc31-1a	Lf	Vc		167	Tanzania	1.36	2a	Neogene and Quaternary: coastal deposits. marl. calcareous sand. clay
Qc32-1ab	Ql Lc	Bh G Lp		972	Botswana	4.22. 2.29. 2.23	4e	Kalahari: sand. ironstone. chalcedony. Precambrian: shale. siltstone. sandstone. conglomerate

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Qc32-1ab	Ql Lc	Bh G Lp		286	Rhodesia	4.22	4e	Karroo: clayey schist. sandstone. shale. arkose. Kalahari: sand. ironstone. chalcedony
Qc33-1a	Lc			1 176	Rhodesia	4.22	2d	Cretaceous: sandstone. shale. Kalahari: sand. ironstone. chalcedony
Qc34-1a	Lf Ql	Re		5 198	Madagascar	1.142. 1.144. 1.32. 1.36. 1.484. 1.574. 1.583. 4.32	8a. 2c. 4e	Pliocene: sand. sandstone. clay. Jurassic and Cretaceous: sandstone. Triassic: sandstone. often overlain by Quaternary sands
Qc35-1a	Bc Rc	Lc	petrocalcic	157	Madagascar	1.583	8a	Quaternary dunes
Qc36-1a	Bd Lf			182	Madagascar	4.32	4e	Jurassic sandstone
Qc37-1a	Af Qf	Vp I		189	Somalia	5.74	2a	Recent coastal deposits. calcareous sand
Qc37-1a	Af Qf	Vp I		955	Kenya	1.134. 1.36. 1.54	2a	Recent coastal deposits. calcareous sand
Qc38-1a	Qa Xk	Z V R		24 610	Namibia	3.26. 2.16. 4.22	7b. 4g. 8a	Kalahari: sand. ironstone. chalcedony. Quaternary: lacustrine sediments
Qc38-1a	Qa Xk	Z V R		8 810	South Africa	2.23. 3.26	4g	Kalahari: sand. ironstone. chalcedony. Quaternary lacustrine sediments
Qc38-1a	Qa Xk	Z V R		33 110	Botswana	3.26. 2.29. 4.22. 2.23. 2.16	4g. 4e	Kalahari: sand. ironstone. chalcedony. Quaternary: lacustrine sediments
Qc38-1a	Qa Xk	Z V R		114	Angola	4.22	2d	Kalahari: sand. ironstone. chalcedony. Quaternary: lacustrine sediments
Qc38-1a	Qa Xk	Z V R		3 223	Rhodesia	2.14. 4.22	2c. 2d	Kàrroo: clayey schist. tillite. sandstone, shale and arkose. for the greater part overlain with Kalahari sand
Qc39-1a	Lc Gh			1 282	Mozambique	1.926. 1.34	2c. 2a	Quaternary alluvial and coastal deposits
Qc40-1a	Lc Vp	Ge I		1 765	Botswana	2.29	2d. 4e	Precambrian: shale. siltstone. sandstone. conglomerate. Karroo: clayey schist. tillite. sandstone. shale, arkose: effusive rocks: basalt. rhyolite
Qc41-1a		So We		1 847	South Africa	2.23	4g	Karroo: clayey schist and sandstone
Qc42-1a	I Lc	Lf		5 130	South Africa	2.26. 2.29. 2.21	4e	Precambrian: sandstone. conglomerate, shale. siltstone. dolomite. quartzite. schist. Karroo: clayey schist. sandstone. shale, arkose
Qc42-1a	I Lc	Lf		347	Botswana	2.29	4e	Precambrian: sandstone. conglomerate. shale. siltstone. Karroo: clayey schist. sandstone. shale. arkose
Qc43-1a	So I L			1 575	South Africa	2.23	4g	Precambrian: quartzite. phyllite. slate. schist. ironstone. andesite. dolomite. conglomerate

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION *(continued)*

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Qc44-1a	Lc	I		9	Rhodesia	3.22	2d	Neogene: limestone, marl, calcareous sandstone, sand, clay
Qc44-1a	Lc	I		5 077	Mozambique	1.926, 1.918, 3.22, 1.929, 4.2	2a, 2c, 2d, 4e	Quaternary: alluvial and lacustrine deposits. Neogene: limestone, marl, calcareous sandstone, sand, clay
Qc45-1/3a	Lc	X		4 358	Mozambique	1.918, 1.928	2d, 4e	Quaternary alluvial and coastal deposits
Qf1				424	Chad	1.42, 1.532	4e	*Continental terminal:* poorly consolidated sandstone, shale, conglomerate, grits, sand, clay
Qf1-1a				1 880	Chad	1.532, 1.533	4e	Quaternary alluvial and lacustrine deposits
Qf4-1a	Fo Nd	Fa		4 630	Central African Empire	1.414, 1.482, 1.483, 4.32	4a, 4c	*Continental intercalaire:* sandstone, conglomerate
Qf17	Je			186	Chad	1.533	4e	Quaternary alluvial and lacustrine deposits
Qf18	Ws	Vp		91	Chad	1.532, 1.533	4e	Quaternary alluvial and lacustrine deposits
Qf19-a		Je		119	Chad	1.532	4e	*Continental terminal:* poorly consolidated sandstone, shale and marl
Qf20-1a	Gh Ph Rd	Od Qa		62	Ghana	1.121	1a	Recent coastal and lagoonal deposits
Qf20-1a	Gh Ph Rd	Od Qa		215	Ivory Coast	1.121, 1.122	1a	Recent coastal and lagoonal deposits
Qf21-1a	Af Rd			5 062	Central African Empire	1.482	1a, 2a, 4a, 4c	Precambrian: sandstone, quartzite, calcareous schist
Qf21-1a	Af Rd			1 173	Congo	1.1211	1a	*Continental intercalaire:* sandstone, arkose, shale, conglomerate
Qf21-1a	Af Rd		stony	53	Zaire	1.471	2a	Precambrian: dolomitic limestone, calcareous schist, sandstone
Qf21-1a	Af Rd		stony	2 059	Central African Empire	1.471, 1.482	2a	*Continental intercalaire:* sandstone, arkose, shale, conglomerate. Precambrian: dolomitic limestone, calcareous schist, sandstone
Qf22-1a		Lf Fo Ao		729	Zaire	1.42, 1.73	4e	Precambrian: limestone, dolomitic shale, schist, quartzite, sandstone, shale, arkose
Qf22-1a		Lf Fo Ao		466	Angola	1.35, 1.73	2c, 4e	Neogene and Quaternary coastal deposits

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION *(continued)*

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Qf22-1a		Lf Fo Ao		254	Angola (Cabinda dist.)	1.35, 1.42	4e	Neogene and Quaternary coastal deposits
Qf22-1a		Lf Fo Ao		30	Congo	1.35	4e	Neogene and Quaternary coastal deposits
Qf23-1a	Ql	R Fo Fr		10 873	Angola	1.73, 2.12, 2.13	2c, 4e	Kalahari: sand, ironstone, chalcedony. Quaternary: lacustrine sediments
Qf23-1a	Ql	R Fo Fr		1 203	Zaire	1.73	2c	Kalahari: sand. ironstone, chalcedony, Quaternary: lacustrine sediments
Qf24-1a	R	Fo L		1 956	Angola	1.35, 2.13, 4.22	2c, 2d, 4e	Quaternary coastal deposits
Qf25-1a	R			305	Zaire	1.73	1a, 4c	Kalahari: sand, chalcedony, ironstone, lacustrine sediments. Precambrian: calcareous schist, dolomite, conglomerate, tillite. Polymorphic sandstone and *continental intercalaire:* sandstone, shale, conglomerate
Qf25-1a	R			2 041	Angola	1.73	1a, 2a	Kalahari: sand, chalcedony, ironstone, lacustrine sediments. Precambrian: calcareous schist, dolomite, conglomerate, tillite. Polymorphic sandstone and *continental intercalaire:* sandstone, shale, conglomerate
Qf25-1a	R			50	Rhodesia	1.842	2d	Quaternary alluvial deposits
Qf26-1a	R Qa	G P		16 189	Angola	1.73, 2.12, 2.13	2c, 4e	Polymorphic sandstone and sands
Qf26-1a	R Qa	G P		16 566	Zaire	1.23, 1.73	1a, 2a. 2c, 4c	*Continental intercalaire:* sandstone, shale, conglomerate, Polymorphic sandstone: consolidated and unconsolidated sands
Qf27-1/2ab	Fo	R G		119	Zaire	2.13	4c	*Continental intercalaire:* sandstone, shale, conglomerate. Polymorphic sandstone and sands
Qf27-1/2ab	Fo	R G		3 601	Angola	2.13	2c, 4a, 4c	*Continental intercalaire:* sandstone, shale, conglomerate. Polymorphic sandstone and sands. Precambrian: gneiss, schist, quartzite, dolerite, syenite
Qf28-1a	Gp	Fo Lf		840	Angola	2.12	4a, 4c	Precambrian: gneiss, schist, quartzite, dolerite, syenite, calcareous schist, dolomite, conglomerate, tillite
Qf29-1a	F			33	Zaire	1.73	2c	Polymorphic sandstone
Qf29-1a	F			948	Angola	1.73, 2.13	2c	Polymorphic sandstone. Kalahari: sand, chalcedony, ironstone, lacustrine sediments
Qf30-1a	Gp	R G		764	Angola	2.12, 2.25	2c	Precambrian: gneiss, schist, quartzite, dolerite, syenite; granitic batholiths

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Qf31-1a	Af Lf	Gp		162	Mozambique	1.36	4e	Neogene and Quaternary: coastal deposits, marl, calcareous sand, clay
Qf31-1ab	Af Lf	Gp		1 600	Tanzania	1.32, 1.36, 1.741	2c, 4e	Neogene and Quaternary alluvial, lacustrine and lagoonal deposits
Qf31-1ab	Af Lf	Gp		534	Mozambique	1.36	4e	Neogene and Quaternary: marl, calcareous sand, clay, alluvial, coastal and lacustrine deposits
Qf32-1/2b	Af			995	Tanzania	1.32, 1.741	2c, 4e	Quaternary alluvial and lacustrine deposits
Qf33-1/2a	Af Fo			824	Mozambique	1.32, 1.36	4e	Neogene and Quaternary alluvial, lacustrine and lagoonal deposits
Qf33-1/2a	Af Fo			283	Tanzania	1.32	4e	Neogene and Quaternary alluvial, lacustrine and lagoonal deposits
Qf34-1/2b	Fo	G		4 310	Zaire	1.482, 1.77	2c	Precambrian: gneiss, amphibolite, quartzite, micaschist, sandstone, schist, syenite, dolerite
Qf35-1b	Af	Ap Gp		69	Zanzibar Island (Tanzania)	1.12	2a	Neogene terrestrial sediments
Qf35-1/2bc	Af	Ap Gp		35	Tanzania	1.134	2a	Tertiary and Quaternary: fine-grained marl, calcareous sand and clay overlying Jurassic limestone, shale and gypsiferous beds
Qf35-1/2bc	Af	Ap Gp		694	Kenya	1.134, 1.36, 1.54	2a	Tertiary and Quaternary: fine-grained marl, calcareous sand and clay overlying Jurassic limestone, shale and gypsiferous beds
Qf36-1a	Fx Ql	Bf Jd Gd		462	Congo	1.132, 1.42	4e	Precambrian: calcareous schist, dolomite, conglomerate and tillite. Neogene: sandy limestone and marl
Qf36-1a	Fx Ql	Bf Jd Gd		17	Zaire	1.42	4e	Neogene sands and marl
Qf36-1a	Fx Ql	Bf Jd Gd		152	Angola (Cabinda dist.)	1.42	4e	Neogene sandy limestone and marl
Qf36-1a	Fx Ql	Bf Jd Gd		307	Equatorial Guinea	1.11	1a	Quaternary coastal deposits
Qf36-1a	Fx Ql	Bf Jd Gd		1 788	Gabon	1.132	2a	Precambrian: calcareous schist, dolomite, conglomerate, tillite. Quaternary: coastal deposits
Qf37-1ab	Fo Fx			3 159	Congo	1.23, 1.73	2a	Polymorphic sandstone: consolidated fine sandstone. *Continental intercalaire:* sandstone, shale, conglomerate

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION *(continued)*

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Qf37-1ab	Fo Fx			1 330	Gabon	1.23. 1.73	1a	Polymorphic sandstone: consolidated fine sandstone. *Continental intercalaire:* sandstone, shale. conglomerate
Qf38-1a	Nh Rd	Qa Ph Pg		1 612	Congo	1.73	2a	Polymorphic sandstone: consolidated fine sandstone. *Continental intercalaire:* sandstone. shale. conglomerate
Qf39-1a	Ao Af			171	Mozambique	1.32	2c	Neogene and Quaternary alluvial, lacustrine and lagoonal deposits
Qf40-1a	Lc Re			2 746	Mozambique	1.31. 1.23	2a. 2c	Quaternary alluvial and coastal deposits
Qf40-1a	Lc Re			14	Zanzibar Island (Tanzania)	1.12	2a	Neogene terrestrial sediments
Ql1				717	Niger	1.532. 1.533, 1.534, 1.918	4e, 4g	Precambrian: schist, quartzite. *Continental terminal:* poorly consolidated sandstone, mudstone, conglomerate. grits. Quaternary: alluvial and lacustrine deposits
Ql1				404	Mali	1.534, 1.54	4g	Precambrian: schist. quartzite. *Continental terminal:* poorly consolidated sandstone, conglomerate. grits
Ql1				181	Upper Volta	1.534	4g	*Continental terminal:* poorly consolidated sandstone. mudstone, conglomerate. grits
Ql1-1a				17 162	Niger	1.533. 1.534, 1.54. 3.22, 3.21. 1.919	4e. 4g. 8c	*Continental intercalaire:* arkose, sandstone and claystone. partly covered with *continental terminal:* poorly consolidated sandstone. mudstone, shale, conglomerate, grits. Quaternary: alluvial deposits
Ql1-1a				2 205	Nigeria	1.532, 1.533, 1.917	4e	Quaternary alluvial and lacustrine deposits
Ql1-1a				32	Chad	3.22	4g	*Continental terminal:* poorly consolidated sandstone, mudstone. conglomerate, grits. Quaternary: alluvial deposits
Ql1-1a				2 334	Mali	1.534, 1.54, 3.14, 3.22	4e. 4g	*Continental terminal:* poorly consolidated sandstone. mudstone, conglomerate. grits, sand, clay. Quaternary: alluvial deposits
Ql1-1a				427	Upper Volta	1.533, 1.534	4e. 4g	*Continental terminal:* poorly consolidated sandstone, mudstone. conglomerate. grits. sand. clay

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION *(continued)*

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Ql2-1/2b	Ao	1		1 281	Rhodesia	2.15. 2.29	2d	Basement complex: granite. gneiss. migmatite: basic intrusive rocks: diorite. gabbro
Ql2-1/2b	Ao	1		117	Botswana	2.29	2d	Basement complex: granite. gneiss. migmatite: basic intrusive rocks: diorite. gabbro
Ql3	Lg Re	Bv		77	Upper Volta	1.533	4e	Precambrian (Birrimian): schist. quartzite. greenstone: basic effusive rocks: basalt
Ql3-1a	Lg Re	Bv		107	Upper Volta	1.533	4e	Basement complex: granitic gneiss. schist. quartzite: granitic batholiths
Ql4-1a	Re	Lg		2 202	Mali	1.534. 1.54. 3.14	4g	Precambrian: schist. quartzite. *Continental terminal:* poorly consolidated sandstone. conglomerate. grits
Ql5	Lf	Lg		1 190	Nigeria	1.532. 1.916. 1.484	2c. 4c. 4e	Basement complex (Gwarian): granitic gneiss, micaschist. amphibolite. migmatite: granitic batholiths
Ql6	Qc			914	Niger	1.534	4g	*Continental terminal:* poorly consolidated sandstone. mudstone. conglomerate. grits. sand. clay. *Continental intercalaire:* sandstone. arkose. shale. conglomerate
Ql6	Qc			788	Nigeria	1.532	4e	*Continental terminal:* poorly consolidated sandstone. shale. conglomerate. grits. sand. clay. *Continental intercalaire:* sandstone. arkose. shale. conglomerate. Cretaceous: sandstone and marl
Ql6	Qc			2 620	Mauritania	1.534. 1.544	4g	Cambrian: calcareous schist. quartzite. pelites
Ql6	Qc			3 500	Mali	1.533. 1.534	4g	Cambrian: calcareous schist. quartzite. pelites. Precambrian: schist and quartzite. *Continental terminal:* poorly consolidated sandstone. mudstone, conglomerate. grits
Ql6	Qc			144	Upper Volta	1.534	4g	*Continental terminal:* poorly consolidated sandstone. mudstone, conglomerate. grits
Ql6-1a	Qc			255	Upper Volta	1.534	4g	*Continental terminal:* poorly consolidated sandstone. mudstone. conglomerate. grits
Ql6-1a	Qc			2 282	Senegal	1.533. 1.534	4g	Eocene: nummulitic limestone. Quaternary: alluvial and lagoonal deposits

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION *(continued)*

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Ql6-1a	Qc			230	Mauritania	1.543	4g	Precambrian: crystalline schist and quartzite; granitic batholiths
Ql6-1a	Qc			2 125	Mali	1.54, 3.22	4g	Precambrian: schist and quartzite. *Continental terminal:* poorly consolidated sandstone, mudstone, conglomerate, grits, sand, clay
Ql6-1a	Qc			520	Niger	1.54, 3.22	4g	*Continental terminal:* poorly consolidated sandstone, mudstone, conglomerate, shale, grits, sand, clay
Ql7	Qc	I		57	Upper Volta	1.532	4e	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths
Ql8	Bv Re			104	Upper Volta	1.533	4e	Precambrian (Birrimian): schist, quartzite, greenstone
Ql8	Bv Re			37	Niger	1.533	4e	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths
Ql8-1a	Bv Re			191	Upper Volta	1.533, 1.534	4e	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths
Ql9-1a	Lc	Je Vp I		5 315	Namibia	3.26, 2.16	4g	Precambrian: quartzite, arkose, chert, limestone, conglomerate. Karroo: clayey schist, sandstone, shale, arkose
Ql10	Lf Rd			713	Niger	1.534, 1.54	4g	*Continental terminal:* poorly consolidated sandstone, mudstone, conglomerate, grits
Ql10	Lf Rd			523	Mali	1.54	4g	*Continental terminal:* poorly consolidated sandstone, mudstone, conglomerate, grits
Ql10-1a	Lf Rd			1 448	Niger	1.534, 1.54, 3.22	4g	*Continental terminal:* poorly consolidated sandstone, shale, conglomerate, grits, sand, clay
Ql11	Re			260	Niger	1.533	4e	*Continental terminal:* poorly consolidated sandstone, mudstone, conglomerate, grits
Ql11-1a	Re			6 058	Mali	3.22, 1.54	4g, 8c	*Continental terminal:* poorly consolidated sandstone, mudstone, conglomerate, grits. Quaternary: alluvial deposits
Ql11-1a	Re			4 838	Niger	1.534, 1.533, 1.532, 3.21	4e, 4g	*Continental terminal:* poorly consolidated sandstone, mudstone, conglomerate, grits, sand, clay

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Ql1-1a	Re		petric	2 034	Senegal	1.532, 1.533, 1.534	4g	*Continental terminal:* sandstone, shale, marl, *sand, clay*
Ql1-1b	Re			2 263	Sudan	1.532, 1.533	4e	*Continental terminal:* clay, sand. Precambrian: schist, quartzite, syenite, dolerite
Ql2-1a	I Re	Jc		1 604	Niger	1.533, 1.534, 1.54, 3.22	4e, 4g, 8c	Palaeogene: limestone, partly overlain with *continental terminal:* poorly consolidated sandstone, shale, conglomerate, grits, sand, clay
Ql2-1a	I Re	Jc		105	Nigeria	1.532	4e	Palaeogene: limestone, partly overlain with *continental terminal:* poorly consolidated sandstone, shale, conglomerate, grits, sand. clay
Ql3-1a		Ge		464	Niger	1.533, 1.534, 1.532	4e	*Continental terminal:* poorly consolidated sandstone, mudstone, conglomerate, shale, grits, sand, clay. Quaternary: alluvial deposits
Ql4-1a	Ge			182	Niger	1.532	4e	*Continental terminal:* poorly consolidated sandstone. mudstone. conglomerate, grits. Quaternary: alluvial deposits
Ql4-1a	Ge			72	Benin	1.532	4e	*Continental terminal:* poorly consolidated sandstone, mudstone, conglomerate, grits. Quaternary: alluvial deposits
Ql5-1a	Lo			2 996	Mozambique	1.918	2c, 4e	Quaternary alluvial and coastal deposits
Ql6	Qc Re			203	Nigeria	1.532	4e	*Continental terminal:* poorly consolidated sandstone, shale, conglomerate, grits, sand, clay
Ql6-1a	Qc Re			650	Niger	1.533, 1.534	4e	*Continental terminal:* poorly consolidated sandstone, shale, conglomerate, grits. sand, clay
Ql6-1a	Qc Re			252	Nigeria	1.532	4e	*Continental terminal:* poorly consolidated sandstone. shale, conglomerate, grits. sand, clay
Ql7	I			455	Nigeria	1.532	4e	Cretaceous: sandstone and shale. Palaeogene: limestone, marl and shale. *Continental terminal:* poorly consolidated sandstone, shale conglomerate, grits. sand, clay
Ql7-1a	I			105	Mozambique	2.14	2c	Precambrian: gneiss, quartzite, schist. phyllite, greenstone. Quaternary: alluvial deposits
Ql7-1a	I			400	Rhodesia	2.14, 2.29, 4.22	2d, 4e, 4g	Basement complex: granite, gneiss, migmatite, Basic intrusive rocks; diorite. gabbro. Precambrian: gneiss. quartzite. schist, phyllite, greenstone. Quaternary: *alluvial deposits*

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION *(continued)*

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Ql17-1/2a	I			93	Rhodesia	4.2	2d	Cretaceous sandstone and shale
Ql17-1/2a	I			9	Mozambique	4.2	2d	Cretaceous sandstone and shale
Ql18-1b	I Lf Lv			648	Nigeria	1.484, 1.916	2c, 4c, 4e	Cretaceous sandstone and shale
Ql19-1a	Be Bk	Zg		37	Niger	1.917	4e	Quaternary alluvial and lacustrine deposits
Ql19-1a	Be Bk	Zg		1 778	Nigeria	1.916	4e	Quaternary alluvial and lacustrine deposits
Ql20-1a	Gh			1 532	Mozambique	1.918	2c, 4e	Quaternary: alluvial and coastal deposits. Neogene: limestone, marl, calcareous sandstone, sand and clay
Ql21	Lg Qc	Ge Ws		98	Nigeria	1.532	4e	Cretaceous sandstone and marl
Ql22-1a	Lf			274	Chad	1.916	4e	Quaternary alluvial and lacustrine deposits
Ql22-1a	Lf			173	Sudan	1.532	4e	*Continental terminal:* clay and sand
Ql23-1a	I Je			442	Chad	1.916, 4.32	4e	Quaternary alluvial and lacustrine deposits
Ql23-1a	I Je			75	Sudan	1.917	4e	Quaternary alluvial and lacustrine deposits
Ql24-1a	Lf	G		320	Central African Empire	1.42, 1.915, 4.32	4e	Quaternary alluvial and lacustrine deposits
Ql24-1a	Lf	G		2 267	Sudan	1.532, 4.32	4e	Quaternary alluvial and lacustrine deposits
Ql25-1/2a	Lf Lp	Ge R		754	Botswana	4.22, 2.23	4e, 4g	Quaternary lacustrine deposits. Basement complex: granite, gneiss, migmatite; basic intrusive rocks: diorite, gabbro, partly overlain with Kalahari: sand, ironstone, chalcedony
Rl				390	Mauritania	3.23	9b	Precambrian granite, gneiss, schist, quartzite
Rl			stony	1 300	Mauritania	3.23, 3.11, 3.21	8c, 9b	*Continental terminal:* sandy deposits. Precambrian: granite, gneiss, schist, quartzite
Rl			stony	239	Spanish Sahara	3.23	9b	*Continental terminal:* sandy deposits. Precambrian: granite, gneiss, schist, quartzite
Rcl			petrocalcic	277	Algeria	3.23	9b	Pliocene lacustrine deposits, often with calcareous crusts
Rcl-1b				5	Canary Islands	6.84	8c	Quaternary coastal deposits

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION *(continued)*

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Rc1-2a				141	Egypt	3.2	8c, 9a	Coastal sediments, recent and unconsolidated
Rc2-2b	I	Jc Xh		2 084	Somalia	3.11	8c	Precambrian: gneiss, schist, quartzite; granitic batholiths. Aden volcanic series: basalt, basaltic breccias, tuff. Cretaceous and Palaeocene: limestone, marl, sandstone; recent aeolian deposits
Rc2-3c	I	Jc Xh	lithic	114	Kenya	3.12	4g	Jurassic limestone, marl, gypsum
Rc2-3c	I	Jc Xh	lithic	2 312	Ethiopia	1.843, 1.85, 3.12, 3.51	4g, 5a	Jurassic limestone, marl, gypsum
Rc10	Yl	I Yh		262	Algeria	3.23	9b	Quaternary alluvial and lacustrine deposits with aeolian sand deposits
Rc10	Yl	I Yh	shifting sands	348	Algeria	3.23	9c	Cretaceous calcareous sediments overlain with Quaternary alluvial and aeolian deposits
Rc15-1/2a	Yy	Zo		646	Algeria	6.912, 6.741	8e	Neogene: clayey marl. Quaternary: alluvial and lacustrine deposits
Rc15-1/2a	Yy	Zo		67	Somalia	3.12	8c	Recent coastal and aeolian deposits
Rc16-1b	I		shifting sands	23	Somalia	3.11	8c	Recent coastal and aeolian deposits
Rc16-1b	I		shifting sands	190	Egypt	6.822	9b	Recent coastal and aeolian deposits
Rc17-3a	Vc	Zo Zt		297	Egypt	3.23	9b, 9f	Quaternary aeolian deposits
Rc18-2b	Jc		lithic	1 237	Ethiopia	3.51	4b	Jurassic limestone, marl, gypsum
Rc18-3b	Jc		lithic	1 444	Ethiopia	1.843, 3.12, 3.51	4b, 4f	Jurassic limestone, marl, gypsum
Rc19-bc	Jc	I Xh	lithic	4 512	Ethiopia	1.85, 3.12, 3.51	4b, 4g	Jurassic limestone, marl, gypsum
Rc19-2ab	Jc	I Xh	lithic	1 470	Somalia	3.12	4b, 8a	Neogene: marl, calcareous sand, clay. Jurassic and Cretaceous: limestone, marl, sandstone, gypsum
Rc19-2ab	Jc	I Xh	lithic	25	Ethiopia	3.12	4b	Neogene: marl, calcareous sand and clay. Jurassic and Cretaceous: limestone, marl, sandstone and gypsum
Rc20-ab		Jc	lithic	4 815	Somalia	1.534, 1.543, 3.12	4b, 8a	Jurassic and Cretaceous limestone, marl, sandstone and gypsum
Rc20-ab		Jc	lithic	2 484	Ethiopia	1.85, 3.12, 3.51	4b, 4g	Jurassic and Cretaceous limestone, marl, sandstone and gypsum
Rc20-3a		Jc		487	Ethiopia	3.12, 3.51	4b	Jurassic limestone, marl and gypsum

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Rc21-2c	Be Xh	Ao Jc Vp	lithic	756	Ethiopia	1.843, 2.32	4f, 5a	Trap series: basalt, phonolite, nephelinite, trachyte, rhyolite, pyroclastics. Jurassic and Cretaceous: limestone, marl, sandstone, gypsum
Rc22-2b	I Jc	Zo Qc Je	lithic	263	Ethiopia	1.534	8a	Tertiary-recent volcanics: basalt, phonolite, nephelinite, pyroclastics, tuff
Rc22-2b	I Jc	Zo Qc Je	lithic	2 227	Kenya	1.534	8a	Tertiary-recent volcanics: basalt, phonolite, nephelinite, pyroclastics, tuff
Rc23-1/2ab	Re	I J Xh	stony	1 049	Somalia	3.12	8a	Cretaceous limestone and marl, overlain with siltstone, sandstone, conglomerate
Rc23-1/2ab	Re	I J Xh	stony	5 193	Ethiopia	3.12, 3.51	4b	Cretaceous limestone and marl, overlain with siltstone, sandstone, conglomerate
Rc23-2/3c	Re	I J Xh	lithic	56	Ethiopia	1.85, 3.11	4b	Aden volcanic series: basalt, basaltic breccias, tuff
Rc23-2/3c	Re	I J Xh	lithic	9	Somalia	3.11	4b	Aden volcanic series: basalt, basaltic breccias, tuff
Rc24-1ab	I Re	Jc Zo Je	shifting sands	1 468	Somalia	3.11	8c	Recent coastal and aeolian deposits
Rc24-1ab	I Re	Jc Zo Je	shifting sands	53	Territory of the Afars and the Issas	3.12	8c	Recent coastal and aeolian deposits
Rc24-2c	I Re	Jc Zo Je	lithic	647	Ethiopia	3.11	8a, 8c	Precambrian: gneiss, quartzite, cipolin, conglomerate, argillite, andesite, rhyolite. Aden volcanic series: basalt, basaltic breccias, tuff
Rc25-3c	Qc Re	I Jc Xh	lithic	656	Ethiopia	3.11	8a	Jurassic dolomite, limestone, marl and minor sandstone
Rc26-2b	Bk I	Gc V		398	Madagascar	1.484	2c, 4e	Jurassic marl
Rc27-2a	Bc I	Lc		461	Madagascar	1.484	4e	Jurassic limestone
Rc28-1b	Gc Qa	Bk Z		299	Madagascar	1.583	8a	Quaternary dunes
Rc29-2b	Bk I	V E		354	Madagascar	1.142, 1.144, 1.32, 1.484	2c, 4e	Cretaceous limestone
Rd1-1a				7	Togo	1.35	2a	Quaternary lagoonal and marine deposits
Rd1-1a				59	Ghana	1.31, 1.35	2a	Quaternary lagoonal and marine deposits
Rd2-2c	I	Bh Jd	lithic	31	Ethiopia	2.37	4f	Trap series: basalt, phonolite, nephelinite, trachyte, rhyolite, pyroclastics
Rd3-1a	G Jd	Qa		856	Madagascar	1.11, 1.121, 1.123	1a, 2a	Quaternary coastal, alluvial and marine deposits

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION *(continued)*

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Rd3-1a	G Jd	Qa		76	Senegal	1.533, 1.534	4g	*Continental terminal:* slightly consolidated sandstone, shale, marl, sand, clay
Rd3-1/2b	G Jd	Qa		177	Senegal	1.533, 1.534	4g	*Continental terminal:* slightly consolidated sandstone, shale, marl, sand, clay
Rd4-1/2a	La			22	Algeria	6.141	5a	Recent dunes and alluvial and lagoonal deposits
Rd6-a	Lf Nd	I	petric	35	Nigeria	1.482	4a, 4c	Precambrian (Dahomeyan): schist, quartzite, syenite, dolerite. Acid and basic effusive rocks: rhyolite, basalt, andesite
Rd7	Lf	I	petroferric	242	Upper Volta	1.484, 1.483	4a, 4c	Precambrian (Birrimian): schist, quartzite, greenstone
Rd7	Lf	I	petroferric	3	Ivory Coast	1.483	4a, 4c	Precambrian (Birrimian): schist, quartzite, greenstone
Rd8-1a	Gh Ph Qa			655	Nigeria	1.121, 1.123	3a	Recent marine, lagoonal and aeolian deposits
Rd8-1b	Gh Ph Qa			200	Sierra Leone	1.133	2a	Recent coastal and lagoonal deposits and aeolian sands
Rd12-2bc	Bf I			1 194	Central African Empire	1.483, 1.414, 1.914, 4.32	2c, 4a, 4c	Basement complex: granitic gneiss, mica-schist, migmatite, schist, quartzite, syenite, dolerite; granitic batholiths
Rd12-2bc	Bf I			792	Sudan	1.914, 4.32	2c, 4c	Precambrian: granitic gneiss, migmatite, schist, quartzite, syenite, dolerite; granitic batholiths
Rd12-2bc	Bf I			28	Chad	1.483	4a, 4c	Basement complex: granitic gneiss, mica-schist, migmatite; granitic batholiths
Rd15-1a	Qf			136	Angola	1.73	2c	*Continental intercalaire:* sandstone, shale, conglomerate; polymorphic sandstone and sands
Rd15-1/2b	Qf			1 112	Congo	1.122, 1.23	1a, 2a	Polymorphic sandstone: consolidated fine sandstone. *Continental intercalaire:* sandstone, shale, conglomerate
Rd15-1/2b	Qf			143	Zaire	1.23	2a	Polymorphic sandstone: consolidated fine sandstone. *Continental intercalaire:* sandstone, shale, conglomerate
Rd16-1a	G			42	Nigeria	1.121, 1.35	3a, 4d	Recent coastal deposits
Rd16-1a	G			24	Togo	1.35	3a, 4d	Recent coastal deposits
Rd16-1a	G			68	Benin	1.35, 1.135	3a, 4d	Recent coastal deposits
Rd17-1a	Bf	I	saline	362	Liberia	1.11, 1.121	2a, 7c	Coastal and lagoonal deposits and aeolian sand

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION *(continued)*

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Rd17-2b	Bf	I	lithic	148	Central African Empire	1.482	4a, 4c	Precambrian: granitic gneiss. migmatite. schist. quartzite. syenite. dolerite: granitic batholiths
Rd18-3ab	I Lg	Gd Jd	petroferric	11 061	Sudan	1.42. 1.532. 1.914. 4.32	2c. 4c. 4e	*Continental terminal:* clay and sand. Precambrian: schist. quartzite. syenite, dolerite
Rd19-1ab	Gp	Qf Fo Fx		60	Angola	1.73	2c	Precambrian: calcareous schist. dolomite. conglomerate. tillite: polymorphic sandstone
Rd20-2c	I	Nd	stony	20	Malawi	1.36	2c	Precambrian: schist. gneiss. charnockite. quartzite. cipolin
Rd20-2c	I	Nd	stony	15	Zambia	1.73	2c	Precambrian: schist. gneiss. charnockite. quartzite. cipolin
Rd20-2c	I	Nd	stony	1 468	Tanzania	1.73, 1.741. 2.33	2b. 2c	Precambrian: schist. gneiss. charnockite. quartzite. cipolin. Neogene and Quaternary: alluvial and lacustrine deposits. Basement complex: orthogneiss. granite. migmatite. amphibolite. clastic rocks, shale, sandstone. phyllite. conglomerate
Rd21-1a	Qa	Gh Ph Rc		207	Madagascar	1.11. 1.123. 1.222	2a	Quaternary: coastal dunes. Cretaceous: sandstone and marl
Rd22-2c	Bf I	U		1 882	Madagascar	1.11. 1.121. 1.72. 1.73. 2.25. 2.31. 2.32	4a. 4c	Granite and quartzite. Precambrian: migmatite. gneiss. leptite. pyroxenite. cipolin
Re1			petric	210	Nigeria	1.532. 1.916, 1.917	2c. 4c. 4e	*Continental terminal:* poorly consolidated sandstone. shale, conglomerate. grits. sand. clay. Basement complex (Gwarian): granitic gneiss. micaschist, amphibolite. migmatite: granitic batholiths. Cretaceous: sandstone and marl. *Continental intercalaire:* sandstone. arkose. shale. conglomerate
Re1			petric	37	Niger	1.916	4e	*Continental intercalaire:* sandstone. arkose. shale. conglomerate
Re1			rock debris	404	Mali	3.21	8c	Precambrian: gneiss, micaschist. quartzite. cipolin. granite
Re1			shifting sands	71	Spanish Sahara	3.11	8c	Recent dunes
Re1			shifting sands	110	Mauritania	3.21	9c	Recent dunes
Re1			shifting sands	930	Mali	3.21	9c	Recent dunes
Re1			shifting sands	111	Algeria	3.23	9d	Recent dunes
Re1			shifting sands	108	Niger	3.23	9d	Recent dunes

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Re1-1				1 337	Niger	3.22	8c	*Continental intercalaire:* sandstone. arkose. shale. conglomerate
Re1-1a				173	Sudan	3.22. 4.31	8c	Recent aeolian deposits. Precambrian: schist. quartzite. syenite. dolerite
Re1-1a				200	Libya	3.23	9b	Recent alluvial and lacustrine deposits
Re1-1a				156	Spanish Sahara	3.21	9b. 9c	*Continental terminal:* sandstone. shale. marl: recent aeolian deposits
Re1-1a				2 802	Mali	1.54. 1.534	4g	*Continental terminal:* sandstone. shale. marl: recent aeolian deposits
Re1-1a				8 670	Mauritania	3.11. 3.14. 3.21. 1.544	4g. 8c. 9b. 9c	*Continental terminal:* sandstone. shale. marl recent aeolian deposits
Re1-1a			shifting sands	8 217	Sudan	3.21. 3.22	9b. 9c	Sand and dunes
Re1-1a			shifting sands	697	Libya	3.21	9c	Recent alluvial. lagoonal and aeolian deposits
Re1-1a			shifting sands	404	Spanish Sahara	3.21. 3.34	8c	Recent coastal and aeolian deposits
Re1-1a			shifting sands	68	Morocco	3.34	8c	Recent coastal and aeolian deposits
Re1-1ab			shifting sands	778	Spanish Sahara	3.34	8c	Recent coastal and aeolian deposits
Re1-1ab			shifting sands	250	Mauritania	3.11. 3.33. 3.34	8c	Recent coastal and aeolian deposits
Re1-1b			shifting sands	148	Egypt	6.822	9b	Recent coastal and aeolian deposits
Re1-1/2a				1 108	Egypt	3.21. 3.23. 3.24	9b	Quaternary alluvial and deltaic deposits
Re5-b	J Yh			366	Morocco	3.24	5b	Villafranchian lacustrine limestone, partly overlain with Quaternary deposits
Re16-b	Je			591	Ethiopia	2.39. 3.12	8a. 8c	Precambrian: gneiss. quartzite. cipolin. andesite. conglomerate. argillite. rhyolite: granitic batholiths
Re16-b	Je			3	Sudan	2.39	8a. 8c	Precambrian: gneiss. quartzite. cipolin, andesite. conglomerate. argillite. rhyolite: granitic batholiths
Re24	I			64	Mali	1.534	4g	Precambrian: schist and quartzite. *Continental terminal:* poorly consolidated sandstone. mudstone. conglomerate. grits. sand. clay
Re24	I			188	Upper Volta	1.532. 1.533	4e	Precambrian; schist and quartzite. Basement complex: granitic gneiss. schist. quartzite: granitic batholiths
Re24	I		petroferric	537	Upper Volta	1.532. 1.534. 1.54	4e. 4g	Precambrian (Birrimian): schist. quartzite. greenstone. granitic gneiss: granitic batholiths

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION *(continued)*

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Re24	I		petroferric	1 273	Mali	1.54. 1.534	4g	Precambrian schist and quartzite
Re24	I		petroferric	186	Niger	1.534	4g	Precambrian schist and quartzite
Re24	I		lithic/ petric	1 523	Mali	1.532. 1.533	4a. 4c. 4e	Infracambrian sandstone and tillite with minor limestone
Re24-1a	I		petric	131	Upper Volta	1.533	4e	Basement complex: granitic gneiss. schist. quartzite: granitic batholiths
Re24-1a	I		petric	15	Niger	1.533	4e	Basement complex: granitic gneiss. schist. quartzite: granitic batholiths
Re24-1a	I		petroferric	910	Upper Volta	1.533. 1.532	4e	Basement complex: granitic gneiss. schist. quartzite: granitic batholiths
Re24-2c	I		lithic	1 253	Ethiopia	1.534. 2.39. 3.2	4b	Precambrian: gneiss. quartzite. cipolin. andesite. conglomerate. argillite. rhyolite: granitic batholiths
Re24-2c	I		lithic	272	Sudan	2.39	4b	Precambrian: gneiss. quartzite. cipolin. andesite. conglomerate. argillite. rhyolite: granitic batholiths
Re32-1a	Bv Vc	I	petroferric	228	Upper Volta	1.534	4g	Basement complex: granitic gneiss. schist. quartzite: granitic batholiths: greenstone
Re33	I Lf			253	Cameroon	1.484	4a. 4c	Basement complex: granitic gneiss. mica-schist. migmatite: granitic batholiths
Re33	I Lf			50	Upper Volta	1.533	4e	Basement complex: granitic gneiss. schist. quartzite: granitic batholiths
Re33	I Lf		petric	77	Chad	1.532	4e	*Continental terminal:* poorly consolidated sandstone. shale. conglomerate. grits. sand. clay
Re33	I Lf		petric	151	Upper Volta	1.533	4e	Basement complex: granitic gneiss. schist. quartzite: granitic batholiths
Re33	I Lf		petroferric	35	Mali	1.533	4e	*Continental terminal:* poorly consolidated sandstone. mudstone. conglomerate. grits. Quaternary: alluvial deposits
Re33	I Lf		petroferric	1 216	Upper Volta	1.532. 1.533	4a. 4c. 4e	Cambrian: sandstone. tillite. minor limestone. *Continental terminal:* poorly consolidated sandstone. mudstone. conglomerate. grits. sand. clay. Basement complex: granitic gneiss. schist. greenstone. quartzite: granitic batholiths. Basic effusive rocks: basalt
Re33	I Lf		lithic/ petric	3 315	Mali	1.484, 1.532	4a. 4c, 4e	Infracambrian sandstone. tillite and minor limestone

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Re33-1a	I Lf		petric	106	Mali	1.532	4e	Cambrian: sandstone, tillite, minor limestone
Re33-1a	I Lf		petric	104	Upper Volta	1.532	4e	Cambrian: sandstone, tillite, minor limestone
Re33-1a	I Lf		petroferric	410	Chad	1.484, 1.42	4a, 4c	Basement complex: granitic gneiss, mica-schist, migmatite; granitic batholiths
Re33-1a	I Lf		petroferric	747	Cameroon	1.484	4a, 4c	Basement complex: granitic gneiss, mica-schist, migmatite; granitic batholiths
Re33-1a	I Lf		petroferric	266	Mali	1.54	4g	Cambrian: sandstone, tillite, minor limestone. Basic intrusive rocks: dolerite, gabbro, diorite
Re33-1a	I Lf		petroferric	2 189	Upper Volta	1.532, 1.533	4e	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths
Re34	Lf Ql	I		41	Niger	1.533	4e	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths
Re34	Lf Ql	I	petroferric	175	Upper Volta	1.532	4e	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths. Voltaian: sandstone, shale, conglomerate, dolomitic limestone and schist, partly overlain with *continental terminal:* poorly consolidated sandstone, mudstone, conglomerate, grits, sand, clay
Re34	Lf Ql	I	petroferric	23	Benin	1.532	4e	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths. Voltaian: sandstone, shale, conglomerate, dolomitic limestone and schist, partly overlain with *continental terminal:* poorly consolidated sandstone, mudstone, conglomerate, grits, sand, clay
Re34	Lf Ql	I	petroferric	241	Niger	1.532	4e	Basement complex: granitic gneiss, schist, quartzite, granitic batholiths. Voltaian: sandstone, shale, conglomerate, dolomitic limestone and schist, partly overlain with *continental terminal:* poorly consolidated sandstone, mudstone, conglomerate, grits, sand, clay
Re34-1a	Lf Ql	I	petroferric	121	Upper Volta	1.533, 1.534	4e	Precambrian (Birrimian): schist, quartzite, greenstone. *Continental terminal:* poorly consolidated sandstone, mudstone, conglomerate, sand, clay
Re34-1a	Lf Ql	I	petroferric	186	Mali	1.534	4e	Precambrian (Birrimian): schist, quartzite, greenstone. *Continental terminal:* poorly consolidated sandstone, mudstone, conglomerate, sand, clay

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION *(continued)*

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Re35	Ql			709	Niger	3.22	8c	*Continental terminal:* poorly consolidated sandstone, mudstone, conglomerate, grits; Quaternary: alluvial deposits
Re35	Ql		petric	192	Nigeria	1.532	4e	Cretaceous sandstone and marl
Re35-a	Ql		stony	2 388	Niger	3.22	8c	*Continental intercalaire:* sandstone, arkose, shale, conglomerate
Re35-1a	Ql			99	Mali	1.534	4g	Precambrian schist and quartzite
Re35-1a	Ql		petroferric	675	Upper Volta	1.533	4e	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths
Re35-1a	Ql		petroferric	452	Mali	1.54, 1.534	4g	Precambrian schist and quartzite
Re35-1a	Ql		petric	257	Mali	1.534	4g	*Continental terminal:* poorly consolidated sandstone, mudstone, conglomerate, grits. Quaternary: alluvial deposits
Re35-1a	Ql		petric	17	Upper Volta	1.533, 1.534	4g	*Continental terminal:* poorly consolidated sandstone, mudstone, conglomerate, grits. Quaternary: alluvial deposits
Re36-1a	Lg Ql	I	petroferric	544	Upper Volta	1.533	4e	Precambrian (Birrimian): schist, quartzite, greenstone
Re37	Be Ql		petric	553	Nigeria	1.532	4e	*Continental terminal:* poorly consolidated sandstone, shale, conglomerate, grits, sand, clay. Cretaceous: sandstone and marl
Re37	Be Ql		petroferric	59	Nigeria	1.532	4e	*Continental terminal:* poorly consolidated sandstone, shale, conglomerate, grits, sand, clay
Re37	Be Ql		petroferric	687	Niger	1.533, 1.534	4e	Basement complex: granitic gneiss, schist, quartzite: granitic batholiths. *Continental terminal:* poorly consolidated sandstone, mudstone, conglomerate, grits, sand, clay
Re38		I	lithic	190	Mauritania	3.12	8c	Recent aeolian deposits
Re38-a		I	stony	2 350	Mauritania	1.533, 1.534, 1.544	4g	Precambrian crystalline schist, quartzite; granitic batholiths
Re39	Qc Y		shifting sands	901	Mali	3.21	9c	Aeolian deposits
Re39	Qc Y		shifting sands	450	Mauritania	3.23	9c	Aeolian deposits
Re39	Qc Y		shifting sands	420	Algeria	3.23	9c	Aeolian deposits
Re39-1a	Qc Y		shifting sands	9 383	Niger	3.21, 3.22	8c, 9b	Quaternary alluvial and lacustrine deposits

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION *(continued)*

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Re39-1a	Qc Y		shifting sands	8 017	Chad	3.22, 3.21	8c	Quaternary: alluvial and lacustrine deposits. *Continental terminal:* poorly consolidated sandstone, shale, marl. Pleistocene and recent: alluvial, lacustrine and aeolian deposits
Re40-bc	Lg We			562	Cameroon	1.532, 1.8	4e	Precambrian: granitic gneiss, micaschist, migmatite, quartzite, syenite, dolerite: granitic batholiths
Re40-bc	Lg We			77	Nigeria	1.8	4e	Precambrian: granitic gneiss, micaschist, migmatite, quartzite, syenite, dolerite: granitic batholiths
Re40-1b	Lg We			45	Cameroon	1.532	4e	Precambrian (Dahomeyan): schist, quartzite, syenite, dolerite
Re43	Gh	Zg		200	Mauritania	3.12, 3.11	4g	Recent coastal dunes
Re43-1ab	Gh	Zg		59	Senegal	1.32	4e, 4g	Recent coastal dunes
Re45	I Lf	Lg	petroferric	1 381	Senegal	1.532	4e	*Continental terminal:* sandstone, shale, marl, sand, clay. Pliocene: lagoonal and deltaic deposits
Re45	I Lf	Lg	petroferric	74	Gambia	1.484	4e	*Continental terminal:* sandstone, shale, marl, sand, clay
Re45	I Lf	Lg	lithic/ petroferric	748	Senegal	1.483, 1.532	4c, 4e	Precambrian: granite, gneiss, schist, quartzite
Re45	I Lf	Lg	lithic/ petroferric	567	Mali	1.532	4e	Precambrian: granite, gneiss, schist, quartzite
Re47-2c		Je		472	Ethiopia	1.85	4b, 1d	Trap series: basalt, phonolite, nephelinite, trachyte, rhyolite, pyroclastics
Re48-2a		Je Xk		616	Ethiopia	3.12	4b	Jurassic limestone, marl and gypsum
Re49	I Qc		petroferric	160	Niger	1.532	4e	*Continental terminal:* poorly consolidated sandstone, shale, conglomerate, grits, sand, clay
Re49	I Qc		petroferric	378	Nigeria	1.532	4e	*Continental terminal:* poorly consolidated sandstone, shale, conglomerate, grits, sand, clay
Re49-1a	I Qc		petroferric	2 489	Nigeria	1.916	4e	Basement complex (Gwarian): granitic gneiss, micaschist, amphibolite, migmatite: granitic batholiths. Palaeogene: sandstone and shale
Re49-1bc	I Qc			911	Madagascar	1.484, 4.32	2c, 4e	Triassic and Jurassic: sandstone. Precambrian: gneiss and migmatite
Re50	Af	Lf		35	Nigeria	1.532	4e	Cretaceous sandstone and marl

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION *(continued)*

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Re51-b	Jc Yh		stony	11	Libya	3.23	8c. 9b, 9d	Devonian sandstone
Re51-b	Jc Yh		stony	2 255	Chad	3.23	9d	*Continental intercalaire:* sandstone. shale. conglomerate. Devonian: sandstone
Re51-1a	Jc Yh			200	Egypt	3.21	9b	*Continental intercalaire:* poorly consolidated sandstone. conglomerate. shale
Re52	Ws	I		1 448	Chad	1.916	4e	Quaternary alluvial. lacustrine and aeolian deposits: granitic batholiths
Re59-a		I Je	lithic	32	Somalia	3.12	4b	Trap series: basalt. phonolite. nephelinite. trachyte. rhyolite. pyroclastics. Jurassic: limestone, marl and gypsum
Re59-a		I Je	lithic	344	Ethiopia	3.12	4b	Trap series: basalt. phonolite. nephelinite. trachyte. rhyolite. pyroclastics. Jurassic: limestone. marl and gypsum
Re59-a		I Je	lithic	1 781	Kenya	1.574. 1.73. 3.12	8a. 4g	Tertiary-recent volcanics: basalt. phonolite. nephelinite. pyroclastics. tuff
Re59-2b		I Je	lithic	328	Ethiopia	1.534, 1.544	8c	Aeolian sand on Precambrian: gneiss. quartzite. schist. cipolin, conglomerate, argillite, andesite. rhyolite: granitic batholiths
Re59-2b		I Je	lithic	1 098	Sudan	1.544. 3.21	8c	Aeolian sand on Precambrian: gneiss. quartzite. schist. cipolin. conglomerate. argillite, andesite. rhyolite: granitic batholiths
Re59-2c		I Je	lithic	1 740	Ethiopia	1.42. 1.533. 1.77. 1.813. 1.85	4b. 4g, 5a	Nubian sandstone: sandstone. mudstone. clay, marl. conglomerate. Jurassic: dolomite. limestone. marl, minor sandstone. Precambrian: gneiss. schist. quartzite: granitic batholiths
Re59-2c		I Je	lithic	785	Sudan	1.532, 1.533	4b	Precambrian: gneiss. schist. quartzite: granitic batholiths
Re59-2c		I Je	lithic	617	Kenya	1.813. 1.83	4g	Precambrian: gneiss. schist. quartzite. amphibolite. charnockite. cipolin: granitic batholiths
Re60-b	Bk Lc	I Rc		223	Morocco	6.1314	5b	Upper Cretaceous and Neogene marl
Re63-2c	I	Jc	lithic	1 748	Kenya	1.534, 3.12	4g	Tertiary-recent volcanics: basalt, phonolite, nephelinite. pyroclastics. tuff
Re64-2a		Zg Jt		1 512	Ethiopia	3.11. 3.12	8c. 8a	Neogene: calcareous sediments. Quaternary: coastal sediments

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Re64-2a		Zg Jt		186	Territory of the Afars and the Issas	3.11	8c	Neogene calcareous sediments. Quaternary coastal sediments
Re64-2a		Zg Jt		336	Sudan	1.544, 3.12	8a, 8c	Neogene calcareous sediments. Quaternary coastal sediments
Re65-1a	Qc			2 590	Sudan	1.534, 1.544, 3.11, 3.12	4g, 8c	Nubian sandstone: sandstone, mudstone, clay, marl, conglomerate. *Continental terminal:* unconsolidated clay, sand, gravel
Re68-1ab		Zt	shifting sands	3 938	Namibia	3.43, 3.44, 3.37	9b	Quaternary coastal deposits; recent aeolian deposits
Re68-1ab		Zt	shifting sands	333	Angola	3.37	9b	Quaternary coastal deposits; recent aeolian deposits
Re69-1a	Qc Qf			844	Mozambique	1.928	2c, 3a	Recent and Quaternary coastal deposits
So1-a	Zo			29	Tunisia	6.171	5b, 8e	Recent lagoonal deposits
So1-2/3a	Zo		saline	436	Somalia	1.534	4b	Quaternary alluvial and lacustrine deposits
So6-a	Zo	Re		15	Tunisia	6.833	5b	Recent lagoonal deposits
So8-2/3a	Qc Ws	Z		1 305	Chad	1.534, 1.917, 3.22	4g, 8c	Quaternary alluvial and lacustrine deposits
So9-2/3a	Vp Ws	Z		2 423	Chad	1.534, 1.916	4e	Quaternary alluvial and lacustrine deposits
So10-2a	Sm Zo	Sg Bc Xk	saline	1 241	Somalia	1.534	4b	Quaternary terrestrial deposits
So11-2/3a	Sm Zo	Sg Bc Jc		575	Somalia	1.534, 1.54	4g	Neogene and Quaternary: alluvial, coastal and marine deposits, fine gravel, marl, calcareous sand and clay
So11-2/3a	Sm Zo	Sg Bc Jc	saline	677	Somalia	1.534	4g	Quaternary alluvial and lagoonal deposits
So12-3ab	Vc	Vp Rc Bc		825	Somalia	1.534, 3.12	4b	Jurassic limestone, marl and gypsum
So13-1a		Qc Ql		1 751	Namibia	4.22	7b	Kalahari: sand, ironstone, chalcedony. Quaternary: lacustrine sediments
So13-1a		Qc Ql		86	Angola	4.22	7b	Kalahari: sand, ironstone, chalcedony. Quaternary: lacustrine sediments

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Th2-c	I Tv			158	Cameroon	1.73	1a	Basic effusive rocks: basalt, andesite
Tm3	Gh			72	Cameroon	1.73	2a	Basic effusive rocks: basalt, andesite
Tm4-b	Lf Ne	I Re V		60	São Tomé and Principe	1.131	1a, 4a	Basic effusive rocks: basalt, andesite, pyroclastics
Tm8-2/3c	Be Ne	G		391	Zaire	1.72, 1.76	2b	Pyroclastic rocks, tuff and ashes
Tm9-2c	I	Je O		378	Kenya	2.31	4a, 4c	Tertiary-recent volcanics: basalt, phonolite, nephelinite, pyroclastics, tuff
Tm9-2c	I	Je O		355	Uganda	1.72, 1.76, 2.7	2a, 4a, 4c	Tertiary-recent volcanics: basalt, phonolite, nephelinite, pyroclastics, tuff
Tm9-2c	I	Je O		33	Zaire	2.7	2a	Tertiary-recent volcanics: basalt, phonolite, nephelinite, pyroclastics, tuff
Tm10-2bc	Ne	Ge		458	Kenya	1.72, 2.31	2b	Tertiary-recent volcanics: basalt, phonolite, nephelinite, pyroclastics, ashes, tuff
Tm10-2bc	Ne	Ge		156	Uganda	1.72, 1.76	4f, 4a, 4c	Tertiary-recent volcanics: basalt, phonolite, nephelinite, pyroclastics, ashes, tuff
Tm10-2bc	Ne	Ge		86	Rwanda	1.76	4f	Pyroclastic rocks, tuff and ashes
Tm11-1/2ab	To			240	Kenya	1.33, 1.812, 2.31	2b	Tertiary-recent volcanics: basalt, phonolite, nephelinite, pyroclastics, tuff
Tm12-2b	To	I		41	Tanzania	2.33	2b	Tertiary-recent volcanics: basalt, phonolite, nephelinite, pyroclastics, tuff
Tm13-2/3c	Ne	I		466	Tanzania	1.846, 2.13, 2.33	2c, 4g	Tertiary-recent volcanics: basalt, phonolite, nephelinite, pyroclastics, tuff
Tm14-1/2c	Bh Re	I		40	Zaire	1.72, 1.76	4f	Pyroclastic rocks, tuff and ashes
Tm14-1/2c	Bh Re	I		48	Rwanda	1.72, 1.76	4f	Pyroclastic rocks, tuff and ashes
To6-2bc		Be		844	Ethiopia	1.85, 2.32	5a	Trap series: basalt, phonolite, nephelinite, trachyte, rhyolite, pyroclastics
To7-2/3a	Bc Tv	I		671	Tanzania	1.33, 1.846	4g	Tertiary-recent volcanics: basalt, phonolite, nephelinite, pyroclastics, tuff
To7-2/3a	Bc Tv	I		89	Kenya	1.33, 1.846	4g	Tertiary-recent volcanics: basalt, phonolite, nephelinite, pyroclastics, tuff
To8-1b	Be	Ne		25	Comoro Islands	1.121	4e	Basalt and rhyolite
To9-2bc	Be Lc			66	Canary Islands	6.41	6b	Basalt and some acid effusive rocks: trachyte and rhyolite

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Tv11-ab	Th			58	Cameroon	1.73	2a	Basic effusive rocks: basalt, andesite, pyroclastics
Tv12-b	Fo			86	Cameroon	1.73	2a	Basic effusive rocks: basalt, andesite, pyroclastics
V1-3a				85	Malawi	1.533	4e	Quaternary alluvial deposits
V1-3a				864	Mozambique	1.32, 1.533	4e	Cretaceous limestone and marl, Quaternary coastal and alluvial deposits
V2-3a	Kk			116	Morocco	6.1314	8a	Quaternary alluvial and lagoonal deposits
V3-3a	Kk	Bk		300	Morocco	6.1313	5b	Upper Cretaceous marl, overlying Palaeozoic schist and quartzite
V4-3a	G Jc	S	saline	273	Morocco	6.1912	5a	Pliocene lacustrine deposits
V5-3b	Rc			54	Morocco	6.1311	6d, 6e	Carboniferous metamorphic rocks, Miocene lacustrine deposits
V9-3a	I	Be		61	Rhodesia	2.14	2c	Karroo: clayey schist and tillite
V10-3a	Lc I	Be S	sodic	26	Rhodesia	4.22	2d	Kalahari: sand, ironstone, chalcedony
V10-3a	Lc I	Be S	sodic	670	Botswana	2.29, 4.22	4g, 4a	Kalahari: sand, ironstone, chalcedony, Karroo: basalt, rhyolite
Vc1				124	Senegal	1.532	4e	Eocene nummulitic limestone
Vc1				90	Mauritania	1.544	4g	Quaternary alluvial deposits
Vc1				181	Upper Volta	1.532	4e	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths
Vc1-2/3a				37	Sudan	1.532	4e	*Continental terminal:* clay and sand
Vc1-3a				1 073	South Africa	2.38, 2.29	7a, 4e	Karroo; basalt, andesite and some rhyolite, clayey schist and sandstone
Vc1-3a				160	Mali	1.533	4e	*Continental terminal:* poorly consolidated sandstone, mudstone, conglomerate, grits, sand, clay
Vc1-3a				107	Upper Volta	1.533	4e	*Continental terminal:* poorly consolidated sandstone, mudstone, conglomerate, grits, sand, clay
Vc1-3a			sodic	161	Ghana	1.35	4e	Precambrian (Dahomeyan): schist, gneiss, quartzite
Vc4	Lf Ws			59	Ghana	1.412	4e	Precambrian (Dahomeyan): schist, gneiss, quartzite
Vc5-3a	Zg	G	sodic	39	Ghana	1.31	4e	Basement complex: orthogneiss, paragneiss, granite, micaschist, quartzite

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Vc6-a	G			36	Ghana	1.412	4e	Basement complex: orthogneiss, paragneiss, granite, micaschist. quartzite
Vc7-3a	Xk Zo	Ge I So		75	Ethiopia	3.11	8c	Quaternary lacustrine deposits
Vc8	Vp			50	Upper Volta	1.533	4e	*Continental terminal:* poorly consolidated sandstone, mudstone, conglomerate, grits, sand. clay
Vc8	Vp			19	Mali	1.533	4e	*Continental terminal:* poorly consolidated sandstone, mudstone, conglomerate, grits, sand, clay
Vc8	Vp			198	Togo	1.411, 1.482	4a, 4c	Precambrian (Dahomeyan): schist, gneiss. quartzite
Vc8-3a	Vp			366	Somalia	3.12	4b	Jurassic limestone, marl and gypsum
Vc8-3a	Vp		sodic	163	Somalia	1.534	4b	Jurassic limestone, marl and gypsum
Vc9	Ws			3	Mali	1.533	4e	Precambrian (Birrimian): schist, quartzite. greenstone. Basement complex: granitic gneiss, schist, quartzite
Vc9	Ws			510	Upper Volta	1.533, 1.532	4e	*Continental terminal:* poorly consolidated sandstone, mudstone, conglomerate, grits, sand. clay. Precambrian (Birrimian): schist, quartzite, greenstone. Basement complex: granitic gneiss; granitic batholiths
Vc9	Ws			105	Ghana	1.421	4e	Precambrian (Birrimian): schist, quartzite. greenstone. Basement complex: granitic gneiss, schist, quartzite: granitic batholiths
Vc9-3a	Ws			357	Nigeria	1.533	4e	Quaternary alluvial and lacustrine deposits
Vc9-3a	Ws			24	Cameroon	1.533	4g	Quaternary alluvial and lacustrine deposits
Vc10	Lp			101	Upper Volta	1.532	4e	Basement complex: granitic gneiss, schist. quartzite: granitic batholiths
Vc11	I			34	Upper Volta	1.532	4e	Greenstone
Vc12	Bv Ws	I		292	Upper Volta	1.532	4e	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths
Vc13	Bv			30	Upper Volta	1.534	4g	Precambrian: schist. quartzite
Vc13-3a	Bv			65	Sudan	4.32	4e	Precambrian: schist, quartzite. syenite, dolerite
Vc14-3a	Re		stony	116	Sudan	4.32	4g	Precambrian: schist; quartzite, syenite, dolerite
Vc14-3b	Re			82	Niger	1.54	4g	*Continental intercalaire:* sandstone. arkose. shale, conglomerate

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION *(continued)*

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Vc15	Lg Qc		sodic	579	Niger	1.918	4g	Recent alluvial and lacustrine deposits
Vc16-3a	Lf Xh			878	Mali	1.534	4g	*Continental terminal:* sandstone. shale. marl. sand, clay
Vc20	Lg Lv			133	Nigeria	1.916. 1.484	2c. 4c	Cretaceous sandstone and shale
Vc23-3a	Lc			50	Algeria	6.141	5a	Oligocene: sandstone. Quaternary: alluvial and lacustrine deposits. dunes
Vc23-3a	Lc			203	Ethiopia	1.77. 2.32	4b. 4f	Trap series: basalt. phonolite. nephelinite. trachyte. rhyolite. pyroclastics
Vc23-3a	Lc			1 504	South Africa	2.29. 2.23. 2.21. 2.26	4e	Intrusive rocks: felsite. norite: basic effusives: basalt. andesite
Vc24-3a	Jc			108	Algeria	6.141	5a	Oligocene sandstone: some upper Cretaceous limestone
Vc25-3a	Jc	Zo		59	Ethiopia	3.11	4b	Aden volcanic series: basalt. basaltic breccias. tuff
Vc26-3a		Jc So Zo		37	Sudan	1.534	4g	Quaternary alluvial and lacustrine deposits
Vc26-3a		Jc So Zo		656	Ethiopia	1.533. 1.534. 2.32. 3.11	4b. 4g	Aden volcanic series: basalt. basaltic breccias. tuff. Quaternary: alluvial and lacustrine deposits
Vc27-3a	Be			197	Ethiopia	1.85	4b	Jurassic limestone. marl and gypsum
Vc28-3a		Je Ge Oe		11 792	Sudan	1.42. 1.532. 1.533	4d	*Continental terminal:* clay and sand
Vc28-3a		Je Ge Oe		1 031	Ethiopia	1.42. 1.532	4b	*Continental terminal:* clay and sand
Vc29-3a	Ao			1 481	Ethiopia	1.42	4b	*Continental terminal:* clay and sand. Precambrian: gneiss. schist. quartzite: granitic batholiths. Trap series: basalt. phonolite. nephelinite. trachyte. rhyolite. pyroclastics
Vc29-3a	Ao		stony	982	Sudan	1.533. 1.534	4g	Trap series: basalt. phonolite. nephelinite. trachyte. rhyolite. pyroclastics. Quaternary: alluvial and lacustrine deposits
Vc29-3a	Ao		stony	403	Ethiopia	1.533. 1.534	4g	Trap series: basalt. phonolite. nephelinite. trachyte. rhyolite. pyroclastics. Quaternary: alluvial and lacustrine deposits
Vc30-3a	Je	Be		203	Ethiopia	1.77	4b	Precambrian: gneiss. schist. quartzite: granitic batholiths. Trap series: basalt. phonolite. nephelinite. trachyte. rhyolite. pyroclastics
Vc31-2/3a	Lo So	Lc		1 665	Sudan	4.31	4g	*Continental terminal:* clay and sand. Precambrian: gneiss. quartzite. cipolin. andesite, conglomerate, argillite. rhyolite: granitic batholiths

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Vc32-3a	Ge Je			197	Sudan	1.534, 4.31	4g	*Continental terminal:* clay and sand. Precambrian: gneiss, quartzite, cipolin, andesite, conglomerate, argillite, rhyolite; granitic batholiths
Vc33-3a		Ge		1 533	Sudan	4.31	4g	*Continental terminal:* clay and sand. Precambrian: gneiss, quartzite, cipolin, andesite, conglomerate, argillite, rhyolite; granitic batholiths
Vc34-3a	Ge	Lf Re		1 570	Sudan	1 533	4d	*Continental terminal:* clay and sand. Quaternary: alluvial and lacustrine deposits
Vc34-3a	Ge	Lf Re		516	Kenya	1.534	4d	*Continental terminal:* clay and sand. Quaternary: alluvial and lacustrine deposits
Vc35-3a	Be Vp	Lo		5 128	Sudan	1.532, 1.533, 1.534, 4.31	4g	*Continental terminal:* clay and sand. Precambrian: gneiss, quartzite, cipolin, andesite, conglomerate, argillite, rhyolite; granitic batholiths
Vc36-3a	Vp	X G		17 229	Sudan	1.532, 1.533, 1.534, 1.544, 3.12	4b, 4g, 8c	Precambrian: gneiss, quartzite, cipolin, andesite, conglomerate, argillite, rhyolite; granitic batholiths. *Continental terminal:* sand and clay
Vc36-3a	Vp	X G		100	Ethiopia	1.533	4b	Precambrian: gneiss, quartzite, cipolin, andesite, conglomerate, argillite, rhyolite; granitic batholiths. *Continental terminal:* sand and clay
Vc37-3a	Jc Vp	Xk Xy So		1 572	Somalia	1.534	4b	Quaternary terrestrial deposits
Vc38-3a	Lf Vp	Jd Bk Lc		627	Madagascar	1.36, 1.484, 4.32	4e	Jurassic marl and limestone. Cretaceous basalt
Vc39-3a		Vp		68	Kenya	1.134, 1.144	4c	Jurassic limestone, shale and gypsiferous beds
Vc40-3a	We			3 226	South Africa	2.38	7a	Karroo: clayey schist, sandstone, shale, mudstone
Vc41-3a	I L So			1 502	South Africa	2.21, 2.27	7a	Karroo: clayey schist, sandstone, shale, mudstone
Vp1-3a				22	Ethiopia	2.32	5a	Trap series: basalt, phonolite, nephelinite, trachyte, rhyolite, pyroclastics
Vp1-3a				193	Chad	1.532	4e	Quaternary alluvial and lacustrine deposits
Vp1-3a				279	Mozambique	1.918, 1.23, 1.533	4e	Cretaceous, Neogene and Palaeogene: limestone, marl, sandstone, calcareous sand

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION *(continued)*

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Vp7-3a	Ge			136	Sudan	1.532	4d	*Continental terminal:* clay and sand
Vp8		Ge		249	Chad	1.533. 1.534	4e	Quaternary alluvial and lacustrine deposits
Vp8-2/3a		Ge		24	Togo	1.412	2a	Eocene calcareous marl
Vp8-2/3a		Ge		144	Benin	1.412	2a	Eocene calcareous marl
Vp8-2/3a		Ge		70	Nigeria	1.412	2a	Eocene calcareous marl
Vp8-3a		Ge		50	Algeria	6.141	5a	Recent alluvial and lacustrine deposits
Vp9	Je			40	Upper Volta	1.533	4e	*Continental terminal:* poorly consolidated sandstone. mudstone. conglomerate, grits. sand, clay
Vp9-a	Je			171	Cameroon	1.484	4e	Basement complex: granitic gneiss. mica-schist. migmatite: granitic batholiths. Cretaceous: sandstone and shale
Vp10-3a	Bv			55	Cameroon	1.532	4e	Basement complex: granitic gneiss. mica-schist. migmatite: granitic batholiths
Vp10-3a	Bv			2 500	Chad	1.42. 1.915. 4.32	4d	Quaternary alluvial and lacustrine deposits
Vp10-3a	Bv			14	Sudan	4.32	4d	Quaternary alluvial and lacustrine deposits
Vp11	Lf Re	I Lc		435	Cameroon	1.532	4e	Precambrian (Dahomeyan): schist. quartzite. syenite. dolerite
Vp12-3a	Lg Vc Ws			418	Cameroon	1.532	4g	Precambrian (Dahomeyan): schist. quartzite. syenite. dolerite
Vp13-a	Ge Qc			394	Cameroon	1.532	4e	Quaternary alluvial and lacustrine deposits
Vp13-a	Ge Qc			53	Chad	1.532	4e	Quaternary alluvial and lacustrine deposits
Vp14-3a		Lc		1 066	Ethiopia	2.21. 2.32	4f	Trap series: basalt. phonolite. nephelinite, trachyte. rhyolite. pyroclastics
Vp15-3a	Oe Gm	Je		6 800	Sudan	1.532. 1.533	4d	*Continental terminal:* clay and sand
Vp16-3a	Qc Re			2 039	Sudan	1.532. 1.533	4d	*Continental terminal:* clay and sand
Vp17-3a	Qc	Lc W		151	Cameroon	1.532	4g	Quaternary alluvial and lacustrine deposits
Vp19-3a	Lf Vc			140	Nigeria	1.484. 1.916	2c. 4c. 4e	Quaternary alluvial deposits
Vp20-3a	Vc		sodic	2 736	Sudan	1.534. 1.544	4g. 8c	Nubian sandstone: sandstone. mudstone. clay. marl. conglomerate
Vp20-3a	Vc		sodic	863	Zambia	2.13. 2.26. 4.342	2c. 2d	Karroo: sandstone. conglomerate. siltstone. Quaternary: alluvial and lacustrine deposits
Vp23-3a	Lf Lg			1 189	Chad	1.532	4e	Quaternary alluvial and lacustrine deposits
Vp23-3a	Lf Lg			865	Nigeria	1.484, 1.916	2c, 4c. 4e	Cretaceous sandstone and shale

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Vp24-2a	Ws			258	Sudan	3.22	8c	Precambrian: schist, quartzite, syenite, dolerite
Vp24-3a	Ws		sodic	2 017	Chad	1.532, 1.533, 1.534	4g	Quaternary alluvial and lacustrine deposits
Vp25	Ws	Qf		105	Chad	1.533	4e	Quaternary alluvial and lacustrine deposits
Vp26	Je	I Re		1 897	Chad	1.534, 1.916	4e	Basement complex; granitic gneiss, migmatite, schist, quartzite; granitic batholiths
Vp44-3ab	Lc			234	Tunisia	6.1311	5a	Cretaceous and Palaeogene limestone and marl
Vp45-2/3a	Be Vc	I		737	Kenya	1.77, 1.811	4a, 4c	Quaternary alluvial deposits. Precambrian: schist, gneiss, charnockite, quartzite and cipolin, partly overlain with volcanic rocks
Vp45-2/3a	Be Vc	I		539	Tanzania	1.812	4g	Precambrian: schist, gneiss, charnockite, quartzite and cipolin, partly overlain with volcanic rocks
Vp46-3a	Zm	G		50	Uganda	1.72	4c	Quaternary alluvial deposits
Vp46-3a	Zm	G		587	Zaire	1.42, 1.72	4c, 4d	Quaternary alluvial deposits
Vp46-3a	Zm	G		188	Burundi	1.74, 1.812	4d	Quaternary alluvial deposits
Vp47-1a		Xh Fo I		586	Angola	4.22	2d, 7b	Precambrian and basement complex: granitic gneiss, schist, quartzite; intrusive rocks: granite, syenite, diorite, dolerite, gabbro
Vp48-a	Xh	Je		165	Angola	4.22	2d	Quaternary alluvial deposits
Vp49-3a	Zo	Je	sodic	583	Tanzania	1.134, 1.32, 1.812, 1.85	4e, 4g, 2a	Quaternary: alluvial and lacustrine deposits. Cretaceous: sandstone, conglomerate and marl
Vp49-3a	Zo	Je	sodic	448	Kenya	1.54, 1.846, 3.12	4b	Quaternary alluvial and lacustrine deposits
Vp50-3a	Vc	Je Ge		274	Tanzania	1.32	4e	Quaternary alluvial and lacustrine deposits
Vp50-3a	Vc	Ge Je		312	Zaire	1.73	4e	Precambrian: limestone, dolomitic shale, schist, quartzite, sandstone, shale, arkose
Vp50-3a	Vc	Ge Je		798	Zambia	2.13, 2.26	2c	Quaternary alluvial and lacustrine deposits
Vp51-3a	J Vc	G		318	Tanzania	1.32, 1.36	4e	Quaternary alluvial and lacustrine deposits
Vp52-3a	G L	I		2 435	Tanzania	1.72, 1.811, 1.812	4c, 4g	Basement complex: orthogneiss, granite, migmatite, amphibolite, schist, quartzite. Quaternary and Neogene: lacustrine and alluvial deposits
Vp53-3a	Vc	Bk Qf		548	Tanzania	1.36	4e	Jurassic and Cretaceous: shale, marl, sandstone and conglomerate
Vp54-3a	I			31	Mozambique	4.2	2d	Karroo: basalt, minor rhyolite

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Vp54-3a	I			755	Rhodesia	4.22, 4.2	2d, 4e	Karroo: basalt, minor rhyolite. Kalahari: sand, ironstone and chalcedony
Vp55-3bc	Bk Lc	I	petrocalcic	383	Namibia	2.16	4g	Precambrian: quartzite, arkose, chert, limestone and conglomerate, partly or completely overlain with Kalahari: sand, ironstone and chalcedony. Quaternary: lacustrine sediments
Vp56-3ab	X			421	Mozambique	2.14, 4.2, 1.918	4e	Karroo basalt and minor rhyolite
W2-a	Qc	Vp Z		821	Chad	1.533, 1.534	4g	Quaternary alluvial and lacustrine deposits
Wd2-2/3a	Fo Fr			12	Guinea	1.73	4c	Ordovician sandstone
We2-1a	So		sodic	105	Chad	1.534	4e	Quaternary alluvial and lacustrine deposits
We4-2a	Gp	Fo		240	Kenya	2.31, 1.811	4g	Tertiary-recent volcanics: basalt, phonolite, nephelinite, pyroclastics, tuff
We8-1/2a	Je V	G	saline	2 954	Tanzania	1.32, 1.812, 1.85	2c, 4e	Neogene and Quaternary: alluvial and lacustrine deposits. Tertiary: limestone, sandstone, mudstone, clay and sand. Precambrian: schist, gneiss, charnockite, quartzite and cipolin
We9-2/3b	Bc I S	Lc	stony	884	Lesotho	2.38	7c	Karroo: clayey schist, sandstone, shale, arkose
We9-2/3b	Bc I S	Lc	stony	2 450	South Africa	2.36, 2.38	7a, 7c	Karroo: clayey schist, sandstone, shale, arkose
We16-2/3a	Lc V	I Kk Re		514	Morocco	6.1912, 6.1313	6d, 6e	Quaternary alluvial and colluvial deposits. Neogene lacustrine deposits
We18-1/2a	Be	I Ws		388	Swaziland	2.21, 4.41	4e	Basement complex: granite, gneiss, schist, phyllite, amphibolite, greenstone, clayey schist, sandstone
We18-1/2a	Be	I Ws		369	South Africa	4.41, 1.9291	4e	Basement complex: granite, gneiss, schist, phyllite, amphibolite, greenstone, clayey schist, sandstone
Ws2	Lg			39	Ghana	1.31	4e	Precambrian (Dahomeyan): schist, gneiss, quartzite
Ws2	Lg			127	Cameroon	1.532	4g	Quaternary alluvial and lacustrine deposits
Ws2	Lg			74	Upper Volta	1.533	4e	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths
Ws2-1a	Lg			164	Ghana	1.412	4e	Precambrian (Dahomeyan): schist, gneiss, quartzite

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Ws2-1a	Lg			13	Togo	1.412	4e	Precambrian (Dahomeyan): schist, gneiss quartzite
Ws3				359	Upper Volta	1.534	4g	Basement complex: granitic gneiss, schist, quartzite: granitic batholiths
Ws3				19	Niger	1.534	4g	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths
Ws3-1a				49	Ghana	1.31	4e	Precambrian (Dahomeyan): schist, gneiss, quartzite
Ws4	I			26	Ghana	1.412	4e	Precambrian (Birrimian): schist, quartzite, greenstone; granitic batholiths
Ws4	I			64	Upper Volta	1.532	4e	Precambrian (Birrimian): schist, quartzite, greenstone; granitic batholiths
Ws4-1a	I			69	Ghana	1.412	4e	Precambrian (Dahomeyan): schist, gneiss, quartzite
Ws5-1a	Lg	Vc		23	Mali	1.533	4e, 4g	Cambrian: calcareous schist, quartzite, pelites
Ws5-1a	Lg	Vc		265	Senegal	1.532, 1.533	4e, 4g	Cambrian: calcareous schist, quartzite, pelites
Ws6	Vc			50	Upper Volta	1.532	4e	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths
Ws6-1a	Vc			81	Upper Volta	1.532	4e	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths
Ws8	Bv Ql			188	Upper Volta	1.534	4g	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths
Ws9	Re			215	Upper Volta	1.534	4g	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths
Ws10-a	Vp			210	Chad	1.533, 1.534	4g	Quaternary alluvial and lacustrine deposits
Ws10-a	Vp			161	Nigeria	1.533	4g	Quaternary alluvial and lacustrine deposits
Ws10-a	Vp			322	Cameroon	1.533, 1.534	4g	Quaternary alluvial and lacustrine deposits
Ws11-a	Je			25	Chad	1.534	4g	Quaternary alluvial and lacustrine deposits
Ws11-a	Je			130	Cameroon	1.534	4g	Quaternary alluvial and lacustrine deposits
Ws12-1a	Ql Re			235	Upper Volta	1.534	4g	Basement complex: granitic gneiss, schist, quartzite; granitic batholiths
Ws13-2ab	I So We	Lk		43	Lesotho	2.36	7a	Karroo: clayey schist, sandstone, shale, arkose
Ws13-2ab	I So We	Lk		5 920	South Africa	2.36, 2.38, 5.622	7a	Karroo: clayey schist, sandstone, shale, arkose

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION *(continued)*

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
X2-2a	Jc Z		saline	33	Morocco	3.272	8d	Recent alluvial deposits
X3-2ab	I Jc	Xy Z	petrocalcic	2 051	Morocco	3.272	8d	Cretaceous flysch. Neogene marl and sand deposits. Quaternary alluvial deposits
X4-2a	I Y	Jc R Z	petrocalcic	2 045	Morocco	3.272, 6.912	8d	Jurassic dolomitic limestone. Quaternary alluvial deposits
X4-2a	I Y	Jc R Z	petrocalcic	1 436	Algeria	6.912	8d	Quaternary alluvial deposits
X5-1/2b	I Zo		petrocalcic	11	Tunisia	6.822	5b	Quaternary alluvial, lagoonal and marine deposits
X6-1/2b	Bk Bv	Jc		109	Tunisia	6.833	5b	Miocene: limestone and marl. Pliocene and Quaternary: lacustrine and alluvial deposits
X7-2ab	Re Y	Zo Jc Xk		1 646	Kenya	1.83, 3.12	4b	Precambrian: schist, gneiss, amphibolite, charnockite, quartzite, cipolin
X8-2a	Re Zo			204	Sudan	3.12	8c	Recent coastal deposits
Xh1-2ab	I			1 645	Angola	1.34, 3.37	4e, 8c	Precambrian: granitic gneiss, migmatite, schist, quartzite, dolerite, syenite; granitic batholiths
Xh2-2a				4	Algeria	6.922	5b	Recent alluvial deposits
Xh2-2a				60	Mauritania	1.54, 3.12	4g	Recent alluvial deposits
Xh2-3a				107	Egypt	3.23	9b	Recent alluvial and lagoonal deposits
Xh11-1/2a	Bk E Xk	I Jc Yy Zo		1 442	Tunisia	3.24, 6.812, 6.822	5b, 6a, 8d	Pliocene and Quaternary alluvial and lacustrine deposits; some outcroppings of Cretaceous and Palaeogene limestone
Xh12	Xk		petrocalcic	86	Algeria	6.922	5b	Recent alluvial and lacustrine deposits
Xh12-2a	Xk		petrocalcic	794	Algeria	6.741	5b	Cretaceous and Miocene limestone overlain with recent alluvial and lacustrine deposits
Xh13	Re		lithic	573	Libya	3.23	9b	Upper Cretaceous dolomitized and marly limestone
Xh14-ab	Re	Vc Yt	shifting sands	1 067	Sudan	3.11	8c	Nubian sandstone: sandstone, mudstone, clay, marl, conglomerate; recent aeolian deposits
Xh14-1a	Re	Vc Yt	stony	21 242	Sudan	1.544, 3.11, 3.12, 3.22, 4.31	8c	*Continental intercalaire* and Nubian sandstone: poorly consolidated sandstone, mudstone, shale, marl, conglomerate
Xh15-a	Jc Xk		stony	3 028	Sudan	1.544, 3.11, 3.21	4g, 8c	Aeolian sand on Precambrian: gneiss, quartzite, schist, cipolin, conglomerate, argillite, andesite, rhyolite; granitic batholiths
Xh15-2a	Jc Xk			137	Somalia	3.51	4b	Quaternary alluvial, lacustrine and aeolian deposits

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION *(continued)*

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Xh15-3a	Jc Xk			46	Kenya	1.85	4g	Precambrian: granitic gneiss. schist. quartzite: granitic batholiths. Jurassic: limestone. marl and gypsum
Xh15-3a	Jc Xk			7 365	Ethiopia	1.843. 1.85. 3.51	4f. 4g. 5a	Precambrian: granitic gneiss. schist. quartzite: granitic batholiths. Jurassic: limestone. marl and gypsum
Xh16-a	To	Re		331	Ethiopia	1.85	5a	Aden volcanic series: basalt. basaltic breccias. tuff. Quaternary: alluvial deposits
Xh17-2a	Re To	I Vc		1 003	Ethiopia	1.85	5a	Aden volcanic series: basalt. basaltic breccias. tuff. Jurassic: limestone. marl and gypsum. Quaternary: alluvial deposits
Xh19-2a	Vc	Xk Zo Jc		803	Ethiopia	1.533. 1.534	4b	Precambrian: gneiss. quartzite. cipolin.. andesite. conglomerate. argillite. rhyolite: granitic batholiths
Xh20-2a		Je Qc		106	Ethiopia	2.35	4f	Precambrian: gneiss. quartzite. cipolin. conglomerate. argillite. andesite. rhyolite: granitic batholiths
Xh21-2a	I Xk			118	Territory of the Afars and the Issas	3.12. 3.51	8c	Quaternary alluvial and lacustrine deposits
Xh22-1/2ab	Lf	I	lithic	415	Angola	1.34, 1.35	4e	Precambrian: gneiss, schist, quartzite, dolerite. syenite: granitic batholiths
Xh23-1/2ab	Be	I		564	Angola	1.34. 1.35	4e	Cretaceous sandstone. marl and limestone
Xh24-ab		I		1 205	Angola	1.77. 3.37. 3.51, 4.22	2d. 8c	Basement complex: granitic gneiss. migmatite. schist. quartzite: granitic batholiths. Precambrian: gneiss. schist. quartzite. diorite. syenite. Quaternary: alluvial and coastal deposits
Xh25-1/2a	Lf	Vp		95	Angola	4.22	2d	Precambrian: gneiss. schist. quartzite. diorite. syenite
Xh26-1/2a	Lf	Re		1 230	Angola	4.22	2d	Kalahari: sand. ironstone. chalcedony. Quaternary: lacustrine sediments
Xh27-1/2a		Lf Q Zo		770	Angola	4.22	2d	Kalahari: sand. ironstone. chalcedony. Quaternary: lacustrine sediments
Xh28-1/2a	Be Je	We Ge		159	Angola	4.22	4e	Quaternary alluvial and aeolian deposits
Xh29-1/2a	We	Je G Be		149	Angola	4.22	4e	Quaternary alluvial and aeolian deposits
Xk1-2ab	I			546	Algeria	6.922	5b	Cretaceous and Miocene limestone and marl. mostly overlain with recent alluvial and lacustrine deposits

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION *(continued)*

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Xk1-2/3a	I		saline	829	Libya	3.23. 6.822	8d	Cretaceous: limestone. Pliocene and Quaternary: alluvial. lacustrine and coastal deposits. Neogene: limestone. marl and gypsum
Xk4-2a			petrocalcic	178	Morocco	3.24	5b	Quaternary alluvial and lacustrine deposits
Xk5-1a	Rc		petrocalcic	700	Algeria	6.741	8d	Cretaceous: limestone. Neogene: clayey marl. Quaternary: alluvial and lacustrine deposits
Xk5-2b	Rc			68	Morocco	3.24	5b	Recent alluvial deposits
Xk8-1a	R	I Lc Zg		306	Morocco	3.24	8a	Recent alluvial. lagoonal. aeolian and coastal deposits
Xk9-2ab	Xy		petrocalcic	4 629	Somalia	1.85, 3.12	4b. 8c	Palaeogene limestone and marl
Xk9-2ab	Xy		petrocalcic	456	Algeria	6.741. 6.833. 6.922	5b	Cretaceous and Palaeogene: limestone and marl. partly overlain with recent alluvial and lacustrine deposits
Xk9-2ab	Xy		petrocalcic	11	Tunisia	6.922	5b	Cretaceous and Palaeogene: limestone and marl. partly overlain with recent alluvial and lacustrine deposits
Xk10-2a	Lc Xl	Rc V		1 269	Morocco	6.161. 6.81. 3.24	5b	Recent alluvial deposits
Xk10-2a	Lc Xl	Rc V		18	Algeria	6.161	5b	Recent alluvial deposits
Xk11-2a	Xl		petrocalcic	68	Morocco	6.1922	6d. 6e	Recent alluvial deposits
Xk12-2a	I Rc		petrocalcic	2 322	Somalia	3.51	4b	Cretaceous and Palaeogene: limestone. marl. sandstone
Xk12-2a	I Rc		petrocalcic	181	Ethiopia	3.51	4b	Cretaceous and Palaeogene: limestone. marl. sandstone
Xk12-2a	I Rc		petrocalcic	1 016	Algeria	6.912. 6.741	8d	Mesozoic: limestone and dolomite. Neogene: clayey marl
Xk13-2b	I Xh		petrocalcic	611	Algeria	6.1912, 6.741	5b	Cretaceous and Palaeogene: limestone and marl. partly overlain with recent alluvial and lacustrine deposits
Xk14-1/2b	Bk E	Jc	petrocalcic	109	Tunisia	6.833	5b	Villafranchian and Quaternary alluvial and lagoonal deposits
Xk15-1/2a	Qc Rc		shifting sands	347	Libya	6.171. 6.822	8d	Quaternary marine. lagoonal and aeolian deposits
Xk16-2a	Jc Rc			121	Libya	3.23. 6.812	6c	Quaternary marine. lagoonal and aeolian deposits
Xk16-2a	Jc Rc			247	Somalia	3.11, 3.51	4b. 8c	Neogene and Quaternary: marl. calcareous sand. clay. Cretaceous and Palaeogene: limestone. marl. sandstone
Xk17-2a	I Rc	Jc Bk		1 059	Libya	6.812. 3.23	6c. 8d, 9f	Quaternary marine. lagoonal and aeolian deposits

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Xk18-1b	I Jc			58	Tunisia	3.23	9b	Upper Cretaceous dolomitized and marly limestone
Xk18-1b	I Jc			3 457	Libya	3.23	9b	Upper Cretaceous dolomitized and marly limestone
Xk19-2a		Zo		752	Kenya	1.534, 3.12	4g	Trap series: basalt, phonolite, nephelinite, trachyte, rhyolite, pyroclastics. Quaternary: alluvial and lacustrine deposits
Xk19-2a		Zo	sodic	1 972	Ethiopia	1.543, 1.85, 3.11	4b	Trap series: basalt, phonolite, nephelinite, trachyte, rhyolite, pyroclastics. Aden volcanic series: basalt, basaltic breccias, tuff. Quaternary: alluvial deposits
Xk20-2a	I	Zo	lithic	816	Ethiopia	1.85, 3.11	4b	Trap series: basalt, phonolite, nephelinite, trachyte, rhyolite, pyroclastics
Xk23-1a	Bk Qc	Bv		57	Cape Verde	1.573	4g	Tertiary limestone, marl and shale
Xk24-2ab	Bk I	Lc Qc	stony	24 410	Namibia	3.23, 3.26, 3.43	4g, 8c, 9b	Basement complex: granite, gneiss, schist, phyllite. Palaeozoic: dolomite, limestone, quartzite, shale. Karroo: clayey schist and tillite with Kalahari sand, ironstone, chalcedony
Xk24-2ab	Bk I	Lc Qc	stony	28 805	South Africa	3.43, 3.23, 3.82, 3.42, 3.53, 5.77, 2.39, 5.42, 5.622	8c, 9b, 8a, 8b	Basement complex: granite, gneiss, schist and phyllite, mostly overlain with Palaeozoic: sandstone, quartzite, shale, clayey schist and tillite
Xk24-2ab	Bk I	Lc Qc	stony	168	Angola	1.77	7b	Basement complex: granite, gneiss, schist, phyllite. Kalahari: sand
Xl14-2a	Vc			338	Ethiopia	1.534	4b	Nubian sandstone: sandstone, mudstone, clay, marl, conglomerate. Trap series: basalt, phonolite, nephelinite, trachyte, rhyolite, pyroclastics
Xl14-2a	Vc			591	Sudan	1.534	4b	Nubian sandstone: sandstone, mudstone, clay, marl, conglomerate. Trap series: basalt, phonolite, nephelinite, trachyte, rhyolite, pyroclastics
Xl15-2a	Lo Z			70	Angola	1.35	4e	Quaternary alluvial deposits
Xy2-2a	Rc Z	Jc	lithic	2 394	Libya	6.822, 3.23, 3.43	8d, 9b	Quaternary: coastal, alluvial, lagoonal and aeolian deposits. Neogene: limestone, marl and gypsum
Xy2-2a	Rc Z	Jc	lithic	555	Somalia	1.85	4b	Palaeogene limestone and marl
Xy3-2ab	Xk			209	Somalia	1.543	8a	Jurassic limestone, marl and gypsum

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION *(continued)*

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Y1				313	Libya	3.23	9b	Sandstone, shale and granitized rocks, partly overlain with recent alluvial and lacustrine deposits
Y1				533	Algeria	3.23	9b	Sandstone, shale and granitized rocks, partly overlain with recent alluvial and lacustrine deposits
Y1			stony	607	Libya	3.23	9b	Carboniferous sandstone and shale
Y1			stony	3 052	Algeria	3.23	9b, 9d	Pliocene lacustrine deposits, partly covered with aeolian sands
Y1-a			stony	442	Chad	3.21, 3.23	9b	Carboniferous sandstone and shale
Y1-a			stony	21 901	Niger	3.21, 3.23	9b	Carboniferous sandstone and shale
Y1-a			stony	1 926	Libya	3.23	9b	Carboniferous sandstone and shale
Y1-a			stony	1 519	Algeria	3.21	9b	Carboniferous sandstone and shale
Y1-a			saline	1 533	Algeria	3.23	9b	Pliocene and Quaternary: alluvial and lacustrine deposits, partly covered with aeolian sands
Y1-b			stony	4 787	Algeria	3.23, 3.21	9a, 9b	Tertiary: nummulitic limestone. Triassic and Carboniferous: sandstone and shale, overlain with aeolian sands. *Continental intercalaire:* sandstone, claystone. Cretaceous: marine deposits, limestone, marl and calcareous sandstone
Y1-b			stony	7 190	Mali	3.21	8c, 9b	*Continental intercalaire:* sandstone, claystone. Cretaceous: marine deposits, limestone, marl and calcareous sandstone
Y1-b			stony	1 782	Niger	3.21	9b	*Continental intercalaire:* sandstone, claystone. Cretaceous: marine deposits, limestone, marl and calcareous sandstone
Y1-b			stony	3 744	Libya	3.23	9a, 9b	Tertiary: nummulitic limestone. Triassic and Carboniferous: sandstone and shale, overlain with aeolian sands
Y1-1a				226	Libya	3.23	9b	Carboniferous: sandstone and shale. Cretaceous: sandstone, shale and limestone. Pliocene and Quaternary: alluvial and lacustrine deposits
Y1-1a				445	Algeria	3.23	9b	Carboniferous: sandstone and shale. Cretaceous: sandstone, shale and limestone. Pliocene and Quaternary: alluvial and lacustrine deposits
Y1-1a				63	Niger	3.23	9b	Carboniferous: sandstone and shale. Cretaceous: sandstone, shale and limestone. Pliocene and Quaternary: alluvial and lacustrine deposits
Y2-1b	Rc			704	Tunisia	3.23	9b	Upper Cretaceous: limestone and marl, partly overlain with Quaternary alluvial and aeolian deposits

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Y3-2a	Vc	Re Je		2 112	Ethiopia	1.534, 1.8	8c	Precambrian: gneiss, quartzite, cipolin, conglomerate, argillite, andesite, rhyolite; granitic batholiths
Y4-1a		Bv	shifting sands	8 737	Niger	3.21	8c, 9b, 9c	*Continental intercalaire:* arkose, sandstone, claystone, partly covered with *continental terminal:* poorly consolidated sandstone, shale, conglomerate and grits
Ya-1a		Bv	shifting sands	65	Algeria	3.21	9b	*Continental intercalaire:* arkose, sandstone, claystone, partly covered with *continental terminal:* poorly consolidated sandstone, shale, conglomerate *and grits*
Y5	I Re			610	Mauritania	3.11	8c, 9b	*Continental terminal:* sandstone, shale, marl, sand and clay, overlying upper Precambrian: schist and quartzite
Y5	I Re		stony	283	Spanish Sahara	3.34	8c	Quaternary alluvial, lagoonal and coastal deposits
Y5	I Re		stony	1 063	Algeria	3.23	9d	Cambrian: gneiss, schist, quartzite, cipolin
Y5	I Re		stony	1 875	Niger	3.23	9b	Precambrian: schist, quartzite
Y5	I Re		stony	10 379	Libya	3.23	9b	Cambro-Ordovician: sandstone. *Continental intercalaire:* sandstone, shale, dolomite, limestone
Y5-a	I Re		stony	1 570	Mauritania	3.21	9b, 9c	Palaeozoic: pelites, sandstone, shale, conglomerate, limestone, calcareous sandstone, gypsiferous clay, partly overlain with *continental terminal*
Y5-a	I Re		stony	9 684	Mali	3.21	9b	Palaeozoic: pelites, sandstone, shale, conglomerate, limestone, calcareous sandstone, gypsiferous clay, partly overlain with *continental terminal*
Y5-a	I Re		stony	3 142	Algeria	3.21	9b	Palaeozoic: pelites, sandstone, shale, conglomerate, limestone, calcareous sandstone, gypsiferous clay, partly overlain with *continental terminal*
Y5-ab	I Re		shifting sands	448	Spanish Sahara	3.21	9b, 9c	Basement complex; Cambrian and Ordovician: pelites, sandstone, shale, conglomerate
Y5-ab	I Re		shifting sands	7 240	Mauritania	3.11, 3.21	9b, 9c	Basement complex; Cambrian and Ordovician: pelites, sandstone, shale, conglomerate
Y5-b	I Re			186	Niger	3.21	8c, 9c	*Continental intercalaire:* arkose, sandstone, claystone, partly covered with *continental terminal:* poorly consolidated sandstone, shale, conglomerate and grits
Y5-b	I Re			3 228	Mali	3.21	8c	Precambrian (Suggarian): granitic gneiss, micaschist, amphibolite, quartzite, cipolin
Y5-1a	I Re		stony	29 979	Libya	3.23	9b	Palaeogene: nummulitic limestone. *Continental intercalaire:* sandstone, shale, conglomerate

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Y5-1a	I Re		stony	45 468	Sudan	3.11. 3.21. 3.23	9b	*Continental intercalaire* and Nubian sandstone: poorly consolidated sandstone. mudstone. shale. marl. conglomerate
Y5-1a	I Re		stony	19 695	Egypt	3.21. 3.23	9b	*Continental intercalaire:* poorly consolidated sandstone. conglomerate. shale
Y5-1a	I Re		stony	6 870	Chad	3.23. 3.21	9b	*Continental intercalaire:* poorly consolidated sandstone. conglomerate. shale
Y5-1a	I Re		stony. shifting sands	2 640	Mauritania	3.21	9b. 9c	Ordovician: pelites. sandstone. shale. conglomerate. partly overlain with *continental terminal:* sandstone. quartzite. chert
Y5-2ac	I Re		petrocalcic	1 299	Morocco	3.271. 3.272	9b	Jurassic: limestone. dolomite. marl. sandstone. Quaternary: alluvial deposits
Y5-2ac	I Re		petrocalcic	108	Algeria	3.271	9b	Jurassic: limestone. dolomite. marl. sandstone. Quaternary: alluvial deposits
Y6	Z			204	Libya	3.23	9b	Precambrian: conglomerate. sandstone. arkose. micaschist. leptite. amphibolite. gneiss. Silurian: clayey schist
Y6	Z			941	Algeria	3.23	9b	Precambrian: conglomerate. sandstone. arkose. micaschist. leptite. amphibolite. gneiss. Silurian: clayey schist
Y6-a	Z			123	Niger	3.21	9b	*Continental intercalaire:* sandstone. arkose. shale. conglomerate
Y7	Re	Z		194	Algeria	3.23	9f	Cambro-Silurian: quartzite. shale. schist. Devonian: limestone with minor sandstone and schist
Y7	Re	Z	stony	298	Algeria	3.23	9b	Carboniferous limestone with minor sandstone and schist
Y7-a	Re	Z	stony	24 063	Algeria	3.21. 3.23	9b	Sandstone. shale and limestone. for the greater part overlain with *continental terminal*
Y7-a	Re	Z	stony	128	Mali	3.21	9b	Sandstone. shale and limestone. for the greater part overlain with *continental terminal*
Y8-a	Jc			2 466	Libya	3.23	9b	Palaeogene: nummulitic limestone. quartz gravel
Y8-a	Jc			5 024	Algeria	3.23	9b	Cretaceous: dolomitic limestone. slate. anhydrite
Y8-a	Jc		stony	130	Mauritania	3.11	8c	*Continental terminal:* sandstone. shale. marl, sand. clay
Y8-a	Jc		stony	1 597	Spanish Sahara	3.11	8c	*Continental terminal:* sandstone. shale. marl. sand. clay
Y8-ab	Jc			3 370	Libya	3.23	9a, 9b	Upper Cretaceous: dolomitized and marly limestone. Palaeogene: nummulitic limestone

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION *(continued)*

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Y8-ab	Jc			887	Tunisia	3.23	9b, 9f	Upper Cretaceous: dolomitized and marly limestone. Palaeogene: nummulitic limestone
Y8-ab	Jc			7 225	Algeria	3.23	9b	Upper Cretaceous: dolomitized and marly limestone. Palaeogene: nummulitic limestone
Y8-ab	Jc		stony	2 006	Spanish Sahara	3.21, 3.34	8c	*Continental terminal:* sandstone. shale, marl. sand, clay
Y8-b	Jc		rock debris	2 603	Algeria	3.23	9b	*Continental terminal:* sandstone, shale, anhydrite
Y10	Re	J I		277	Algeria	3.23	9b	Lower Precambrian granitized rocks, partly overlain with recent alluvial and lacustrine deposits
Y10-ab	Re	J I	stony	2 532	Algeria	3.23	9b	Devonian sandstone, partly overlain with aeolian sands
Y11-ab	I J	R Yy Z	stony	7 850	Sudan	3.11, 3.21	8c	Nubian sandstone: sandstone, mudstone, clay, marl and conglomerate, overlying Precambrian: gneiss, quartzite, schist and cipolin
Y11-2ac	I J	R Yy Z	petrocalcic/stony	91	Spanish Sahara	3.23	9a, 9b	Metamorphic rocks with granitic intrusions, limestone partly overlain with Quaternary lacustrine and alluvial sediments
Y11-2ac	I J	R Yy Z	petrocalcic/stony	8 937	Morocco	3.271	9a, 9b	Metamorphic rocks with granitic intrusions, limestone partly overlain with Quaternary lacustrine and alluvial sediments
Y11-2ac	I J	R Yy Z	stony/petrocalcic	905	Algeria	3.271	9a, 9b	Metamorphic rocks with granitic intrusions, limestone partly overlain with Quaternary lacustrine and alluvial sediments
Y12-1a	Je	Re	shifting sands	831	Chad	3.21	8c	*Continental terminal:* poorly consolidated sandstone, shale and marl. Pleistocene and recent alluvial, lacustrine and aeolian deposits
Yh2	Zo			1 190	Mauritania	3.12	4g, 8c	Quaternary coastal and lagoonal deposits
Yh2-a	Zo			260	Mauritania	3.11	8c	*Continental terminal*: sandstone. shale, marl, sand. clay
Yh9	I Rc Yk	Je	saline	217	Morocco	3.34	8c	Upper Cretaceous and Eocene: calcareous sandstone and limestone
Yh9-ab	I Rc Yk	Je	stony	5 921	Spanish Sahara	3.21, 3.23, 3.11	8c, 9b	Upper Cretaceous and Eocene: marine sediments. *Continental intercalaire:* calcareous sandstone. limestone
Yh9-ab	I Rc Yk	Je	stony	856	Morocco	3.23, 3.34	8c	Upper Cretaceous and Eocene marine sediments. *Continental intercalaire:* calcareous sandstone. limestone
Yh9-ab	I Rc Yk	Je	stony	180	Algeria	3.23	9b	Upper Cretaceous and Eocene: marine sediments. *Continental intercalaire:* calcareous sandstone, limestone

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION *(continued)*

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Yh9-ab	I Rc Yk	Je	stony	70	Mauritania	3.23	9b	Upper Cretaceous and Eocene: marine sediments. *Continental intercalaire:* calcareous sandstone. limestone
Yh10-a	Yk Yy	Jc	stony/ shifting sands	9 620	Mali	3.21	9b. 9c	*Continental intercalaire:* sandstone. quartzite. silex
Yh10-a	Yk Yy	Jc	stony/ shifting sands	650	Mauritania	3.21	9b. 9c	*Continental intercalaire:* sandstone. quartzite. silex
Yh10-a	Yk Yy	Jc	stony/ shifting sands	2 826	Algeria	3.21	9b, 9c	*Continental intercalaire:* sandstone. quartzite. silex
Yh13-2/3a	Jc	So	sodic	129	Algeria	3.24	8d	Neogene clayey marl
Yh14-2a	Jc		saline	115	Algeria	3.24	8d	Neogene clayey marl. Quaternary alluvial deposits
Yh15-1a	Re Yk		saline	1 227	Sudan	3.11	8d	Coastal deposits
Yh15-1a	Re Yk		saline	1 321	Egypt	3.11. 3.21. 3.23. 3.271	9a. 9b	Cretaceous: marly and dolomitized limestone. Palaeogene: limestone. mostly overlain with red sand
Yh15-1a	Re Yk		saline	60	Libya	3.23	9b. 9f	Cretaceous: marly and dolomitized limestone. Palaeogene: limestone. mostly overlain with red sand
Yh16-2c	I Vc		stony	156	Ethiopia	1.543. 1.85	5a	Aden volcanic series: basalt. basaltic breccias. tuff
Yh16-2/3c	I Vc		stony	859	Ethiopia	1.533. 1.843. 1.85	4b, 4f, 4g	Trap series: basalt. phonolite. nephelinite. trachyte. rhyolite. pyroclastics. Aden volcanic series: basalt. basaltic breccias, tuff
Yh17-2c	I	Vc Je	lithic	147	Kenya	1.534	8a	Precambrian: gneiss. schist. quartzite: granitic batholiths. Aden volcanic series: basalt, basaltic breccias. tuff
Yh17-2c	I	Vc Je	lithic	1 565	Ethiopia	1.534. 1.77. 1.85	4g	Precambrian: gneiss. schist. quartzite: granitic batholiths. Aden volcanic series: basalt. basaltic breccias. tuff
Yh18-2c	I	Je	lithic	2 450	Ethiopia	1.843. 1.85	5a	Precambrian: granitic gneiss. schist. quartzite: granitic batholiths
Yh19-2a	Zo	Re I		1 372	Somalia	3.12	4b	Jurassic: limestone. shale. sandstone. siltstone and gypsiferous beds. Quaternary: alluvial. lacustrine and lagoonal deposits
Yh19-2a	Zo	Re I		5 608	Kenya	3.12	4b. 8a	Jurassic: limestone. shale. sandstone. siltstone and gypsiferous beds. Quaternary: alluvial. lacustrine and lagoonal deposits. Precambrian: schist. gneiss. amphibolite. charnockite. quartzite. cipolin

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION *(continued)*

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Yh19-2a	Zo	Re I		375	Ethiopia	3.12	4b	Jurassic limestone. marl and gypsum
Yh20-2b	Xl	Jc Re		3 658	Kenya	1.534, 1.83, 3.12	4b	Precambrian: schist, gneiss, amphibolite, charnockite, quartzite, cipolin
Yh20-2b	Xl	Jc Re		84	Ethiopia	1.534	4b	Precambrian: schist, gneiss, amphibolite, charnockite, quartzite, cipolin
Yh21-2ab		I Je		4 193	Ethiopia	3.12, 3.51	4b	Jurassic and Cretaceous: limestone, marl, sandstone, gypsum
Yh21-2ab		I Je		1 366	Somalia	3.12	8a, 8c	Palaeogene limestone and marl
Yk1-1a				47	Tunisia	3.24	8d	Quaternary alluvial and lacustrine deposits
Yk1-2ab			petrocalcic	187	Algeria	6.922	8d	Miocene: limestone; recent alluvial and lacustrine deposits
Yk2-3a		I Vc	petrocalcic	1 450	Somalia	3.12	4b	Jurassic: limestone, shale, sandstone, siltstone and gypsiferous beds
Yk2-3a		I Vc	petrocalcic	1 487	Kenya	3.12	4b, 4g	Jurassic: limestone, shale, sandstone, siltstone and gypsiferous beds
Yk2-3a		I Vc	petrocalcic	34	Ethiopia	3.12	4b	Jurassic: limestone, shale, sandstone, siltstone and gypsiferous beds
Yk3-1a	Yy			140	Algeria	6.912	8d	Upper Cretaceous limestone. Neogene clayey marl. Quaternary alluvial and lagoonal deposits
Yk3-2a	Yy			269	Algeria	6.741	8d	Quaternary alluvial and lacustrine deposits
Yk3-2a	Yy		petrocalcic	664	Algeria	3.23	8d	Palaeogene limestone and marl
Yk3-2ab	Yy			176	Algeria	6.741	8d	Pliocene and Quaternary alluvial and lacustrine deposits
Yk5-1a	Rc	Yy	petrocalcic	2 815	Algeria	3.272, 6.912	8d	Neogene clayey marl, locally Jurassic and Cretaceous limestone and Quaternary alluvial and lacustrine deposits
Yk5-1a	Rc	Yy	petrocalcic	155	Morocco	3.272	8d	Neogene clayey marl; locally Jurassic and Cretaceous limestone and Quaternary alluvial and lacustrine deposits
Yk6-a	I		stony/petrocalcic	1 367	Morocco	3.23	9a, 9b	Villafranchian: limestone, calcareous marl, sandstone
Yk6-a	I		stony/petrocalcic	200	Spanish Sahara	3.23	9b	Villafranchian: limestone, calcareous marl, sandstone
Yk6-a	I		stony/petrocalcic	2 345	Algeria	3.23	9b	Villafranchian: limestone, calcareous marl, sandstone

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Yk7	I	Yh	petrocalcic	252	Tunisia	3.43	5b	Quaternary alluvial, lagoonal and marine deposits
Yk7-2ab	I	Yh		65	Algeria	6.922	8d	Neogene clayey marl. Quaternary alluvial deposits
Yk10-1a	Yh		saline	215	Libya	3.23	9b	*Continental intercalaire:* sandstone. conglomerate. shale. Quaternary red sand
Yk10-1/2a	Yh		sodic	338	Algeria	6.912. 6.741	8d	Neogene clayey marl. Quaternary alluvial deposits
Yk11-1/2ab	I Rc		petrocalcic	5 142	Algeria	3.24, 3.271. 3.272. 6.912	8d. 9b	Jurassic and Cretaceous limestone. Quaternary alluvial deposits
Yk11-1/2ab	I Rc		petrocalcic	262	Morocco	3.23	9b	Jurassic and Cretaceous limestone. Quaternary alluvial deposits
Yk12-1a	Bk E	Jc Zo		66	Tunisia	3.24	8d	Quaternary alluvial and lacustrine deposits
Yk13-1/2a	Rc Z		shifting sands	385	Libya	3.23, 3.43	6c, 9f	Quaternary alluvial and lagoonal deposits
Yk14-2a	I Jc			891	Algeria	3.24	8d	Quaternary alluvial and lacustrine deposits: some dune cover
Yk15-2a	Yy	Jc Rc	stony	128	Egypt	3.23	9c	Palaeogene nummulitic limestone and quartz gravel
Yk15-2a	Yy	Jc Rc	stony	47 657	Libya	3.23	9a, 9b	Palaeogene nummulitic limestone and quartz gravel
Yk15-2ab	Yy	Jc Rc	stony	1 627	Somalia	3.12	8c	Neogene and Quaternary: marl, calcareous sand. clay
Yk16-2a	I Yy		stony	4 317	Libya	3.23	8d. 9b	Neogene: limestone, marl. gypsum
Yk17	Jc Rc Yy	Zo		237	Libya	3.23	9a	Carboniferous limestone; Palaeogene nummulitic limestone
Yk18-1a	Jc Zo		saline	878	Libya	3.23	9b, 9f	Devonian and Carboniferous: calcareous schist, limestone, sandstone. *Continental terminal:* calcareous sandstone. shale. Palaeogene: limestone. Neogene: limestone. marl. gypsum
Yk19-1/2ab	I Yl	Jc Rc Zg Zo		2 790	Ethiopia	3.12	4b	Palaeogene limestone and marl
Yk19-1/2ab	I Yl	Jc Rc Zg Zo		7 245	Somalia	3.12	4b, 8a	Palaeogene limestone and marl
Yk19-1/2ab	I Yl	Jc Rc Zg Zo	stony	690	Egypt	6.822	9b, 8d	Recent coastal, marine, lagoonal and aeolian deposits
Yk20-1ab	I Rc	Jc Zt	lithic	4 601	Egypt	3.23	9b	Palaeogene limestone
Yk21-1a	Rc	I Zt	stony	1 229	Libya	3.23	8d, 9b	Palaeogene: limestone. Neogene: limestone. marl and gypsum

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Yk21-1a	Rc	I Zt	stony	6 605	Egypt	3.23	9b	Palaeogene: limestone. Neogene: limestone. marl. gypsum
Yk22-1/2ab	I Rc	Yy Zt	lithic	23 644	Egypt	3.21. 3.23. 3.271	9a	Cretaceous: marly and dolomitized limestone. Palaeogene: limestone. Neogene: limestone. marl. gypsum
Yk22-1/2ab	I Rc	Yy Zt	lithic	2 081	Libya	3.23. 3.42	8d	Cretaceous: marly and dolomitized limestone. Palaeogene: limestone. Neogene: limestonc. marl. gypsum
Yk23-1/2a		I Z	stony	333	Angola	3.37. 3.51	9b	Tertiary: limestone. marl. sandstone
Yk24-2/3bc	I	R Z Yy	lithic/ stony	39	Egypt	3.2	9b	Cretaceous: marly and dolomitized limestone. Palaeogene: limestone. Neogene: limestone. marl. gypsum
Yt2-3a	Re			80	Morocco	3.34	8c	Quaternary lagoonal deposits
Yy1-1a				29	Tunisia	3.23	9b	Quaternary alluvial and lacustrine deposits: partial aeolian sand cover
Yy1-1a				650	Algeria	3.23	9b	Quaternary alluvial and lacustrine deposits: partial aeolian sand cover
Yy1-1a			shifting sands	72	Algeria	3.24	9b	Quaternary alluvial and lacustrine deposits
Yy2-1a	Yk			6 622	Namibia	3.43. 3.44. 3.38	9b	Precambrian: limestone and dolomite. Karroo: rhyolite and quartz porphyries
Yy2-1a	Yk		petrogypsic	599	Libya	3.23	6c. 9b	Triassic limestone. overlain with Villafranchian lacustrine deposits and Quaternary alluvial and lacustrine deposits
Yy2-1a	Yk		petrogypsic	529	Tunisia	3.23	6c	Triassic limestone. overlain with Villafranchian lacustrine deposits and Quaternary alluvial and lacustrine deposits
Yy2-2a	Yk		stony	1 269	Mali	3.21	9b	Cretaceous: marine and continental deposits, limestone. shale. sandstone. quartzite, silex
Yy2-2a	Yk		stony	3 555	Algeria	3.21	9b	Cretaceous: marine and continental deposits. limestone. shale. sandstone. quartzite. silex
Yy3	Z			144	Algeria	3.23	9f	Recent alluvial and aeolian deposits
Yy3-a	Z			380	Mauritania	3.11	8c	Recent lagoonal. alluvial and aeolian deposits
Yy3-a	Z			359	Algeria	3.23	9f	Recent lagoonal. alluvial and aeolian deposits
Yy4-1a	Rc			948	Algeria	3.23	9b	Quaternary alluvial and lacustrine deposits, partly covered with aeolian sands
Yy4-1a	Rc		saline	338	Algeria	6.741. 3.24	8d	Neogene clayey marl. Quaternary alluvial and lagoonal deposits

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Yy5-1a		Je I Zo	petrogypsic	843	Tunisia	3.43. 3.24	9b	Quaternary alluvial, lacustrine and lagoonal deposits
Yy6-1a	Re			1 508	Algeria	3.23	9b	Villafranchian: limestone. calcareous marl. sandstone. travertine
Yy8-1a		Yk Yh Zt	petrogypsic	989	Namibia	3.38	9b	Quaternary alluvial and aeolian deposits
Yy8-2ab		Yk Yh Zt	petrogypsic	1 912	Ethiopia	3.12	8c	Palaeogene limestone and marl
Yy8-2ab		Yk Yh Zt	petrogypsic	10 875	Somalia	1.85. 3.12	8c	Palaeogene limestone and marl
Yy9-1a	Re	Zo	petrogypsic/saline	635	Tunisia	3.23	9b	Quaternary lacustrine and aeolian deposits; sand dunes
Yy9-1a	Re	Zo	petrogypsic/saline	36	Algeria	3.23	9b	Quaternary lacustrine and aeolian deposits; sand dunes
Z1-2/3a			sodic	274	Chad	1.534	4g, 8e	Quaternary alluvial and lacustrine deposits
Z4-2/3a	Vp Ws	Qc		403	Chad	1.534	8e	Recent alluvial and lagoonal deposits
Z6-2a	Lg Vp		sodic	1 031	Chad	1.42. 1.915. 1.916	4d. 8e	Quaternary alluvial and lacustrine deposits
Zg3-3a	Zo			224	Egypt	3.24	8e	Recent coastal and lagoonal deposits
Zg3-3a	Zo			514	Algeria	6.912. 6.741	8e	Neogene clayey marl. Quaternary alluvial and lacustrine deposits
Zg6-3a				33	Morocco	6.161, 3.24	8e	Coastal and alluvial deposits
Zg7-1a	Jt Lf			141	Senegal	1.532	8e	Recent lagoonal deposits
Zg8-3a	Rc			9	Morocco	6.1912	8e	Coastal and alluvial deposits
Zg9-3a	Sm Zm	G	sodic	573	Egypt	3.23. 6.822	8e	Recent lagoonal and deltaic deposits. Quaternary alluvial and lacustrine deposits
Zg11-2/3a	Jc Zo			37	Madagascar	1.574	8e	Quaternary lacustrine and alluvial deposits
Zg12-1/2a	Zo	Qa		562	Namibia	4.22	8e	Kalahari: sand. ironstone. chalcedony. Quaternary: lacustrine sediments
Zo2-1a			shifting sands	1 162	Egypt	3.23	9e	Quaternary alluvial and lacustrine deposits; recent aeolian deposits
Zo4-2a	Sg Ws			455	Nigeria	1.916	8e	Quaternary alluvial and lacustrine deposits
Zo5-2/3a	Ws			330	Chad	1.534. 3.22	8e	Recent alluvial deposits
Zo6	Gh Qc			379	Chad	1.534	4h	Recent lacustrine deposits

TABLE 3. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*concluded*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Occurrence	Climate	Vegetation	Lithology
Zo6	Gh Qc			11	Niger	1.534	4h	Recent lacustrine deposits
Zo7-3a	Zg			905	Libya	3.23. 3.43. 6.822	9e	Quaternary alluvial. lagoonal and lacustrine deposits
Zo7-3a	Zg			22	Tunisia	3.43	8e	Quaternary alluvial. lagoonal and lacustrine deposits
Zo7-3a	Zg			61	Algeria	6.163. 6.741	8e	Salt flat (sebkha)
Zo7-3a	Zg		sodic	338	Algeria	3.23	8e	Salt flat (sebkha)
Zo8-3a	Vc			36	Algeria	6.741	8e	Recent alluvial and lacustrine deposits. salt flats (sebkha)
Zo9-3a	So	Jc X Zg		274	Tunisia	6.812	8e	Recent alluvial and lacustrine deposits. salt flats (sebkha)
Zo9-3a	So	Jc X Zg	sodic	3 501	Kenya	1.534. 3.12	4b. 8a. 4g	Quaternary alluvial deposits
Zo9-3a	So	Jc X Zg	sodic	805	Somalia	3.12	3a. 4b. 4g	Recent alluvial deposits. Quaternary alluvial deposits
Zo11-2/3a		Yk Yy		1 145	Egypt	3.23	9e. 9f	Quaternary alluvial and lacustrine deposits
Zo12-		Xk	sodic	319	Ethiopia	3.11	8e	Aden volcanic series: basalt, basaltic breccias. tuff. Quaternary: alluvial and lacustrine deposits
Zo13-2/	Xy Xk	Bc	sodic	238	Somalia	1.534	4b. 8e	Precambrian: metamorphic rocks. Cretaceous: limestone. marl and sand. Quaternary: alluvial deposits
Zo14-1/2a	I	X J		63	Angola	3.37	8e	Quaternary lagoonal deposits
Zo15-1/2a	I			63	Angola	3.37	8e	Quaternary lagoonal deposits
Zo16-3a	Zt		sodic	694	Tunisia	3.23. 3.24	8e	Recent alluvial and lacustrine deposits. salt flats (sebkha)
Zo16-3a	Z Zt		sodic	18	Algeria	3.23	8e	Recent alluvial and lacustrine deposits. salt flats
Zo17-1/2a	Je Zt	Q S		1 131	Botswana	4.22	4e. 8e	Quaternary lacustrine deposits
Zt1				3	Mali	3.21	9b. 9e	Recent alluvial deposits
Zt1			saline	150	Mauritania	3.21	9e	Recent lacustrine deposits
Zt2-2a	Zo		shifting sands	179	Egypt	3.23	9b. 9e	Quaternary alluvial and lacustrine deposits: recent aeolian sand
Zt2-2/3a	Zo			59	Territory of the Afars and the Issas	3.12	9e	Quaternary alluvial and lacustrine deposits
Zt2-3a	Z		sodic	165	Algeria	3.24	8e	Salt flat (sebkha)

TABLE 4. – MISCELLANEOUS LAND UNITS

Miscellaneous land units	Extension (1 000 ha)	Occurrence	Miscellaneous land units	Extension (1 000 ha)	Occurrence
Rock debris or desert detritus	16 648	Algeria	Salt flats (*concluded*)	448	Spanish Sahara
	2 925	Chad		25	Territory of the Afars and the Issas
	86	Egypt			
	4 004	Libya		26	Tunisia
	564	Mali			
	1 770	Mauritania	Dunes or shifting sands	43 717	Algeria
	431	Niger		7 112	Chad
	1 355	Spanish Sahara		16 084	Egypt
	2 844	Sudan		35 589	Libya
				19 717	Mali
				29 280	Mauritania
Salt flats	1 559	Algeria		15	Morocco
	316	Ethiopia		19 075	Niger
	121	Libya		328	Somalia
	420	Mali		309	Spanish Sahara
	920	Mauritania		408	Sudan
	6	Morocco		1 643	Tunisia

6. LAND USE AND SOIL SUITABILITY

The study of African land use and soil suitability is a vast subject which is difficult to treat comprehensively. The main objective of the present study is therefore limited to drawing attention to areas chosen for their geographical interest or high agricultural potential.

Apart from the Nile valley in Egypt, certain irrigated valleys in the Mediterranean zone, the Gezira region in Sudan and some parts of southern and eastern Africa, soil use in the continent mainly consists of shifting cultivation practised in great forests and vast savannas, steppes and deserts. The result of this practice is an agricultural subsistence economy, and temporary fields scattered throughout the bush reflect the density of the population (Figure 7).

South of the Sahara there is a discontinuous but striking series of relatively high population densities at the edges of the Sahel (about 300 to 500 mm of rainfall) and Sudan (500 to 1 200 mm). These densities are markedly over the average of 11 inhabitants/km^2 for the sub-Saharan region (Fitzgerald, 1968). From west to east the highest population densities occur in coastal Senegal, the Niger valley in Mali, Upper Volta (Ouagadougou, Ouahigouya), Hausaland (Kano in Nigeria, Zinder in Niger), the region of the Logone and the Chari, the Darfur region (Jebel Marra, Al-Fashir and Al-Ubayyid), Khartoum and the Gezira region, the Abyssinian high plateaus and the Sidamo region. Less densely populated areas include inland Senegal, southern Mali, northern Guinea, Ivory Coast, Ghana and Benin, the valley of the Niger, the Benue valley in Cameroon, the immense and sparsely populated zones on the borders of Chad, the Central African Empire, Zaire and Sudan. Other sparsely populated regions are southeastern Sudan and the border regions of Kenya and Ethiopia. The population along the west coast of Africa from Senegal to Cameroon is fairly dense.

Southern Cameroon, Gabon, Congo, Zaire and Angola are in general sparsely populated, but this varies from one country to another. There are large depopulated areas in the equatorial forest and on the very poor plateaus on Kalahari sand in Zaire and Angola (Vennetier, 1968).

In eastern Africa population density is high in the lake region (Rwanda, Burundi, southern Uganda, the Kikuyu country in Kenya and the Chagga country to the south of Mount Kilimanjaro in Tanzania).

The southern African countries are thinly populated, with the exception of some parts of Malawi and the South African coast.

In Madagascar there is an exceptionally high density of population and cultivation on the Merina and Betsileo plateaus and a small densely populated area on the southeast coast.

In Africa agricultural planning will have to take into account traditional housing customs and cultural practices which determine diets.

The peoples of northern Africa are accustomed to arid and semiarid environmental conditions. Nomads live in the desert, seminomadic stock breeders on the steppes and settled farmers in the oases and the Nile valley. The latter irrigate their land and use domestic animals for tilling and transport.

The peoples of Africa south of the Sahara show three levels of agricultural experience. The Guineans, the Sudanese and the Bantu people have long been farmers, while the peoples of eastern Africa are primarily livestock breeders. The pygmies, bushmen and Hottentots are hunters to whom agriculture is unknown. As a result of infiltrations of stock breeders from the north and east, the Guineans, Sudanese and Bantus have learned to supplement their shifting cultivation with rudimentary animal husbandry. However, they never use their animals for traction.

In Madagascar the influence of immigrants from Southeast Asia is noticeable in the population's housing, crops and diet. The Malagasies traditionally cultivate irrigated rice and, unlike the other sub-Saharan populations, use their livestock as draught animals.

Balanced crop rotation is not practised by African subsistence farmers. At most, the farmer haphazardly sows a succession of plants or plant associations dictated by his experience and apparent whim. The result is a mosaic of field types which vary greatly over a period of time. Such a pseudo-rotation is aimed at combining crops which will best meet the family's seasonal dietary requirements, and not at attaining a maximum overall production.

Basically this subsistence agriculture can be subdivided into cereal steppe agriculture on savanna and forest agriculture based on vegetative reproduction species. Cereal agriculture is generally associated with livestock raising, which supplies diet proteins. Tribes driven back into the forests by their conquerors have left behind their trypanosomiasis-affected livestock and those cereals which could not be adapted to the new ecological conditions. Vegetative reproduction plants, chiefly bananas and cassava, supply carbohydrates. Proteins and animal fats are attained by hunting and fishing. Forest farmers have, however, developed a crop association system that makes optimum use of the soil and protects it as far as possible against erosion. The simplest example is the pseudo-association of maize, rice, cassava and bananas which evolves into forest fallow.

On the Guinean savanna farmers often plant a pseudo-association of cassava and groundnuts which is followed by another of cassava and beans and then by at least three years of fallow. In many places on the savanna there is no true rotation. Cassava is planted in widely spaced rows and occupies the field for nearly three years; pseudo-associations of groundnuts and maize succeed each other in the open spaces between the rows. When ecological conditions in Sudano-Zambezian savanna become too severe owing to a prolonged dry season, maize is replaced by sorghum and millet and dry-season cultivation is practised in the swamps. This type of traditional agriculture is one of the least advanced. It is therefore not surprising that the yields obtained in Africa are among the world's lowest.

While an increase in yields through better soil use is technically possible, it often proves difficult owing to the complex problems attending the changeover from shifting cultivation to intensive agriculture. Under the present circumstances economics are not taken into account. When intensification of agriculture is undertaken, the chief criterion is profit. According to Jurion and Henry (1969), the main obstacles to the intensification of African agriculture are the economic and human factors, i.e. the changes that must be made in housing, domestic economy, and national and regional infrastructure. They stress that it is necessary to modify not only the system of agricultural and livestock production, but also the structural and material aspects of economic, social, family and personal life.

The many tests performed at various agricultural stations and the experience gained in a number of development projects have led to the following conclusions:

Any increase in food production first requires a proper choice of soil and then a crop rotation adapted to ecological conditions.

When population density is such that the soil can no longer be regenerated by fallow, mineral fertilizers must be introduced. However, the high cost of fertilizers makes this anti-economic unless a cash crop is included in the rotation. The development of a rural economy entails the introduction of a cash crop.

The introduction of a cash crop is simpler in equatorial forest zones than in savanna zones because perennial equatorial crops (rubber, palm, coffee and cocoa) are particularly well adapted to the customs of rural populations, and their introduction entails neither heavy investment nor considerable preparatory work.

In the Guinean savanna, which receives a good rain supply but has a marked dry season, a cotton/food crop rotation has frequently helped to improve the population's living standards.

In the Sudano-Zambezian savanna and the semi-arid steppes ecological conditions are becoming harsh and successful cultivation is erratic owing to the lack of regular rainfall. Traditional agriculture is now based on cereals such as sorghum, eleusine and millet. Under these conditions it is extremely difficult to introduce intensified agriculture, as happened in the unsuccessful Groundnuts Scheme in Tanzania. The improvement of agriculture must be directed at livestock raising in conjunction with a very modest and prudent programme of cultivation. Modern intensive agriculture is possible only where there is good level land and plentiful irrigation water, as in the Gezira region in Sudan.

Agriculture in the arid zones of Africa can be developed only with the use of irrigation. This requires favourable soil conditions and the availability of good-quality water.

The map units must be interpreted on the basis of the prevailing ecological conditions, which have been evaluated according to the system of Papadakis (1967). Such interpretation must also take into account the specifically African context of technological and psychological limitations.

A. Acrisols

Af. Ferric Acricols - Ao. Orthic Acrisols - Ap. Plinthic Acrisols

An examination of the Soil Map of Africa reveals that Acrisols occur most often in the Sudano-Zambezian savanna zone where ecoclimatic conditions tend to be unfavourable to agricultural development. Such regions, with a rainfall of under 1 200 mm, belong to the fersiallitic zone. The Acrisols are found mainly on poor materials (Luvisols of higher base saturation normally develop on richer materials). The soils concerned are therefore mainly poor and are subject to difficult ecological conditions.

Only a few limited areas have been mapped under dense forest in Ghana, Ivory Coast and Cameroon. These profiles are slightly ferralitic and highly desaturated.

Acrisols have a coarse or medium texture; some are petric while others have a petroferric contact. Differences in agricultural value are therefore greater within subgroups than between them.

The Acrisols of northern Cameroon, northern Nigeria, the Central African Empire and Guinea enjoy a hot tropical climatic regime (1.4)[1] with a long dry season; they are covered by a Sudanese-type tree savanna. A poor subsistence agriculture is practised on these soils, which have a below-normal potential for the region. Yam or cassava is grown in association with groundnuts and a little intercrop maize. Cultivation is usually done on ridges.

In eastern Africa most Ferric Acrisols occur in Tanzania under a dry tierra templada climate (1.8). These profiles, like the other Acrisol units in this region and in Angola, are covered with Myombo woodlands and degraded formations such as Zambezian-type tree savannas. Ecological conditions are severe. Subsistence agriculture based on cassava, sorghum, eleusine, beans and some groundnuts and maize is combined with the raising of zebu-type cattle and goats. When the climatic regime evolves toward the humid tierra templada type (1.7) maize rather than sorghum dominates the rotation.

The use of Ferric or Orthic forest Acrisols in Cameroon, Ghana and Ivory Coast likewise varies according to soil characteristics. In coarse-texture zones deep in the forest there is a poor subsistence agriculture based on cassava in association with maize, rice and groundnuts. After two or three years these small fields evolve into forest fallow. Medium-texture profiles under mesophyllous forest often display a greater base saturation in the humus-bearing horizon. The subsistence crop pseudo-rotation is supplemented by banana and cocoa crops.

The suitability of Acrisols must be judged in the light of ecoclimatic conditions, variations in texture and the presence of petric and petroferric horizons while bearing in mind that Orthic Acrisols are more suitable for cultivation than Ferric and Plinthic Acrisols.

In the forest zone of Ghana, Cameroon and Ivory Coast agricultural development would entail the introduction of perennial crops such as cocoa, palm, rubber and coffee. The medium-texture Acrisols, which lack a petroferric horizon but have a humus-bearing horizon of good base saturation, are very suitable for rubber and palm and suitable for cocoa and coffee. They are also suitable for a more intensive cultivation of food crops. Sandy non-petroferric profiles are reasonably suitable for rubber but of little or no suitability for other perennial crops. Units with a petroferric horizon are not suitable for plantations of perennial crops or intensification of food crop production.

However, most Acrisols lie under savanna in areas of unfavourable ecological conditions. Every effort should be made to prevent the establishment of large-scale agricultural modernization projects on these soils. Instead, extensive livestock raising should be developed in conjunction with a modest food crop programme based on cassava, beans, sorghum and eleusine. Groundnuts, cotton or tobacco might eventually be grown on the better soils.

B. Cambisols

Cambisols are found in all the ecological zones of Africa from the equator to the edge of the desert. They are characteristic of a recent stage of soil formation and therefore possess a fairly high potential fertility. However, their use depends essentially on ecological and topographical conditions and their suitability on the management work needed to exploit them.

Bc. Chromic Cambisols

The Chromic Cambisols of the coastal region of Algeria and Libya enjoy a subtropical Mediterranean climate (6.1) and carry olive trees and winter crops such as wheat and barley. The soils of the Algerian High Atlas under a continental Mediterranean climate are likewise used for winter cereals and winter pasture. Under arid conditions in South Africa they are covered by a subtropical steppe with thornbushes; they are used extensively for summer pasture. In Tanzania and Kenya stony Chromic Cambisols occur in hilly areas, and profiles with a petrocalcic horizon are found in undulating terrain. Both are covered by an acacia savanna which is practically unused for agriculture. In Madagascar these soils, some of which are petrocalcic, are covered

[1] The numbers referring to climatic regimes in this chapter correspond to the Papadakis classification system used in the climatic map (Figure 1) and key.

by thorntree steppe. In places they are used for extensive grazing and here and there for growing sorghum and millet.

Chromic Cambisols have a high potential, but in many places hilly relief, stoniness or the presence of a shallow petrocalcic horizon constitute limiting factors. For example, the Chromic Cambisols of Kenya and Tanzania are not suitable for a more intensive cropping. The suitability of non-stony, non-petrocalcic profiles situated in a level or highly undulating terrain depends essentially on ecoclimatic conditions and the availability of irrigation water.

Under a subtropical Mediterranean climate (coastal areas of Algeria and Libya) they constitute excellent soils for wheat, barley, grapes, olives and figs. When irrigated in the summer they are suitable for the introduction of citrus, and for growing cotton and vegetables. Under a continental Mediterranean climate (Algerian Atlas) they are also suitable for winter cereals, grapes, figs and olives. Citrus and vegetables can be cultivated with supplementary irrigation, but cotton no longer flourishes.

Rational exploitation of the Chromic Cambisols of South Africa and southern Madagascar would require the development of irrigation projects. The use of these soils for anything other than extensive livestock raising essentially depends on water resources. With irrigation they would make excellent land for sugarcane, cotton, groundnuts, maize, rice, lucerne and citrus.

Bd. Dystric Cambisols

On the African continent Dystric Cambisols occur in hilly relief in association with Lithosols. Hence in the Ethiopian highlands these areas are not used for agriculture. In Madagascar, however, they occur in relatively flat terrain and are subject to dry climatic conditions under which they have developed from a poor substratum. They are covered by tree savanna and are little used for agriculture.

Dystric Cambisols are poor soils. Efficient cultivation and livestock raising are often impossible because of the hilly topography. In such cases they should be reserved for forest management. In Madagascar, where the relief is gentler, they could be used for extensive livestock raising combined with a subsistence cropping in which the rotation could include groundnuts and tobacco. However, under present conditions these soils are unsuitable for large-scale management projects.

Be. Eutric Cambisols

In Africa Eutric Cambisols occur mainly in the transition zones between subhumid tropical and semi-arid climates, i.e. the tree savannas of Cameroon, Ghana, Ivory Coast, Guinea, Upper Volta, the Central African Empire, Ethiopia, Kenya, Angola, South Africa and southern Madagascar. They are used mainly for extensive grazing.

In equatorial forest Eutric Cambisols occur on rocks rich in ferromagnesian minerals in a dissected topography (Ivory Coast) or in recent alluvia in the western Rift valley (Zaire). The former are preferred for cultivation of food crops and cocoa. In Zaire coffee and food crops are grown under shifting cultivation.

Eutric Cambisols are good soils rich in nutrient elements. Under equatorial conditions they are perfectly suitable for demanding perennial crops such as cocoa and coffee. However, the hilly topography presents problems for annual crops and prevents mechanization. Under a dry climate their exploitation should be directed at extensive livestock raising. If some areas of level relief such as Sudan and Upper Volta could be managed for irrigation, they would constitute excellent ground for sugarcane, rice, groundnuts or cotton.

Bf. Ferralic Cambisols

These soils are generally found in residual terrain in association with Lithosols in the tropical forest zone of Nigeria, Ivory Coast, Liberia and Gabon. Some associations of Ferralic Cambisols and Ferralsols occur in the Guinean savannas.

Ferralic Cambisols constitute the recent phase of ferralitic weathering. They maintain a mineral reserve and their exchange capacity, though lower than that of the other Cambisols, is higher than the capacity of the Ferralsols. They usually have a fine or medium texture. Compared with Ferralsols they are good soils for cocoa, coffee, palm and rubber.

The Ferralic Cambisols of the Guinean savannas occur under ecological conditions that are favourable for *Coffea robusta*, bananas, sisal, maize, rice, sugarcane, groundnuts, cotton and pineapple. However, crop intensification requires the use of mineral fertilizers with a complete balanced formula.

Bg. Gleyic Cambisols

These soils mostly occur in association with Fluvisols and Gleysols. They are extensively used for rain-fed cultivation of food crops, and sometimes for irrigated rice.

Simple drainage work can make Gleyic Cambisols suitable for all rain-fed crops and the establishment of good pastures. Their location also makes them suitable for establishing rice fields.

BH. HUMIC CAMBISOLS

These soils occur in tropical highland zones. In Cameroon they lie under highland forest and carry bananas and subsistence crops. In Ethiopia, Burundi and Uganda they occur under a dry highland savanna. Topography is frequently a limiting factor, particularly on the Ethiopian plateaus, where they are associated with Lithosols. These steeplands are best suited to forest management, but the less steep slopes could be used for tea growing. In Burundi and Uganda Humic Cambisols are good land for *Coffea arabica* and food crops. The steep slopes are more suitable for eucalyptus and cypress plantations.

BK. CALCIC CAMBISOLS

These soils occur in dry climates. They are found under subtropical Mediterranean conditions (6.1) in Morocco, Algeria and Tunisia. The relief is usually undulating, but some units are found in highly dissected mountainous terrain. In the Algerian Atlas they are subject to a continental Mediterranean climate (6.7) and then, changing to desert, the climate becomes semiarid (6.8 and 6.9). Under these conditions they are used for winter cereals and extensive grazing. Olives and figs are also grown, and, less frequently, citrus which sometimes suffer from chlorosis.

In Senegal and Mauritania they occur under a semiarid tropical climate (1.5) and are used for extensive winter grazing and a subsistence agriculture based on sorghum and millet.

In eastern Africa they occur in Uganda and Kenya under a humid tierra templada climate (1.7) and in Tanzania usually under dry tierra templada conditions (1.8). They are covered by a grassy savanna of *Hyparrhenia*, *Themeda* and *Panicum*. Annual subsistence crops consist of millet, sorghum, beans, cassava and sweet potatoes. Shifting cultivation is combined with some livestock raising.

In dry or semidry regions Calcic Cambisols should be used for irrigated agriculture or for ranching. The soil has a good mineral reserve and its suitability depends essentially on texture, which determines water retention capacity, on the possible presence and depth of a petrocalcic horizon, and on topography. Hilly topography and an abundance of calcareous crusts are a handicap to development.

In Morocco, Algeria and Tunisia most of these soils are suitable or very suitable for olive, fig and vine cultivation. Citrus growing is frequently inadvisable due to the high calcium carbonate content.

Medium-texture soils in level to very undulating terrain are perfectly suitable for intensive rain-fed winter cereal cropping and for summer crops (maize, tobacco, vegetables) where irrigation water is available. On light-texture soils, which have a smaller water reserve, a policy of extensive cultivation combined with livestock raising is preferable.

In Senegal, Mauritania and eastern Africa these soils have a good-to-medium fodder value. The main problem is still water supply, and for this reason they are normally used for grazing. Stabling of livestock in well-chosen spots may bring an improvement in essential annual crops, the area of which, however, is necessarily limited.

BV. VERTIC CAMBISOLS

Some Vertic Cambisols occur in alluvial valleys in association with Vertisols and Regosols, and others in residual countryside with Lithosols. They are of some importance in northern Ghana and Nigeria and in several sedimentary basins in Upper Volta, and occur locally in Guinea, Mali, Niger, Benin, Rhodesia and Namibia. They are covered by grassy or tree savanna. In residual terrain they are practically never used for agriculture. Even in valleys this heavy cracked soil is little exploited. In Upper Volta some areas carry a transplanted millet crop.

Vertic Cambisols are poor in organic matter but have a good mineral reserve. They are well endowed with calcium and potassium, but at shallow depth sometimes show a high content of exchangeable Na which makes them alkaline. These soils are difficult to till and are thus often neglected by the local inhabitants.

Without irrigation, agriculture is extensive and based on livestock raising. Rational development requires heavy investment, which is justified on level ground if sufficient irrigation water is available. When irrigated, such soils are suitable for the cultivation of sugarcane, cotton, rice and maize.

E. Rendzinas

In Africa the geographical distribution of Rendzinas is very limited. They occur on a very local scale under semiarid conditions in southern and eastern Africa. In Morocco and Tunisia some larger areas occur under a Mediterranean climate in extremely hilly terrain and are terraced locally and used for winter cereals.

These soils are rich and have a high humus content, but topographical conditions constitute a serious limitation. In hilly country they are suitable only for the cultivation of olives, figs and vines.

Moderate slopes are suitable for winter cereals (wheat and barley) and winter pastures. The development of intensive irrigated agriculture is possible only where topographical conditions are more favourable locally. Under such conditions Rendzinas form excellent soils. However, cultivation of chlorosis-sensitive plants such as citrus is not advisable.

F. Ferralsols

Ferralsols, which represent the final stage of ferralitic weathering, are widely distributed throughout central Africa. These soils, which have a low adsorbing complex and are often highly desaturated and possess no mineral reserve, have a limited potential fertility. The fertilizing elements of Ferralsols are mostly immobilized in the organic matter of the soil and in the plant cover. The clay content, which determines the water and base retention capacity, is also an important yardstick in appraising fertility.

FH. Humic Ferralsols

Humic Ferralsols occur in tropical highland regions and are covered by forest or savanna. At altitudes above 2 000 metres bamboo forest predominates in association with other montane forest groups. These soils are used for subsistence agriculture based on cassava, maize, sweet potatoes, beans, bananas, sorghum and eleusine. Above the 1 800-metre level cassava and bananas are replaced by wheat, barley, potatoes and vegetables. In central Africa there is local cultivation of pyrethrum and cinchona. Tea plantations develop normally, but *Coffea arabica* often shows mineral deficiencies. Agriculture is of the extensive type, and under present conditions fertilizers are not used.

In northeastern Zaire (Ituri), large tracts of these soils occur under *Loudetia* savanna and are never used by farmers. They are highly weathered, deep clayey soils with a positively charged clay. They provide only a very poor range for livestock and present problems of fertility which must be resolved by the agricultural testing services before development can be considered. Apart from the areas covered by *Loudetia* savanna, Humic Ferralsols are suitable for a very prudent introduction of mixed agriculture combining livestock raising and food crops and the use of long-term grazed fallow (five to 10 years). In most cases they are suitable for tea growing. *Coffea arabica* can be cultivated only on small individual plots on which the mulch needed to maintain the fertility of the plantations can be applied every year. The rational introduction of wheat, barley and potatoes in these regions can be undertaken when mineral fertilizers are used. Above an altitude of 2 000 metres these soils are suitable mainly for grazing.

Fo. Orthic Ferralsols

Orthic Ferralsols are widely distributed and typically occur in underpopulated regions under natural plant cover, e.g. rain forest, Guinean savanna and Sudano-Zambezian formations. The population uses them for subsistence crops which are rotated according to local conditions. After carrying associated crops for two or three years, the fields are abandoned and return to fallow. In equatorial forest there are plantations of oil palm, coffee, rubber and sometimes cocoa. In the Guinean savanna zone a cotton/food crops rotation is often practised. The savannas on these soils are also used for extensive grazing.

The chief limitation of Orthic Ferralsols is a low content of fertilizing elements. Under forest, substantial quantities of mineral elements are immobilized in the plant cover, which gives the soils a higher temporary fertility. The savanna Ferralsols are even poorer. In the forest zone (climatic type 1.1) these soils are used primarily for closed-cycle perennial crops which ensure greater conservation of natural fertility. Soil suitability varies with the texture, the depth of the detritus layer and the saturation of the humus-bearing horizon. Deep soils of fine or medium texture and with a humus-bearing horizon of good base saturation are suitable for cocoa, coffee, oil palm and rubber. The same soils with a humus-bearing oligotrophic horizon are suitable for coffee, palm and rubber and less suitable for cocoa and bananas. The poorer sandy clay units are suitable only for rubber.

Under Guinean savanna (climatic types 1.2, 1.4, 1.7), Orthic Ferralsols of fine and medium texture are suitable for a food crops/cotton/groundnuts rotation and for the establishment of coffee and oil palm plantations. The food crops/cotton rotation may be combined with livestock raising. Under present conditions soil regeneration is effected by a natural fallow of several years following each cropping cycle. The productivity of these soils in anthropic and Guinean savanna can be improved by upgrading natural follow, replacing it by soil-improving plants, and using mineral fertilizers. Station tests have furnished a number of guidelines for fertilizer application, but the psychological and technical conditions of the African rural environment are not conducive to the application of the modern methods developed at the stations.

In regions with a marked dry season (the Sudano-Zambezian area of Zaire, the Central African Empire, Angola, Zambia, Tanzania, Mozambique and some parts of Madagascar) ecological conditions are highly unfavourable to agriculture, especially since these Ferralsols constitute a poor substratum. Intensive agricultural development on Orthic Ferralsols in these regions is therefore not advisable. Present use is limited to extensive ranching.

Fp. Plinthic Ferralsols

Plinthic Ferralsols occur locally under forest in Ivory Coast, Cameroon, Liberia and Sierra Leone. In other African countries they are found under savanna. They occur in sparsely populated areas and are largely covered by natural vegetation.

The presence of a petric or sometimes petroferric horizon is a serious limitation. In climatic zone 1.1 silviculture with regeneration and maintenance of forest cover is advisable. Under savanna these poor soils are of little value; they could be used for ranching, but under present conditions exploitation will never be very profitable.

Fr. Rhodic Ferralsols

These soils cover fairly large areas in the savanna regions of various African countries. Present climatic conditions can be highly variable. In the Central African Empire and some regions of Zaire Rhodic Ferralsols occur under a hot tropical climate (1.4). In Cameroon and Angola climatic conditions are of the humid tierra templada type (1.7). In the south (Zambia, Mozambique, Swaziland and South Africa) the climate ranges from semitropical tierra fría (2.1) to medium tierra fría (2.3). In Africa most Rhodic Ferralsols lie under natural vegetation in areas where shifting cultivation is combined with rudimentary animal husbandry. Subsistence agriculture is based on cassava, bananas and maize. Maize is replaced by sorghum in the drier zones. In Rhodesia tobacco is grown and there are a number of irrigated pastures.

The agricultural value of Rhodic Ferralsols is higher than that of other Ferralsols. In climatic zones 1.4, 1.7 and even 1.8 these soils are suitable for coffee, bananas, cotton, maize, groundnuts and traditional crops. Under a cool low- and medium-altitude climate (Malawi, Rhodesia, Mozambique, and Shaba region in Zaire) coffee and bananas cannot be grown, but wheat and sugarcane could be introduced. All these soils are very suitable for the establishment of good pastures and the cultivation of fodder maize and other fodder crops. They react favourably to mineral fertilizers, and the use of a complete formula based on N, P, K, Ca and Mg is recommended.

Fx. Xanthic Ferralsols

In Africa most Xanthic Ferralsols are covered by equatorial forest. Only in Angola, Zambia and Madagascar do they exist in drier conditions under savanna or woodland cover. In equatorial forest shifting cultivation is based on two years of associated crops of bananas, cassava, upland rice and maize followed by forest fallow. On light soils bananas are not included in the pseudo-rotation. There are large plantations of rubber, palm and coffee, but there is relatively little cultivation of cocoa.

These soils have a low base saturation and no mineral reserve. Their fairly low natural fertility depends on their clay content. In the Congo basin Xanthic Ferralsols with a clay content of more than 30 percent are considered very suitable for rubber and oil palm, suitable for coffee and moderately suitable for cocoa. On soils with a clay content of less than 30 percent rubber can be successfully cultivated, but oil palm and coffee develop less well and cocoa cannot be grown. Rubber shows slower development and a drop in production on soils with a clay content of less than 20 percent, especially during dry periods.

Continuous intensive cultivation of annuals is possible if mineral fertilizers are applied. However, the African rural population has not yet reached the stage of development necessary for a systematic utilization of modern methods. Development of Xanthic Ferralsols under savanna presents greater problems because they are poor soils which have often undergone severe erosion. They are mainly suitable for grazing.

G. Gleysols

Although Gleysols show wide variations, they are discussed together because the poor drainage conditions they share constitute an important common limitation. Throughout most of the continent agricultural development has not led to the mobilization of the capital essential for a rational use of these hydromorphic soils.

The Dystric Gleysols of central Africa, especially those of the Congo basin, are covered by swamp forest on a sandy substratum. They are not used for agriculture. In western Africa some Gleysol valleys are used for rice or are drained for growing bananas and other food crops; they are fairly rich soils on recent alluvia (Nigeria, Niger). In many savanna regions swamps are not cultivated and are reserved as extensive grazing for bovines during the dry season. In the highland regions of central Africa, particularly in the densely populated areas of Rwanda and Burundi, dry-season swamp cultivation has become a widespread practice. Extensive rudimentary dry-season drainage permits ridge cultivation of sweet potatoes, maize and beans. After the harvest the waterlogging resulting from rainfall moderates the process of organic matter degradation initiated by cultivation.

The suitability of gley soils varies greatly. Dystric Gleysols under grass cover are relatively easy to drain for dry-season cultivation. More effective drainage may be justified for intensive cultivation if fertilizers are used. Eutric and Mollic Gleysols are typically found in a substratum rich in bases and organic matter. Proper drainage of these soils would make it possible to establish first-class agricultural centres.

Humic Gleysols are often found in swampy zones that are difficult to drain; those under swamp forest in Zaire and Congo are unsuitable for agriculture. Humic Gleysols under papyrus marshes are suitable for rain-fed ridge cultivation after drainage work has been done. Simple rational drainage can be effected in some valleys, and application of fertilizers may make the soils highly suitable for banana growing and intensive agriculture. However, the reclamation of many of these swamps requires considerable agricultural engineering work.

H. Phaeozems

Phaeozems are not widely distributed in Africa. In Morocco they occur in relatively flat terrain under a Mediterranean climate and carry traditional crops based on winter cereals, especially wheat. In Nigeria they are subject to a hot tropical climate (1.9) and are used for extensive grazing and cereal agriculture based on millet and sorghum.

Phaeozems are excellent soils for both traditional and modern agriculture. They have no soil limitations and are very suitable for all crops and for pastures. Seasonal drought is the only limiting factor. The introduction of modern intensive cropping requires additional irrigation in the dry season.

I. Lithosols

The suitability of these soils is limited by dissected topography with steep slopes, and by the rockiness and stoniness of the substratum. These factors generally prevent the practice of traditional agriculture and make agricultural modernization impossible. In the humid tropical region Lithosols on basic rocks and schist show a distinctly higher potential fertility than other soils. The use of these soils for cultivating coffee or cocoa in small individual plots might be justified. In Mediterranean zones some Lithosols are suitable for olives and vines. In most cases Lithosols are not suitable for agriculture and should be left under natural vegetation.

J. Fluvisols

Fluvisols are very important in many African valleys, such as those of the Niger, the Nile, the Senegal, and the Chari. They occupy the best-drained parts of these valleys and usually occur in association with Gleysols, Vertisols and Regosols. In the humid tropics they are more fertile than neighbouring soils. In the semiarid and arid zones water is available and the soils are well situated for irrigation. Fluvisols thus constitute agricultural areas densely occupied by food crops. There are rice fields in the valleys of western Africa, and in Madagascar rice cultivation is even more widespread. Under traditional cultivation Fluvisols (particularly Eutric and Calcaric Fluvisols) constitute good farmland. They are well endowed with exchangeable bases and with total P_2O_5. The adsorbing complex is sometimes mildly saturated with sodium, but in such cases this defect is offset by a wealth of organic matter. In the arid zones they may contain soluble salts.

Dystric, Eutric and Calcaric Fluvisols are all suitable for intensive agriculture. The capital required for management may be substantial, particularly in arid zones where irrigation, sometimes combined with drainage, is necessary for development. The fertilizer formula must match the physico-chemical characteristics of the various soil units. The Dystric subgroups require a complete formula, while Eutric and Calcaric Fluvisols generally show a positive response to nitrogen and phosphorus and do not react to other plant nutrients.

Thionic Fluvisols are particularly difficult to develop owing to formation of toxic elements, high post-drainage acidity, salinity, and often nitrogen deficiency. However, the fine texture, high content of difficult-to-nitrify organic matter and the medium-to-good phosphoric acid content are factors that favour development for rice. These soils are therefore suitable for rice cultivation, which requires complete water control. The alternation of drainage and irrigation must be balanced. Drainage is necessary to eliminate soluble salts, but if pushed too far it can produce excessive acidification by oxidation of sulphides.

K. Kastanozems

These soils, mapped under a tropical Mediterranean climate in Morocco and Tunisia, generally occur in undulating terrain in association with Cambisols, Fluvisols or Vertisols. In hilly relief the associated soils are Lithosols. Traditional agriculture consists of extensive grazing and winter cereals.

Kastanozems are rich, have an extremely high humus content and are well endowed with nutrient elements. They are very suitable for traditional agriculture and suitable for the intensification of winter cereal cropping. They can also be used for vines, olives and figs. With appropriate irrigation they are very suitable for cotton, vegetables and fruit trees with the exception of citrus, which may suffer from chlorosis on Calcic Kastanozems.

L. Luvisols

Of the wide variety of Luvisols shown on the Soil Map of Africa, the most representative soil units are the Chromic and Ferric Luvisols. The former occur mainly in the Mediterranean and semiarid tropical zones, where Orthic and Albic Luvisols are also found locally. Ferric Luvisols, like Gleyic and Plinthic Luvisols, correspond mainly to the tropical zone with a long dry season. All these profiles occur under tree savanna or woodland in the fersiallitic pedoclimatic zone. Most Luvisols occur under unfavourable ecoclimatic conditions, and the irrigation water needed for intensification of agriculture is often lacking. These soils are therefore best suited for extensive livestock raising combined with the cultivation of essential food crops.

Lc. Chromic Luvisols – Lo. Orthic Luvisols

In Morocco and Algeria Chromic and Orthic Luvisols are used for winter cereals and olive groves. These soils are good for traditional agriculture. Lack of water is the main obstacle to development of intensive agriculture.

South of the Sahara Chromic Luvisols are covered by a tree savanna which often includes thorntrees. They occur fairly extensively in northern Nigeria and in Rhodesia, Zambia, Swaziland and South Africa, mostly under a semitropical climate with a long dry season (2.1 and 2.2). These regions are sparsely populated and exploitation is limited to essential food crops such as cassava, maize, sorghum and eleusine combined with some livestock raising. In Rhodesia these soils are used for ranching and tobacco growing.

These Luvisols are good and well provided with bases, but are relatively poor in organic matter and phosphorus. The greatest problem is insufficient water supply, which prevents the intensification of agriculture. Hence these soils are best suited for livestock raising combined with the cultivation of essential food crops, which must be kept to a minimum. The cultivation of groundnuts, tobacco and cotton could be developed in the better areas where rainfall is more plentiful and regular, and sugarcane could be grown with irrigation.

Lf. Ferric Luvisols – Lg. Gleyic Luvisols – Lp. Plinthic Luvisols

Most of these Luvisols occur under a hot tropical climate (1.4) with a marked dry season, or under a semiarid tropical climate (1.5). Luvisols under these conditions mapped in Nigeria, Cameroon, Benin, Togo, Ghana, Ivory Coast, Guinea, Senegal, Upper Volta, Chad, Mali, the Central African Empire, Uganda and Mozambique carry a subsistence cereal agriculture based on sorghum and millet. When the rainy season is a little longer (1.4), maize, cassava and bananas are also grown. In eastern Africa (Kenya) and southern Africa (Zambia, Rhodesia, Malawi), Ferric Luvisols occur under humid (1.7) and dry (1.8) tierra templada climates or semitropical and low tierra fría climates (2.1 and 2.2).

Ferric Luvisols are more severely weathered than Chromic Luvisols and are thus characterized by a clay fraction with a low exchange capacity. They are well saturated with cations but are usually poor in organic matter. Their fertility depends on texture, ironstone content and the possible presence of a shallow petroferric horizon.

The development and intensification of agriculture are also impeded by the water supply problem. The soils and ecological environment mainly favour livestock raising. The cropping possibilities, which must be combined with livestock raising, depend on the severity of the dry season. Under a hot tropical climate (1.4) the rainy season is long enough to ensure a successful food crop rotation. Under these conditions rotation should be carefully managed by introducing cotton and groundnuts or tobacco and replacing natural fallow by an improved grazed fallow or a soil-improving plant.

When the dry season is longer (1.5 and 1.9) ecological conditions become too erratic to assure successful crops. As the savanna has good-to-medium fodder value, the best soil suitability is grazing. Any intensification of livestock raising would depend on the results of a study of reaping methods and preservation of fodder in the form of silage and hay. Stabling of livestock at well-chosen points can lead to an improvement in essential annual crops, which will nevertheless have to be limited in area.

N. Nitosols

In Africa Nitosols occur under forest or savanna in dissected terrain with a humid tropical climate. They are typical of the intermediate stage of ferralitic weathering on materials of fine or medium texture. In some countries of western Africa (Cameroon, Nigeria) slightly ferralitic soils on coarse materials in a highly undulating topography also show Nitosol characteristics. The weathering stage of Nitosols makes them more fertile than Ferralsols. In general, they still have a small mineral reserve and their adsorbing complex also displays a higher exchange capacity. Each soil unit shows specific utilization characteristics.

ND. Dystric Nitosols

In all ecological zones the rural population prefers these soils to Ferralsols for cultivation of food crops. Even very steep slopes are cultivated. On the whole, they are soils of medium value. Because of their topographical position, development under forest is easier than under savanna. In forest zones the introduction of a perennial crop provides better protection against erosion. They are good soils for rubber and palm, and also for coffee, a more demanding plant. Only units with a high humic base saturation are suitable for cocoa.

If traditional food crop cultivation is to be improved, an effort must be made to control erosion. The main obstacle to a modernization of agriculture based on the rotation of annuals is a difficult topography which often prevents mechanization. These soils react favourably to mineral fertilizers, and the use of a complete formula based on N, P, K, Ca and Mg is recommended.

NE. Eutric Nitosols

Eutric Nitosols are widely used for food crops. They have a high potential fertility and rank among the best soils of the tropics. In the forest zones of Nigeria and Cameroon Eutric Nitosols constitute the best soils for cocoa. In savanna areas they are suitable for coffee and oil palm when the dry season does not exceed four months. For traditional cultivation an attempt should be made to control erosion.

The modernization of agriculture based on annuals is often difficult because steep slopes prevent mechanization. These soils react favourably to nitrogen and phosphate fertilizers and do not need cationic elements.

NH. Humic Nitosols

Humic Nitosols occur in tropical highland zones, mostly under a humid tierra templada climate (1.7) and sometimes under a drier climatic regime (1.8).

The population densities of these regions are often high and the soils are densely occupied by food crops such as bananas, cassava, beans and maize, and by sorghum and millet in the drier parts. When climatic conditions are not too dry, coffee and tea are grown and livestock raising, ranging from extensive ranching to a more intensive dairy breeding, is practised.

Humic Nitosols are considered good agricultural soils. Under a cool dry tropical climate agriculture should be directed at livestock raising with animal stabling at well-chosen points to facilitate improvement of essential food crops by manuring. Under a cool humid climate the possibilities are greater. Moderate slopes are very suitable for traditional agriculture with a crop rotation supplemented by beans, bananas and maize. The soils are also suitable for *Coffea arabica* and very suitable for tea. *Coffea arabica* sometimes suffers from mineral deficiencies. Research has shown that the ideal balance between the Ca-Mg-K cations in the soil is approximately 75-18-7, with a minimum content of 0.7 me/100 g of soil for K. At altitudes exceeding 1 900 metres excellent pyrethrum harvests are obtained. Steep slopes should be reserved for forest management.

O. Histosols

Large areas of organic soils have been mapped in Ivory Coast, Congo, Zaire, Zambia, Malawi and Madagascar. In some smaller areas Histosols occur in association with Humic Gleysols. The soils occur in large swampy areas and are always poorly drained.

Dystric Histosols are covered by swamp forests or papyrus marshes, while a plant association dominated by phragmites often develops on Eutric Histosols. Under present conditions these soils are not used because permanent waterlogging prevents effective drainage. Dystric Histosols are poor soils deficient in cations and trace elements. After drainage they are suitable for pineapple. Although Eutric Histosols are developed from a substratum richer in cations, their deficiency in trace elements must be remedied.

The main problems for development of these soils are drainage, which is difficult and very costly, and subsidence after drainage.

P. Podzols

Podzols, in particular Humic Podzols, may develop on Kalahari and coastal dune sands under the influence of an acid humus produced by a particular vegetation and a high water table. These soils occur in association with Arenosols, Regosols and Gleysols.

Their low fertility is due to their leached surface horizon, insufficient water retention capacity, deficient cation exchange capacity, acidity, and deficiencies in phosphorus, sulphur and microelements. The main land use is extensive grazing. All remaining forest must be protected. Under specific conditions, i.e. after forest clearance and under hot and humid climates, it is possible to grow special crops, such as vanilla on support trees. Along the seacoasts Podzols are locally used for coconut or filao plantations.

Q. Arenosols

In Africa vast regions are occupied by Arenosols. Cambic and Luvic Arenosols occur mainly in dry regions, while Ferralic Arenosols belong to a more humid zone. Whereas the geographical distribution of Arenosols according to ecological conditions necessitates separate treatment of Ferralic Arenosols, Cambic and Luvic Arenosols are discussed together as their places of occurrence and utilization are similar.

Qc. Cambic Arenosols – Ql. Luvic Arenosols

In the dry, semiarid and arid tropical zones there are vast regions occupied by Cambic and Luvic Arenosols, which generally occur in level or highly undulating terrain. Cambic Arenosols of hilly relief associated with Lithosols and shifting dunes are observed only in Ethiopia, Somalia and Kenya.

Plant cover varies according to climatic conditions. Tree savanna occurs in hot tropical (1.4) and semiarid tropical (1.5) zones where precipitation exceeds 500 mm, and tree steppe in areas with less rainfall. Subdesert steppe occurs in areas with less than 200 mm of rainfall and gradually develops into a virtually vegetationless desert formation in regions with less than 50 mm.

These regions are occupied by stock breeders who practise extensive animal husbandry. The alluvial soils bordering valleys offer the best agricultural opportunities, but are little cultivated. Inland they carry some scattered crops of little millet, red millet and sometimes beans.

These soils are generally poor in organic carbon, nitrogen, exchangeable bases and P_2O_5. The pH is slightly acid at the surface and increases with depth.

Luvic and Cambic Arenosols have some fodder value and are suitable for grazing. Essential annual crops can be improved with manure from stabled livestock. A prudent development of groundnut cultivation may be considered where rainfall exceeds 500 mm.

Qf. Ferralic Arenosols

These Arenosols cover extensive areas in southern Zaire and in Angola. Considerable areas are also found in Ivory Coast, Ghana, the Central African Empire, Chad, Congo, Zambia, Tanzania and Kenya. They occupy old plateaus in tropical zones with a highly variable dry season. They are covered by Guinean tree savanna, pseudosteppe, Sudano-Zambezian woodland and Sudanese savanna.

Farmers cultivate the best soils in the depressions around sandy plateaus, and further inland they use Arenosols for a meagre subsistence agriculture determined by the nature of the sand and by ecological conditions. On the Kalahari plateaus in Zaire and Angola (climatic types 1.7, 2.1 and 2.2), the only crops that can be grown by traditional methods are pearl millet, voandzeia and cassava. The yield from these plants is particularly low: 400 to 700 kg/ha for millet, 500 to 750 kg/ha for voandzeia and 3 to 10 tons of fresh tubers for cassava. Groundnuts are cultivated only on former village sites. Ferralic Arenosols on other types of sand in Guinean conditions (climatic types 1.2, 1.3) produce more satisfactory yields of groundnuts and cassava, and maize and upland rice are also grown. Some plateaus are used for extensive livestock raising.

Ferralic Arenosols are poor soils; the clay content is usually below 10 percent, the organic matter content is very small and the acid pH reveals the very low content of exchangeable bases.

These soils are not suitable for modern agriculture. Their only suitability is extensive livestock raising. Since the feeding value of savannas and steppes on Ferralic Arenosols is low and is characterized by mineral deficiencies or imbalances, the raising of bovines is impossible without feed supplements. If livestock are to be kept in good condition they must have a complete mineral mixture at all times. Under such severe conditions only small hardy breeds, such as the N'Dama, or N'Dama × Dahomey crosses, can flourish.

R. Regosols

Some dune formations in the deserts and along the coasts contain Calcaric Regosols. Large areas lie in Algeria, Egypt, Ethiopia, Somalia and Kenya. Other mantles of recent sand deposited in desert and semiarid tropical zones are not calcareous. Eutric Regosols, which are very important, are found in Mali, Mauritania, Libya and Algeria. They often occur in association with lithic and petroferric formations, or with shifting dunes.

All these Regosols occur under natural vegetation of a floristic composition and cover determined by climatic conditions. In the desert there are a number of isolated plants, including a grass (*Aristida*) which develops after the rains. Acacias, some scattered tussocks of perennial grasses and *Aristida* occur in the subdesert zone. Under a semiarid tropical climate (1.5) an open vegetation of perennial and annual grasses develops between trees and bushes. Seminomadic stock breeders use these formations as winter ranges for their herds.

In some areas of the Mediterranean zone of northern Africa peaches and citrus are grown under sprinkler irrigation. The suitability of these soils is extremely limited, but if the prevailing conditions are favourable to irrigation the cultivation of fruit trees, groundnuts and tobacco may be considered.

Dune formations with Dystric Regosols occur in the tropical coastal zones of Africa. These soils are particularly well developed in Sierra Leone, Liberia, Ivory Coast, Ghana, Nigeria, Angola, Tanzania and on the east coast of Madagascar. They are covered by forests or savannas and are used for coconut palm. Further inland the Dystric Regosols of the humid tropical zone are extremely acid. They carry only cassava and pineapple, as well as groundnuts and maize around habitations. In equatorial forest these Regosols carry rubber plantations as well as oil palm, which suffers from serious nitrogen and mineral deficiencies.

The suitability of Dystric Regosols is extremely limited and management in areas where conditions are favourable is beyond the possibilities of African rural populations. Rational exploitation should be based on forestry and possibly on the coconut palm.

S. Solonetz

Orthic Solonetz are widely distributed in the semiarid and arid regions of Chad and Somalia. A large area straddles the Angolan-Namibian border under a monsoon subtropical climate (4.2). Some Solonetz beaches occur on the Tunisian coast. The chief activity of the populations of these regions, particularly in Chad and Somalia, is livestock raising, so Solonetz soils are almost entirely used for extensive grazing. In Chad the slightly sodic calcareous types carry wheat, little millet and maize. On the alkali types some millet is cultivated locally. These soils are of restricted suitability for traditional agriculture and are rarely cultivated because of the difficult soil conditions and the indifference of the population, whose main occupation is livestock raising.

The advisability of introducing intensive agriculture through irrigation work basically depends on the possibility of replacing exchangeable sodium with calcium and preventing the rise of saline and alkaline groundwater. Up to the present the problems of managing Solonetz soils have seldom been solved satisfactorily because in the regions concerned it is difficult to find good-quality irrigation water and establish an efficient drainage system, which must be combined with the irrigation system in order to leach the sodium and prevent saline groundwater from rising. Pasture management could be carried out by introducing alkali-tolerant species.

T. Andosols

Andosols occur in the volcanic regions of Cameroon, Zaire, Rwanda, Uganda, Kenya, Tanzania and Ethiopia. Mollic or Humic Andosols occur in highland regions above 1 500 metres altitude while Ochric Andosols, and exceptionally Vitric Andosols, are found at lower elevations.

TM. Mollic Andosols – TH. Humic Andosols

Highland Andosols show a wide degree of saturation depending on rainfall.

In Cameroon, where they occur under forest, they tend to be desaturated. The region is particularly suitable for tea growing. Mollic and Humic Andosols occur in the highlands of Zaire. The well-watered western slope of the Kivu ridge has a sequence of Mollic and Humic Andosols determined by distance from the volcanoes. In this terrain, which is extremely hilly and covered by tropical forest, shifting cultivation is based on bananas, beans and cassava. There are also some tea plantations. The eastern slope of the ridge is also very hilly but is drier and covered by Mollic Andosols. In this densely populated region dotted with food crops and *Pennisetum* fallow, livestock raising and cultivation of *Coffea arabica* are practised.

In Uganda, Tanzania and Kenya Andosols occur around Mounts Elgon, Kenya and Kilimanjaro. Up to an altitude of 1 800 metres these regions are densely populated and soils are of the Mollic type. Under a montane forest and especially at altitudes exceeding 2 000 metres, heavy desaturation occurs and the soils become humic. The main crops are bananas, beans, peas, potatoes and vegetables. Livestock raising and cultivation of *Coffea arabica* and tea are also practised in these regions.

Highland Andosols show considerable potential fertility. The agricultural value of Mollic Andosols is higher than that of Humic Andosols. In both cases topography is the chief limitation, as it prevents mechanization and requires substantial erosion control work.

Mollic Andosols are excellent soils for bananas, beans, vegetables, potatoes and wheat. At altitudes below 1 800 metres they are particularly suitable for the cultivation of *Coffea arabica*. Humic Andosols are particularly suitable for tea growing; above 2 000 metres conditions are extremely favourable for pyrethrum and the establishment of pastures based on Kikuyu grass (*Pennisetum clandestinum*). Barley, potatoes and vegetables also flourish.

To. OCHRIC ANDOSOLS

Ochric Andosols have been mapped in Ethiopia, Kenya and Tanzania. In the latter two countries they extend as far as the massif of Mount Kilimanjaro.

These soils occur under a relatively dry climate (types 1.8 and 1.7) and are covered by *Hyparrhenia*, *Themeda*, *Panicum* and *Setaria* savannas. Annual crops are mainly sorghum, millet, beans, sweet potatoes and cassava, with some cotton and groundnuts. Livestock raising is highly developed and the cultivation of *Coffea arabica* is fairly widespread, particularly in Tanzania (climatic type 1.7).

The Ochric Andosols of Kenya and Tanzania have a level-to-undulating topography. These excellent soils are suitable for the modernization and intensification of agriculture and livestock raising. In Ethiopia the relief is hillier and the climate (1.8 and 2.3) too dry for coffee and tea growing. These soils should be used for livestock raising and, in favourable spots, for intensification of food crop cultivation.

V. Vertisols

In many African valleys there are large areas of Vertisols. They occur especially in regions with a long dry season and are absent from the humid ferralitic zone. They are particularly well represented in Morocco, Upper Volta, Chad, Sudan, Ethiopia, Tanzania, Somalia and South Africa.

Vertisols, mainly the Pellic unit, are sometimes slightly inundated by river floods or submerged by the rain water which accumulates in poorly drained depressions. The natural vegetation is generally grass savanna with *Themeda triandra* predominating on soils from which the floods have receded, and a floristic composition depending on the intensity and duration of inundations. In certain areas (e.g. Chad) these soils are covered by a tree savanna dominated by almost pure stands of Seyal acacia when flooding is slight. Grass cover dominants are *Schoenefeldia gracilis* in dry places and Andropogoneae in flooded zones.

These very heavy and difficult-to-work soils are rarely used for traditional agriculture as the population practises livestock raising and prefers to use them for extensive pasturage. In Chad, Upper Volta and Mauritania "Berber millet" (millet grown on seasonally flooded ground) is cultivated locally. In Sudan irrigated Vertisols carry cotton, sorghum, *Lubia*, wheat and groundnuts. Wheat, barley, clover and cotton are grown in Morocco. At the Lufira experiment station in southern Zaire cotton, sugarcane, rice, wheat and lucerne have been grown successfully.

While Vertisols qualify as good cotton soils by virtue of their chemical properties, their exploitation entails resolving certain difficulties. Account must be taken of the soils' physical and chemical conditions, i.e. a clay texture with low permeability, the possible concentration of exchangeable Na which may make them alkaline, and the sporadic occurrence of patches of saline-alkali soils.

Exploitation therefore requires a combined irrigation and drainage system and the choice of a rotation or of crops suited to alkaline conditions, i.e. cotton, sugarcane, rice, sorghum, barley, berseem clover and dates. It is possible to improve the soil structure by applying green fertilizer, but this is a difficult and time-consuming process. Conditioners with a gypsum base can improve physical properties by reducing the exchangeable Na/Ca ratio.

When an area is put under cultivation, cropping practices must be directed at conserving infiltration water during the dry season and drainage water during the rainy season.

Since savanna on Vertisols provides good pasture, it is often preferable to reserve these soils as pastureland rather than set up management projects which are both expensive and economically unprofitable.

Thus, every case of Vertisol exploitation requires a thorough study of soils, water resources and drainage potential.

W. Planosols

Both Eutric and Solodic Planosols are found in Africa. The former are well represented in Morocco, and both subgroups are geographically widespread in Chad, Senegal, Mali, Upper Volta, Niger and South Africa.

Owing to their topographical position and the presence of a B horizon of fine and impermeable texture, these soils are often flooded during the rainy season. In most cases they are used by a stock raising population as dry-season pasture. Rice is cultivated locally with the use of natural flooding and millet is sometimes planted at the end of the rainy season.

The suitability of Planosols is fairly specific because the presence of an impermeable B horizon creates special hydric conditions. These soils are particularly suitable for use as rice fields. In Chad, Upper Volta and Niger lack of water is a serious limitation precluding the intensification of agriculture.

Under present African conditions the development of extensive livestock raising is recommended. Locally improved pasture management could be attempted by implementing light surface drainage during the rainy season and by replacing natural vegetation with an artificial pasture composed of grasses and pulses. By controlling natural flooding it might be possible to develop and improve rice cultivation in certain places during the rainy season.

X. Xerosols

Xerosols occur on the edges of the Sahara and the Kalahari and in eastern Africa. They are often difficult to use because of drought and the lithic, stony or petrocalcic nature of the terrain.

In semiarid Mediterranean zones (Morocco, Algeria, Tunisia and Libya) they are used for extensive winter pasture, and in favourable spots some winter cereals (wheat, barley) are grown. South of the Sahara and in Ethiopia, Somalia and Kenya Xerosols are used almost entirely for grazing. Places with a favourable topographical situation which accumulate run-off during the rainy season carry sorghum, millet and beans. Livestock raising on Xerosols differs from that practised in the more humid steppes; as the climate becomes drier, bovines are replaced by sheep and goats.

In a few places irrigation districts have been established on deep Xerosols (e.g. the Karroo in South Africa). The use of Xerosols for unirrigated cultivation is confined to crops with a very short growth cycle, and even under these conditions the success of the crops is threatened by irregular rainfall. For this reason soil use must be based on extensive sheep raising, and cultivated seedbeds should be kept to a strict minimum. Such extensive livestock raising is also limited because regeneration of the thin grass cover is very slow and its development is restricted to a short rainy period. Irrigation of Xerosols is mainly hampered by a shortage of water. However, even if water is available the soils often present serious problems due to the presence of impermeable petrocalcic or argillic B horizons that prevent the vertical or lateral flow of drainage water. However, Xerosols of deep profile and medium texture are very suitable for irrigation.

The content of nutrient cationic elements is always high, and excessively high contents of soluble salts may complicate the use of fertilizers in saline areas. Deficiencies in trace elements such as zinc and iron are common. Rational exploitation of these soils entails the use of nitrogen and phosphate fertilizers.

Y. Yermosols

Yermosols cover enormous areas in the Sahara (Mauritania, Spanish Sahara, Algeria, Tunisia, Libya, Mali, Niger, Chad, Sudan and Egypt) and in the arid regions of eastern Africa (Somalia, Ethiopia and Kenya). They are less extensive in the Kalahari desert (Angola and Namibia).

In the African deserts human occupation, agriculture and livestock raising are concentrated on Fluvisols and Vertisols, soils associated with Yermosols, which are suitable for the establishment of irrigation plots.

Plant cover on Yermosols is absent or very sparse, and these soils are virtually unused. During the winter extensive livestock raising is limited to areas around oases, although most pastoral activity is practised on the associated soils, i.e. Fluvisols and Vertisols.

Yermosols are suitable neither for traditional agriculture nor for the development of intensive modern agriculture. Suitability is limited by many factors, especially lack of water. Even when water is available, agricultural development is limited by stony, lithic or petrocalcic soils, salt crusts and the presence of shifting dunes. Such soils are therefore generally unsuitable, even with irrigation.

Z. Solonchaks

Orthic and Gleyic Solonchaks are fairly widespread in the semiarid and arid zones of Senegal, Niger, Nigeria, Morocco, Algeria, Tunisia, Libya, Egypt, Ethiopia, Somalia, Kenya, Angola, Botswana and Madagascar. Takyric Solonchaks are mapped more locally in Ethiopia, Egypt, Algeria, Mauritania and Mali.

The use of many Gleyic Solonchaks is limited by a heavy sodium saturation. In the least-affected areas farmers using the traditional furrow irrigation technique have been successful in leaching some of the salts from the soils. Desalination occurs in the furrows and on the slopes as salts accumulate on the ridge tops, and salt-tolerant plants are planted on the slopes. In some places, particularly in the Chélif plain in Algeria, cotton growing has been quite successful on these soils. However, most Solonchaks are unsuitable for traditional agriculture, as salinity is too great for cultivation to be possible with the partial leaching achieved by traditional methods.

Management of Solonchaks is often difficult because of their location in closed basins where there is no possibility of drainage. Their development thus depends on the possibility of leaching by abundant irrigation and draining of surplus water to carry away the salts.

Conclusions

This study of the suitability of African soils shows that all production factors are seldom at optimum level. When ecoclimatic conditions are favourable soils are either poor in fertilizing elements or have topographical limitations. As the climate becomes drier and ecological conditions less favourable, the soil colloidal complex grows richer in cationic elements.

In the equatorial forest zone, where mainly Ferralsols and Dystric Nitosols occur, development of a rural economy based on the major perennial crops is fairly simple. The main problem is to adapt crop requirements to soil conditions. For instance, rubber and oil palm demand less from soils than coffee and cocoa. In the equatorial zone production of annual crops can be intensified by introducing a complete mineral fertilizer formula. The chief obstacles to development of this zone are the technological and psychological limitations of the rural population. In this phytogeographical unit the forests in broad swampy valleys are unsuitable for development and are little used.

The ecological zone of the Guinean savannas contains mainly Ferralsols and Dystric Nitosols. Some perennial crops such as rubber and cocoa are no longer successful in this zone, but conditions are still suitable for coffee and oil palm, and cotton growing has become well established. The raising of bovines could be promising if trypanosomiasis is controlled. The prospects for development of a rural economy in the savannas are less favourable than in forest zones, but the obstacles are not insurmountable. Rainfall is sufficient for two crops, and the selection of cropland is an important factor. A food crops/cotton rotation can be introduced on suitable soils. Intensification of crop production can be effected by replacing fallow with a soil-improving crop and by introducing a complete mineral fertilizer formula.

Ecological conditions become difficult in the Sudano-Zambezian zone under dry savanna or open Myombo forest. The Ferralsols and Acrisols in this zone are quite unsuitable for development. Luvisols, Eutric Nitosols and Cambisols, which are chemically richer and have a larger mineral reserve, are more suitable, but their use is limited by insufficient rainfall. Extensive livestock raising and cultivation of meagre cereal crops are practised on the plateaus. In this zone extensive livestock raising should be developed on Luvisols, Eutric Nitosols, Cambisols and Arenosols, and tobacco and groundnuts could be cultivated on the better units. Intensification of agriculture must be centred on Fluvisols, Vertisols and Gleysols in alluvial valleys, where supplementary irrigation and the use of nitrogen and phosphorus fertilizers can increase crop yields.

At present the continent's semiarid region (where precipitation is less than 500 mm) has a large population whose food needs far exceed the present agricultural supply. It is absolutely necessary to stimulate agricultural production. An endeavour should be made to create new irrigation plots on alluvial soils (Fluvisols, Vertisols, Gleysols) or on deep Xerosols of medium texture in level country. Like the Luvisols, Cambisols and Arenosols of this semiarid zone, the other Xerosols should continue to be used for extensive livestock raising which, if possible, should be rationalized without intensification.

Valleys in arid zones, where rational irrigation could be effected with a minimum of engineering work, have been under traditional irrigation for many years. The development of still-unoccupied valleys poses special problems, but technical experts are usually able to overcome these difficulties if the soils and water are of good quality. Agriculturists and skilled farmers have succeeded in creating favourable agricultural conditions at experiment stations and some well-supervised plots, and the results obtained from crops such as cotton, citrus, rice, sugarcane, vegetables and beets have been spectacular. Although these experiments have yet to be applied on a larger scale, it is hoped that one day they will lead to the development of all arid plains.

When arid and semiarid land is developed it is essential to bring about an optimum interaction of all the factors involved in the production process, i.e. soil, irrigation, drainage, plant varieties, fertilizers, insecticides and fungicides. If one of these factors is lacking for want of funds, the project may be a total failure.

The tropical highland region is a special ecological zone comprising mainly Humic Ferralsols, Humic Nitosols and sometimes Mollic or Humic Andosols. It often must feed a very dense population, and agriculture consists of livestock raising and cultivation of food crops. The intensification of food production could be stimulated by the use of mineral fertilizers and the replacement of natural fallow by a shorter grazed fallow. The right crops for the development of a rural economy are *Coffea arabica*, tea and, at altitudes exceeding 1 900 metres, pyrethrum.

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APPENDIX

MORPHOLOGICAL, CHEMICAL AND PHYSICAL PROPERTIES OF AFRICAN SOILS: DATA FROM TYPICAL PROFILES

In this Appendix descriptions and analytical results are presented on soils representing several of the major soil units that occur as dominant or associated soils on the Soil Map of Africa. These data help us to arrive at a better definition of the nature of the soil units used in the map, but do not show the range of characteristics within a major unit. However, if these descriptions and analyses are compared with the definitions in Volume I, they will help to establish the concepts on which the legend is based.

For each unit only one profile is described. Reference is made to the work in which the data are published, as sources are extremely varied. Where established standards such as the U.S.D.A. *Soil survey manual* (U.S. Soil Conservation Service, 1951), the *Guidelines for soil profile description* (FAO, 1968) or the *Glossaire de pédologie* (ORSTOM, 1969) have been used, there is no difficulty. In other profiles there may be some uncertainty in the definition of terms, and care in interpretation is needed.

Presentation of data

Whenever possible the data have been taken from the original documents without alteration. However, some changes have been made for the sake of brevity or uniformity of presentation.

SITE DESCRIPTION

Location: Profiles are located by the distance and direction from an inhabited place or a road, and often by latitude and longitude.

Altitude: The altitude is given in metres above sea level. Where it is not shown in the original document it has been added and the profile situated on a contour map.

Physiography: The terms used to describe landscape vary according to the author. Standardization among profiles is very poor.

Drainage: No reference is made to a specific code, but there is often a synthesis of run-off, permeability, infiltration and internal soil drainage.

Parent material: Parent rock is often given under this heading.

Vegetation: If information is insufficient, only the type of plant cover is given in general terms, e.g. shrubby savanna, forest.

Climate: Rainfall, temperature and the length of the dry season have been given where possible. Reference can be made to the Papadakis climates by using latitudinal and longitudinal coordinates to pinpoint profiles on the climatic map (Figure 1).

PROFILE DESCRIPTION

The soil horizon designations have been rewritten to conform to the definitions given in Volume I.

ANALYTICAL METHODS

When considering analyses it is important to know the method used. In Africa there is a certain uniformity in the methods described. Exceptions are indicated in the text or directly on the analytical table.

pH is usually measured in a 1:2.5 soil/water suspension, but sometimes 1:5 or 1:1 is used. Measurements in N KCl or $Cacl_2$ are given where available.

Exchange capacity (CEC) and exchangeable bases (TEB): the choice of method used is very important as it may cause a soil to change from one unit to another (e.g. Luvisol to Acrisol). In Africa, many countries determine the cation exchange capacity (CEC) by means of ammonium acetate at pH 7. However, for some profiles described it is determined at pH 8.2. South Africa uses the Mehlich method: $Bacl_2$-triethanolamine at pH 8.2 which generally gives a higher value for CEC. Zaire used to employ Ca absorption to determine

CEC and exchangeable bases were determined by extraction with HCl N/20.

Carbon and nitrogen: the Walkley-Black and Kjeldahl methods are used by all laboratories except in the case of Calcic Xerosols and Orthic Solonetz, in which carbon is determined by dry combustion. Organic matter is calculated from carbon.

Mechanical analysis: the pipette method is usually used, but the Chromic Cambisol, Chromic Luvisol, Eutric Planosol and Humic Ferralsol profiles have been analysed by the Boyoucos hydrometer method. The textural classes are international classes unless otherwise specified on the analytical tables.

Total phosphorus is generally extracted by perchloric attack except in the case of Eutric Gleysols, where total P and K have been extracted with magnesium acetate at 550° and dissolved by concentrated HCl.

Available phosphorus is determined by numerous methods as indicated in the analytical tables.

Soluble salts are generally determined in a 1:5 soil/water extract, except in the case of Eutric Gleysols, where soluble cations are determined in the saturation extract.

Electrical conductivity (EC) is that of saturated paste expressed in mmhos/cm at 25°C.

The total elements are extracted with boiling concentrated nitric acid for five hours.

Triacid attack is used to determine the $\frac{SiO_2}{Al_2O_3}$ molecular ratio.

Total iron is determined by HCl, free iron by the Deb or D'Hoore method (Ferralic Arenosol and Humic Cambisol), amorphous iron by the Segalen method.

Total $CaCO_3$ is determined by the volume of CO_2 released by an acid attack, active $CaCO_3$ by the Drouineau method.

Gypsum is dissolved in water and precipitated by acetone.

Hénin indices: K is the laboratory permeability on a reworked sample in cm/h. "Is" is the index of structural instability which includes a flocculation index.

LIST OF SOIL PROFILES

FERRIC ACRISOL	**Af**
Modal rejuvenated ferralitic soil	Madagascar
Reference	F. Bourgeat, *Sols sur socle ancien à Madagascar*, p. 286. Paris, ORSTOM, 1972
Location	East of Moramanga
Altitude	932 m
Physiography	Upper Tertiary plateau dissected by existing hydrographic system; profile taken from narrow shelf with a slight 5 to 10% slope
Drainage	Impeded at depth
Parent material	Migmatite
Vegetation	Dense bush of *Philippia* sp., *Helichrysum* div., *Aristida* div., bracken
Climate	Tropical, little contrast; rainfall 1 500 mm; temperature 19.4°C; two dry months

Profile description

Ah	**0-15 cm**	Yellowish brown (10YR 3/2) moist clay humus horizon; some small (a few mm) weathered minerals; structure of ill-defined clods with strong very fine crumb substructure, high degree of structuring; strong cohesion; very strong porosity; very good rooting; at the surface some scattered weathering residues with an ironstone crust; abrupt transition to the next horizon.
E	**15-40 cm**	Yellow (7.5YR 7/8 dry) reddish yellow (5YR 7/8 moist) clay horizon; shiny crystalline quartz; subangular blocky breaking to granular; slightly compact *in situ*; low to medium porosity; weak rooting; gradual boundary.
Bt	**40-60 cm**	Yellowish red (5YR 7/8 dry, 2.5YR 5/8 moist) clay horizon; stronger medium blocky structure tending toward massiveness; less compact than the previous horizon; pronounced tubular porosity; indurated elements (weathering residues and root-shaped gibbsitic concretions) appearing reworked but not arranged in stone lines; clear boundary.
Bg	**60-90 cm**	Reddish yellow (7.5YR 7/8 dry, 5YR 5/8 moist) clay horizon with rust mottles of ill-defined boundary; shiny quartz and fine black iron and manganese concretions; strong blocky; shiny ped faces and strong cohesion; fairly high porosity between the peds, low or zero within them.
BCg	**90-130 cm**	Light red (2.5YR 5/8 dry, 2.5YR 4/8 moist) clay horizon with redder mottles and some yellowish streaks; some unidentifiable minerals at the bottom; strong medium blocky; shiny ped faces; exceptional degree of structuring; strong cohesion; low porosity.
Cg	**130-290 cm**	Purplish red (10R 5/3 dry, 10R 4/3 moist) clay horizon with rust mottles; rich in loam and decomposing minerals; coarse blocky; medium to low porosity.
C	**> 290 cm**	Pale red (10R 6/4 dry and 10R 5/8 moist) silty clay horizon rich in unidentifiable minerals.

FERRIC ACRISOL

Horizon	Depth cm	pH H₂O	pH KCl	CEC	TEB	% BS	Ca	Mg	K	Na	Al	H	$CaCO_3$ %
		pH		Cation exchange me %									
Ah	0—15	4.8		13.1	0.43	3	0.12	0.12	0.125	0.068			
E	15—40	5.0		3.9	0.27	7	0.07	0.16	0.023	0.016			
Bt	40—60	4.9		1.9	0.25	13	0.05	0.17	0.015	0.016			
Bg	60—90	4.8		2.4	0.20	8	0.05	0.14	0.010	0.005			
BCg	90—130	4.9		2.0	0.30	15	0.05	0.20	0.029	0.021			
Cg	130—290	4.9		1.6	0.20	12	0.05	0.14	0.006	0.005			
C	>290	4.9		1.3	0.24	18	0.05	0.16	0.004	0.030			

Horizon	Sol. salts	Organic matter				Particle size analysis %						Flocc. index
		% C	% N	C/N	% OM	stones	c. sand	f. sand	silt	clay	texture	
Ah		5.9					12.0	6.4	22.5	48.1		
E		0.9					11.2	5.0	15.5	59.8		
Bt							15.7	5.2	9.3	68.5		
Bg							12.3	4.0	19.4	51.3		
Bcg							13.3	7.0	21.0	55.2		
Cg							7.1	6.2	45.4	42.1		
C							11.4	8.2	48.6	30.0		

Horizon	Total elements in me/100 g											
	Ca	Mg	K	Na								
Ah	0.4	2.2	0.26	0.07								
E	0.6	2.7	0.19	0.17								
Bt	0.8	4.8	0.10	0.02								
Bg	1.6	1.8	0.08	0.08								
BCg	1.2	1.5	0.10	0.02								
Cg	1.9	0.5	0.12	0.08								
C	1.2	7.7	0.06	0.48								

Horizon	Triacid attack											
	Ignition loss	SiO_2	Fe_2O_3	Al_2O_3	TiO_2	$\frac{SiO_2}{Al_2O_3}$						
	Percent											
E	18.7	14.6	14.6	32.6	2.8	0.8						
Bt	17.5	18.0	13.2	33.7	1.9	0.8						
Bg	15.9	25.0	11.2	32.6	1.4	1.3						
BCg	14.2	29.9	10.1	33.0	1.4	1.5						
Cg	14.0	30.3	17.9	33.6	4.1	1.5						
C	14.1	31.9	15.3	32.9	1.8	1.6						

GLEYIC ACRISOL	**Ag**
Strongly desaturated ferralitic soil, typical group, hydromorphic subgroup	Ivory Coast
Reference	SOGETHA, *Etude pédologique dans la région de Ferkessedougou,* Annexes, profile 418. Ivory Coast, Ministère du Plan, 1967
Location	Loop of the White Bandama, north of the bridge on the Ferkessedougou-Korhogo road; 9° 39'N, 5° 19'W
Altitude	
Physiography	Intermediate terrace of the Bandama, seldom flooded
Drainage	Medium internal drainage; profile slightly permeable as a whole
Parent material	Old alluvia
Vegetation	Park savanna
Climate	Tropical continental; rainfall 1 340 mm; five dry months

Profile description

Ah	**0-10 cm**	Very dark (10YR 3/2) grey-brown humus horizon, sandy clay loam; fresh; medium granular structure associated with a moderate subangular blocky structure; many very large disconnected pores (alveoli); common pores; friable; abundant roots and fine roots; clear smooth boundary.
Bg1	**10-70 cm**	Horizon of yellowish red (7.5YR 5/6) clay consistence; common, very prominent red mottles sometimes slightly indurated, some grey mottles; medium subangular blocky; few pores; slightly hard (dry); sparse roots and fine roots; clear wavy boundary.
Bg2	**70-90 cm**	Red-brown (5YR 4/4) sandy clay loam; fresh; some small indistinct mottles of diffuse red-ochre boundary; medium subangular; common pores; friable; sparse roots, some fine roots; clear smooth boundary.
BCg1	**90-115 cm**	Pseudogley horizon; pale brown (10YR 6/3) sandy clay loam with common large mottles with a diffuse red-ochre boundary; some pale grey mottles; strong medium blocky; few pores; friable; sparse roots, some fine roots; clear smooth boundary.
BCg2	**115-150 cm**	Pseudogley horizon; light grey (10YR 7/2) sandy clay loam; moist; abundant clearly distinguishable medium red-ochre mottles (friable concretions); medium blocky; few pores; sticky and plastic; friable; some roots.

GLEYIC ACRISOL

Horizon	Depth cm	pH		Cation exchange me %									CaCO$_3$ %
		H$_2$O	KCl	CEC	TEB	% BS	Ca	Mg	K	Na	Al	H	
Ah	0—10	6.4		18.3		27	3.6	1.0	0.24	0.11			
Bg1	10—70	5.3		12.0		5	0.3	0.1	0.11	0.09			
Bg2	70—90	5.5		12.2		7	0.4	0.3	0.13	0.09			
BCg1	90—115	5.7		11.0		5	0.2	0.2	0.10	0.10			
BCg2	115—150												

Horizon	Sol. salts	Organic matter				Particle size analysis %						Total P$_2$O$_5$ ppm
		% C	% N	C/N	% OM	stones	c. sand	f. sand	silt	clay	texture	
Ah		3.51	0.18	19		0	16	21	27	35		198
Bg1						0	12	18	17	53		
Bg2						0	12	15	27	44		
BCg1						0	21	14	22	43		
BCg2												

ORTHIC ACRISOL **Ao**

Griffin form, Griffin series	South Africa
Reference	J.J. van der Eyk, C.N. Macvicar, J.M. de Villiers, *Soils of the Tugela basin*, p. 169. Natal, Town and Regional Planning Commission, 1969
Location	Mooi river; 29° 08'S, 29° 59' 30"E
Altitude	1 524 m
Physiography	Undulating; profile taken from upper part of hill
Drainage	Impeded at depth
Parent material	Beaufort shale
Vegetation	*Themeda* and *Trachypogon* grassland
Climate	Rainfall 900 mm

Profile description

Ah	**0-33 cm**	Moist; very dark greyish brown (10YR 3/2) clay loam; strong fine subangular blocky; porous; friable; gradual smooth boundary.
AB	**33-48 cm**	Moist; dark yellowish brown (10YR 4/4) clay loam; structureless; porous; friable; gradual smooth boundary.
E	**48-79 cm**	Moist; yellowish brown (7.5YR 5/6) clay loam; structureless; porous; friable; very small hard iron concretions; clear smooth boundary.
Bt	**79-117 cm**	Moist; red (2.5YR 4/6-4/8) silty clay; structureless; porous; friable; gradual wavy boundary.
BC	**117-130 cm**	Identical with above but with many fine red (10R 4/8) and yellowish brown (10YR 5/6) speckles which are traces of weathered shale; diffuse smooth boundary.
C	**130-183+ cm**	Moist; variegated red, pink, yellowish brown and greyish brown weathered Beaufort shale with stratified structure preserved; silty clay.

ORTHIC ACRISOL

Horizon	Depth cm	pH		Cation exchange me % — $BaCl_2$ - triethanolamine pH 8.2										$CaCO_3$ %
		H_2O	KCl	CEC	TEB	% BS	Ca	Mg	K	Na	Al	H		
Ah	0—33	5.5		14.2	4.8	34	2.8	0.9	1.2	0.0				
E	48—79	5.2		8.6	1.5	18	0.4	0.5	0.7	0.0				
Bt	79—117	4.9		9.3	2.3	25	0.8	0.7	0.8	0.0				
C	130-183+	5.0		8.2	3.5	43	1.6	1.7	0.3	0.0				

Horizon	Sol. salts	Organic matter				Particle size analysis %						Flocc. index	CEC clay
		% C	% N	C/N	% OM	stones	c. sand	f. sand	silt	clay	texture		
Ah		2.1	0.18				4	30	32	35			41
E		0.7	0.19				4	28	29	39			22
Bt		0.2	0.05				2	24	25	49			19
C		0.1	0.04				1	25	31	43			19

PLINTHIC ACRISOL **Ap**

Moderately desaturated ferralitic soil, typical group, yellow subgroup Ivory Coast

Reference SOGETHA, *Etude pédologique dans la région de Ferkessedougou*, Annexes, profile No. 412. Ivory Coast, Ministère du Plan, 1967

Location 13 km southwest of Ferkessedougou; 9° 31'N, 5° 17'W

Altitude

Physiography Glacis with slope of under 2%

Drainage Medium internal drainage; profile slightly permeable as a whole

Parent material Detritus material derived from ironstone mixed with a material due to weathering of Birrimian flysch

Vegetation Shrubby savanna

Climate Tropical continental; annual rainfall 1 340 mm, fairly irregular; five dry months (November to March); average temperature for March 29.4°C and for August 25.3°C; low relative humidity; evapotranspiration about 1 525 mm

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Profile description

Ah	**0-10 cm**	Dark brown (7.5YR 3/2) sandy clay humus horizon, stony at the surface; dry; moderate medium crumb structure associated with a moderate subangular structure; numerous alveoli, very numerous pores; slightly hard; abundant roots and fine roots; clear smooth boundary.
Bt1	**10-60 cm**	Horizon of red-brown (5YR 5/4) sandy clay loam consistence; dry; slightly gravelly; medium subangular; common pores; slightly hard; few roots and fine roots; clear smooth boundary.
Bt2	**60-95 cm**	Yellowish red (5YR 5/6) sandy clay loam; dry; very gravelly; granular; numerous alveoli; weakly coherent material; sparse roots, some fine roots; clear wavy boundary.
Bsm	**95-120 cm**	Moderately indurated ironstone (plinthite).

PLINTHIC ACRISOL

Horizon	Depth cm	pH		Cation exchange me %									Total P_2O_5 ppm
		H_2O	KCl	CEC	TEB	% BS	Ca	Mg	K	Na	Al	H	
Ah	0—10	6.3		5.3	2.6	49	1.6	0.8	0.16	0.05			225
Bt1	10—60	5.5		6.3	1.2	18	0.6	0.4	0.11	0.05			
Bt2	60—95	5.6		7.2	1.6	21	0.9	0.5	0.12	0.06			
Bsm	95—120												

Horizon	Sol. salts	Organic matter				Particle size analysis %						Flocc. index
		% C	% N	C/N	% OM	stones	c. sand	f. sand	silt	clay	texture	
Ah		0.87	0.69	12	1.59	0	37	39	13	11		
Bt1						13	20	30	15	32		
Bt2						61	18	24	15	41		
Bsm												

CHROMIC CAMBISOL	**Bc**
Shortlands form, Shortlands series	South Africa
Reference	J.J. van der Eyk, C.N. Macvicar, J.M. de Villiers, *Soils of the Tugela basin*, p. 215. Natal, Town and Regional Planning Commission, 1969
Location	Bergville-Winterton; 28°44'N, 29°23'E
Altitude	1 097 m
Physiography	Ecological region: moist interior basin (southern) hill countryside; profile on crest
Drainage	Normal
Parent material	Fine-grained dolerite dyke
Vegetation	*Themeda* and *Hyparrhenia* grassland (moist facies)
Climate	Annual rainfall 790 mm; average temperature 17°C with maximum of 21°C in January and minimum of 10.8°C in July

Profile description

Ah	**0-23 cm**	Dry; very dark brown-grey (10YR 3/2) clay loam; medium subangular; hard; some dolerite pebbles at lower limit of horizon; clear smooth boundary.
Bw	**23-76 cm**	Slightly moist; dark reddish brown (2.5YR 3/4) clay; strong fine subangular blocky; moderately porous; slightly firm; gradual smooth boundary.
BC	**76-112 cm**	Slightly moist; reddish brown (2.5YR 4/4) clay; increasing number of speckled white, yellowish red inclusions of weathered dolerite; slight to moderate fine blocky; porous; fairly firm; clear smooth boundary.
C	**112-132+ cm**	Slightly moist; strong brown (7.5YR 5/6) speckled white, reddish brown and black with a fine lacework of reddish brown clay; coarse sandy loam; spheroidally weathered dolerite; friable to slightly hard; porous.

CHROMIC CAMBISOL

Horizon	Depth cm	pH		Cation exchange me % — $BaCl_2$ - triethanolamine pH 8.2									$CaCO_3$ %
		H_2O	KCl	CEC	TEB	% BS	Ca	Mg	K	N	Al	H	
Bw	23—76	6.0		18.3	15.6	85	7.9	7.1	0.3	0.3			
BC	76—112	6.2		31.9	31.9	100	16.8	14.4	0.3	0.4			
C	112—132	7.1		21.1	35.8	100	21.1	14.0	0.2	0.5			

Horizon	Sol. salts	Organic matter				Particle size analysis %						Flocc. index	CEC clay
		% C	% N	C/N	% OM	stones	c. sand	f. sand	silt	clay	texture		
Bw		0.8					2	17	15	65			28
BC		0.4					10	26	26	40			80
C		0.1					41	24	22	14			155

EUTRIC CAMBISOL	**Be**
Eutrophic brown soil	Ivory Coast
Reference	Marc Latham, *Notice explicative de la carte pédologique de reconnaissance au 1 : 200 000, Séguéla*, p. 25. Abidjan, ORSTOM, 1969
Location	10 km from Séguéla on the Séguéla-Séfié road; 8° 00'N, 6° 40'W
Altitude	
Physiography	Hilltop
Drainage	Good
Parent material	Amphibolic schist
Vegetation	Shrubby savanna
Climate	Rainfall 1 352 mm; water deficit in the dry season about 500 mm (November to May)

Profile description

Ah	**0-10 cm**	Brown-grey (10YR 4/1) clay horizon; strong crumb; moist; friable; many roots and fine roots; clear smooth boundary.
AB	**10-30 cm**	Brown clay horizon containing many pieces of weathered rock; quartz pebbles; firm; moist; strong fine blocky; many roots and fine roots; clear smooth boundary.
Bw	**30-85 cm**	Heavy red-ochre clay horizon; firm; moist; strong fine blocky; no roots or fine roots; many pieces of reddish to ochre weathered rock with black mottles; gradual smooth boundary.
BC	**85-120 cm**	Heavy ochre clay horizon with olive (10YR 4/4) glints; moist; firm; strong medium blocky; no roots; much weathered rock debris; gradual smooth boundary.
C	**120-150 cm**	Greenish silty clay horizon caused by rock weathering.

EUTRIC CAMBISOL

Horizon	Depth cm	pH		Cation exchange me %									$CaCO_3$ %
		H_2O	KCl	CEC	TEB	% BS	Ca	Mg	K	Na	Al	H	
Ah	0—10	6.6		29.3	30.9	100	18.61	11.45	0.80	0.04			
Bw	40—50	5.8		14.3	12.9	90	7.58	5.28	0.04	0.04			
BC	100—110	6.4		20.6	25.0	100	12.36	12.60	0.03	0.04			

Horizon	Sol. salts	Organic matter				Particle size analysis %						Flocc. index
		% C	% N	C/N	% OM	stones	c. sand 2-0.2	f. sand 0.2-0.5	silt 0.5-0.02	clay	texture	
Ah		4.96	0.49	10.2	8.5	0	9.6	11.9	43.8	34.4		
Bw		0.47	0.04	12.3	0.8	7.3	22.7	17.9	32.0	23.4		
BC						7.1	9.0	10.9	39.6	37.7		

Horizon	Total bases				Total P_2O_5 ppm	$\frac{SiO_2}{Al_2O_3}$	Free Fe %	Total Fe %
	Ca	Mg	K	Na				
Ah	34.3	52.8	2.4	0.50	640	2.28		
Bw	29.2	15.7	0.4	0.40		1.92	7.0	14.3
BC	27.3	10.7	0.5	0.65		2.29	7.6	12.8

FERRALIC CAMBISOL	**Bf**
Tropeptic Haplorthox (tentative), Segbwema family	Sierra Leone
Reference	S. Sivarajasingham, *Soil and land use survey in the eastern province. Report to the Government of Sierra Leone*, p. 54, 67. FAO/EPTA Report No. 2584
Location	Mano junction to Segbwema junction, path from Niahun village southwest
Altitude	About 350 m
Physiography	Very high hills; profile near the middle of a very steep 23% slope
Drainage	Good
Parent material	Residual weathering of granodiorite
Vegetation	Upland rice on a clearing of low succulent to woody herbaceous vegetation with many wild oil palms
Climate	Rainfall about 2 500 mm from May to November; harmattan blows from December to February; short dry season in July or August; fairly constant temperature of 25.5°C to 28°C

Profile description

Ap	**0-32 cm**	Dark brown (7.5YR 5/6) gritty, sandy clay loam; no gravel; strong fine subangular blocky and granular; medium density and porosity; friable; slightly sticky and slightly plastic; common fine and medium roots; clear smooth boundary.
AB	**32-70 cm**	Red to light red (10R 4/6-4/4), heavy sandy clay loam; no gravel; slightly gritty; strong medium subangular blocky; porous; friable; slightly sticky and slightly plastic; some fine roots; gradual smooth boundary.
Bs	**70-150 cm**	Red (2.5YR 4/6) with some coarse red (10R 7.5R 4/6) mottles; clay loam texture with white specks of decomposing feldspar; no gravel; strong medium subangular blocky; porous; friable; slightly sticky and slightly plastic; some fine roots; diffuse smooth boundary.
C	**150-235 cm**	Red (2.5YR 4/8 and 10R 4/8 in equal amounts) present as coarse faint mottles and containing white decomposing feldspar and black decomposing hornblende; sandy clay loam texture; no gravel; light fine subangular blocky; porous; non-sticky, slightly plastic; some fine roots.

FERRALIC CAMBISOL

Horizon	Depth cm	pH		Cation exchange me %									$CaCO_3$ %
		H_2O	KCl	CEC	TEB	% BS	Ca	Mg	K	Na	Al	H	
Ap	0—30	4.8		10.65	1.81	17	0.96	0.44	0.06	0.35			
Bs	70—150	5.3		6.86	0.54	8	0.05	0.13	0.04	0.03			
C	150—235	5.5		6.00	1.44	24	0.05	0.10	0.07	0.08			

Horizon	Sol. salts	Organic matter				Particle size analysis %						Flocc. index
		% C	% N	C/N	% OM	stones	c. sand	f. sand	silt	clay	texture	
Ap						22.8	37.8	26.8	9.0	26.8		
Bs						11.4	24.3	26.4	15.9	33.8		
C						8.5	34.6	25.8	16.8	23.4		

Horizon	Total				Kaolin	Gibbsite	Quartz	Illite
	%CaO	$\%K_2O$	$\%F_2O$	P ppm				
Ap	0.189	1.27	5.5	240	70—100	5—20	5—20	1—5
Bs	0.017	0.50	7.7		70—100	5—20	5—20	
C	0.018	1.89	4.8		70—100	5—20	5—20	

GLEYIC CAMBISOL	**Bg**
Aquoxic Dystropept, Soubre series	Ivory Coast
Reference	Development and Resources Corporation, *Soil survey of the southwest region,* Technical Appendix. New York, 1967
Location	About 10 km west of Soubre along the Sassandra river; 5° 50'N, 6° 40'W. Same soil along the Cavally river
Altitude	
Physiography	Level or slightly undulating river terraces (differences in level of under 10 m); 0 to 2% slope
Drainage	Poor
Parent material	Relatively recent alluvial sediments of fairly fine texture
Vegetation	Broken forest and thicket
Climate	Average rainfall between 1 600 and 1 700 mm; average air temperature 26°C

Profile description

Ah	**0-5 cm**	Very dark (10YR 3/2) greyish brown sandy loam; fine crumb structure; fairly hard (dry); very friable (moist); non-plastic, non-sticky; many very fine and fine inped and exped roots; many very fine dendritic pores; abrupt smooth boundary.
AB	**5-13 cm**	Dark brown (10YR 3/3) sandy loam with some fine greyish brown (10YR 4/2) mottles; weak fine subangular blocky; fairly hard (dry); very friable (moist); non-sticky, non-plastic; abundant very fine, fine and medium roots; many very fine dendritic pores; clear smooth boundary.
Bg1	**13-35 cm**	Yellowish brown (10YR 5/4) sandy loam with some faint to distinct brownish grey (10YR 6/2) mottles; medium subangular blocky; fairly hard (dry); friable (moist); non-sticky, slightly plastic; many medium and fine roots; many very fine pores; gradual smooth boundary.
Bg2	**35-60 cm**	Yellowish brown (10YR 5/6) sandy loam with common distinct brownish grey (10YR 6/2) mottles; medium subangular; gradual smooth boundary.
Cg1	**60-78 cm**	Light brownish grey (10YR 6/2) sandy loam with very large distinct yellowish brown (10YR 5/6) mottles; subangular blocky; hard (dry); friable (moist); slightly sticky and slightly plastic; many very fine and medium pores; clear smooth boundary.
Cg2	**78-150 cm**	Light brownish grey (10YR 6/2) sandy loam with many large yellowish brown (10YR 5/6) mottles; medium subangular blocky; other characteristics identical with previous horizon.

GLEYIC CAMBISOL

Horizon	Depth cm	pH		Cation exchange me %									$CaCO_3$ %
		H_2O 1/1	KCl	CEC	TEB	% BS	Ca	Mg	K	Na	Al	H	
Ah	0—5	6.5	5.2	11.3	6.0	53	3.7	1.5	0.45				
AB	5—13	4.6	3.8	5.9	0.7	12	0.2	0.1	0.27				
Bg1	13—35	4.6	3.9	4.5	0.4	10	0.1	<0.1	0.20				
Bg2	35—60	4.7	3.8	5.4	0.5	8	0.1	<0.1	0.19				
Cg1	60—78	4.9	4.0	4.3	0.5	12	0.1	0.1	0.21				
Cg2	78—150	5.2	3.9	5.0	0.7	14	0.1	0.2	0.22				

Horizon	Sol. salts	Organic matter				Particle size analysis %						Flocc. index	Apparent density	Porosity %	Total P ppm
		% C	% N	C/N	% OM	stones	c. sand	f. sand	silt	clay	texture				
							.... *Total*								
Ah		2.8	0.20	14	4.8		82.2		5.8	9.0			1.7	36	195
AB		1.0	0.07	14	1.7		81.2		7.9	10.6			1.7	36	120
Bg1		0.3	0.02	11	0.6		77.3		8.5	13.9			1.7	36	83
Bg2		0.2	0.03	8	0.4		77.1		8.3	14.3			1.8	32	73
Cg1		0.2	0.03		0.4		75.7		6.6	14.1			1.8	32	104
Cg2		0.2	0.03		0.3		76.2		4.5	19.0			1.7	36	103

HUMIC CAMBISOL	**Bh**
Lithosolic Ferrisol	Zaire
Reference	A. Pécrot & A. Leonard, *Notice explicative de la Carte des sols et de la végétation, Dorsale du Kivu,* p. 104. Bruxelles, INEAC, 1960
Location	Eastern slope of the Luholo; 2° 05'S, 28° 30'E
Altitude	1 170 m
Physiography	Hilly profile taken from mid-slope; 60% slope; southwest exposure
Drainage	Good
Parent material	Weathering of granite rock
Vegetation	Secondary forest
Climate	Rainfall about 2 200 mm a year and average temperature of coldest month about 22°C; seasonal variations slight

Profile description

Ah1	**0-13 cm**	Very dark brown-grey (10YR 3/2) clayey sand; moderate medium crumb; strong root activity; loose; non-plastic, non-sticky; diffuse boundary.
Ah2	**13-28 cm**	Dark grey-brown clayey sand; micaceous and with fine gravel; weak medium to coarse crumb with blocky elements; strong root activity; friable; non-plastic; gradual smooth boundary.
Bw	**28-60 cm**	Brown (10YR 5/3) gravelly clayey sand; micaceous, with humus infiltration; moderate medium to coarse blocky with fairly continuous greyish coatings; medium root activity; fairly firm *in situ*; non-plastic, non-sticky; diffuse boundary.
C	**> 60 cm**	Clayey micaceous fine gravel caused by granite weathering.

HUMIC CAMBISOL

Horizon	Depth cm	pH		Cation exchange me %										CaCO$_3$ %
		H$_2$O	KCl	CEC (Ca)	TEB	% BS	Ca HCl N/20	Mg	K HCl N/20	Na	Al	H		
Ah1	0—13	4.7		8.3			1.4		0.11					
Ah2	13—28	4.9		6.0			1.0		0.06					
Bw	28—60	4.5		4.8			1.1		0.04					
C	>60	4.5		4.8			1.1		0.03					

Horizon	Sol. salts	Organic matter				Particle analysis %						Flocc. index	Free Fe$_2$O$_3$ %	P Truog ppm
		% C	% N	C/N	%O M	stones	c. sand	f. sand	silt	clay	texture			
Ah1		1.94	0.260			26.8	42.1	19.4	8.9	29.6			2.2	7
Ah2		1.50	0.185			42.9	51.7	17.0	7.9	23.4			2.1	6
Bw		0.46	0.079			47.9	54.2	17.0	8.2	20.6			2.8	1
C		0.23	0.040			41.0	57.4	15.2	4.6	22.8			2.8	1

CALCIC CAMBISOL **Bk**

Calcareous brown soil Algeria

Reference	T.G. Boyadgiev, *Les sols du Hodna*. Rome, FAO, 1972 (Unpublished)
Location	Algiers-Tablat road, 2.5 km before Sohane village
Altitude	840 m
Physiography	Mountainous
Drainage	Normal
Parent material	Highly weathered schist
Vegetation	Aleppo pine and holly oak
Climate	About 800 mm annual rainfall

Profile description

Ah1	**0-8 cm**	(10YR 3/3) moist; loam; granular; common roots; gradual boundary.
Ah2	**8-25 cm**	Idem, with some calcareous pseudomycelia; clear boundary.
Bwk	**25-41 cm**	(10YR 5.5/3) dry and (10YR 5/3) moist; silt loam with some pieces of weathered rock; massive; common roots; worm casts; clear boundary.
CBk	**41-70 cm**	More yellowish weathered schist with pockets of silt loam.

CALCIC CAMBISOL

Horizon	Depth cm	pH		Cation exchange me %									CaCO₃ %
		H_2O	KCl	CEC	TEB	% BS	Ca	Mg	K	Na	Al	H	
Ah1	0—8	7.6					9.4	3.2	0.25	1.0			18
Ah2	8—25	7.7					12.5	0.5	0.25	0.9			17
Bwk	25—41	8.0					12.5	1.0	0.25	1.0			28
CBk	41—70	8.1					3.1	0.5	0.25	0.9			27

Horizon	Sol. salts	Organic matter				Particle size analysis %						Flocc. index
		% C	% N	C/N	% OM	stones	c. sand	f. sand	silt	clay	texture	
Ah1		1.58	0.21	7	2.68		26	12	35	21		
Ah2		1.62	0.21	7	2.75		20	10	41	24		
Bwk		0.48	0.57	8	0.81		13	10	56	15		
CBk							21	8	51	15		

HUMIC FERRALSOL Fh

Humic soils of the high lava plateau	Cameroon
Reference	P. Hawkins & M. Brunt, *The soils and ecology of west Cameroun. Report to the Government of Cameroun.* Appendix Vol. II, p. 335. FAO/EPTA Report No. 2083, Rome, 1965
Location	Dzeng village; 6° 13'N, 10° 49'E
Altitude	2 015 m
Physiography	Rolling topography; hill about 30 m high; sample taken from halfway up hill; 7% slope
Drainage	Well drained; runoff only when rains are very heavy and then rapid
Parent material	Basalt
Vegetation	*Sporobolus* and bracken with annual plants forming low sparse cover between tufts of *Sporobolus*; used for grazing
Climate	2 000 mm to 2 500 mm rainfall; cold (maximum 20°C, minimum 13°C); misty

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Profile description

A	**0-17 cm**	Dark reddish brown (5YR 2/1.5) loam; fine granular with peds of about 1 mm; very friable; heavy root density; many fine grass roots and thicker bracken roots; clear boundary.
Bh	**17-65 cm**	Clay loam with some reddish brown (5YR 3.5/4) gravel; massive; non-sticky, non-plastic; few roots; irregular boundary.
Bs	**> 65 cm**	Dark red (2.5YR 3/6) gravelly clay; rare roots; massive; some small soft, possibly bauxitic, concretions of 10YR 5/8 colour.

HUMIC FERRALSOL

Horizon	Depth cm	pH		Cation exchange me %									CaCO$_3$ %
		H_2O	$CaCl_2$ N/100	CEC	TEB	% BS	Ca	Mg	K	Na	Al	H	
A	0—17	5.5	4.5										
Bh	17—65	5.4	4.9	16.5	0.7	4	0.37	0.07	0.23	0.04		15.8	
Bs	>65	5.7	5.4	3.4	0.6	18	0.45	0.03	0.11	0.03		2.8	

Horizon	Ignition loss	Organic matter				Particle size analysis %						Flocc. index
		% C	% N	C/N	% OM	stones	c. sand	f. sand	silt	clay	texture	
						Organic						
A	33.1	14.1	1.02	14								
Bh	20.6	4.1	0.29	14			16	—	24	60		
Bs	21.3	0.4	0.03	13			29	2	14	55		

ORTHIC FERRALSOL	**Fo**
Ferralitic desaturated soil	Madagascar
Reference	F. Bourgeat, *Sols sur socle ancien à Madagascar*, p. 306. Paris, ORSTOM, 1972
Location	West of Talata Volonondry; 18° 45'S, 47° 45'E
Altitude	1 450 m
Physiography	Fairly heavily dissected peneplain between Ikopa and Betsiboka basins
Drainage	Good
Parent material	Granitoid migmatite
Vegetation	*Aristida similis, Ctenium elegans* pseudosteppe
Climate	Annual rainfall 1 580 mm; annual mean temperature 18.5°C, minimum 16°C in July, maximum 21°C in December, four to five dry months

Profile description

Ah1	**0-15 cm**	Brown (7.5YR 3/2) moist horizon; sandy clay to clayey sand; very coarse crumb structure of very blunt blocky shape; very weak cohesion, breaking to fine granular; high porosity; good rooting; clear boundary.
Ah2	**15-60 cm**	Brown-yellow (5YR 6/8) sandy clay, quartz-rich horizon; uniform structure of small angular fragments tending to weak subangular blocky; compact *in situ*; rather low porosity; weak rooting.
BA	**60-110 cm**	Light red (5YR 6/8) sandy clay, quartz-rich intermediate horizon; redder (2.5YR 5/8) when moist; subangular blocky with strong massive tendency; rather low tubular porosity; compact *in situ*; zero rooting.
Bu1	**110-260 cm**	Red (2.5YR 4/8 dry, 10R 4/8 moist) horizon, powdery when dry, friable when moist; sandy clay; quartz-rich; subangular blocky with massive tendency; weak cohesion; some concretions being formed; very marked tubular porosity.
Bu2	**260-300 cm**	Red (2.5YR 4/8 dry to 10R 4/8 moist) friable horizon; identical with Bu1, but a little more clayey.
Bu3	**300-400 cm**	Red friable more clayey horizon.

ORTHIC FERRALSOL

Horizon	Depth cm	pH H_2O	pH KCl	Cation exchange me % CEC	TEB	% BS	Ca	Mg	K	Na	Al	H	$CaCO_3$ %
Ah1	0—15	4.9		9.35	0.38	4	0.1	0.20	0.069	0.016			
Ah2	15—60	4.9		6.30	0.12	2	0.05	0.07	0.029	0.011			
BA	60—110	5.1		3.35	0.09	3	0.04	0.03	0.013	0.011			
Bu1	110—260	5.1		2.00	0.09	5	0.04	0.04	0.003	0.005			
Bu2	260—300	5.4		2.40	0.28	12	0.20	0.05	0.013	0.016			
Bu3	300—400	5.5		2.10	0.32	15	0.21	0.09	0.010	0.016			

Horizon	Sol. salts	Organic matter % C	% N	C/N	% OM	Particle size analysis % stones	c. sand	f. sand	silt	clay	texture	Flocc. index
Ah1					3.99		33.0	18.1	17.0	23.1		
Ah2					2.35		33.7	18.2	15.8	29.9		
BA							34.2	17.7	16.5	28.8		
Bu1							27.5	18.6	22.7	30.0		
Bu2							27.4	13.4	20.8	34.4		
Bu3							24.8	11.7	21.4	38.0		

Horizon	Total elements me/100 g Ca	Mg	K	Na	Amorphous Fe %	Triacid attack Ignition loss	SiO_2	Fe_2O_3	Al_2O_3	TiO_2	$\frac{SiO_2}{Al_2O_3}$	Clay
						Percent						
Ah1	2.1	1.9	0.22	0.91		11.3	5.85	7.4	16.2	1.7	0.6	Kaolinite and gibbsite
Ah2	2.3	0.7	0.19	0.50	0.1	10.4	5.85	7.4	17.3	1.7	0.6	
BA	0.6	2.9	0.17	0.35		11.5	10.60	9.0	22.1	1.8	0.8	Kaolinite more plentiful at depth; small proportion of crystallized minerals
Bu1	0.6	2.4	0.22	0.25	1.2	10.1	18.40	8.9	23.1	1.8	1.3	
Bu2	1.5	3.5	0.22	0.17		10.2	23.40	7.8	24.2	1.8	1.6	
Bu3	0.4	3.4	0.12	0.05		9.9	19.10	8.8	24.1	1.4	1.3	

PLINTHIC FERRALSOL	**Fp**
Plinthic Haplorthox, Boka series	Ivory Coast
Reference	Development and Resources Corporation, *Soil survey of the southwest region*, Technical Appendix I-16 and III-4a. New York, 1967
Location	64 km northwest of Sassandra
Altitude	
Physiography	Slightly undulating to undulating; 30 to 40 m high hills; 4 to 16% slope. This soil family occupies the tops and upper parts of the slope
Drainage	Well drained but internal drainage impeded; moderately permeable
Parent material	Residue and weathering of schist and gneiss
Vegetation	Secondary forest and bushes
Climate	Average annual rainfall 1 700 to 1 800 mm; average air temperature 26°C

Profile description

Ah	**0-3 cm**	Dark reddish brown (5YR 3/2) gravelly clay loam; fine crumb; friable; slightly sticky and slightly plastic; abundant fine and medium roots.
BA	**3-15 cm**	Reddish brown (5YR 4/4) gravelly clay loam; moderate fine subangular blocky; slightly sticky, slightly plastic; some thin clay films on ped faces and some stains on mineral grains; plentiful fine roots; many very fine inped pores; 70% by weight of fine and medium ironstone gravel, quartz gravel and iron-cemented rock fragments; gradual smooth boundary.
Bu1	**15-33 cm**	Yellowish red (5YR 4/6) gravelly clay; idem BA except for 65% fine gravel, medium gravel and rock fragments; gradual smooth boundary.
Bu2	**33-60 cm**	Red (2.5YR 5/6) gravelly clay; idem BA-Bu1 except for 38% fine gravel, medium gravel and rock fragments; gradual smooth boundary.
2Bs	**60-98 cm**	Red (2.5YR 5/6) gravelly clay with very few, very fine faint to distinct dark red (10R 3/6) mottles; fine to medium subangular; very firm; sticky, plastic; common clay films in pores; many very fine inped and exped pores; 24% by weight of decomposed schist and slightly polished ironstone gravel; much soft plinthite; gradual smooth boundary.
2Bsm1	**98-142 cm**	Same as 2Bs but with common dark red (10YR 3/6) and brownish yellow (10YR 6/8) mottles; 15% by weight of hard plinthite embedded in patches of decomposing schist; gradual smooth boundary.
2Bsm2	**142-258 cm**	Idem, but with many coloured mottles; some vesicular pores; much hard and soft plinthite; pieces of decomposing micaschist.

PLINTHIC FERRALSOL

Horizon	Depth cm	pH		Cation exchange me %									$CaCO_3$ %
		H_2O	KCl	CEC	TEB	% BS	Ca	Mg	K	Na	Al	H	
Ah	0—3	4.0	3.4	13.7	4.0	30	1.3	1.6	0.92	0.24			
BA	3—15	4.4	3.6	9.8	1.0	10	0.2	0.5	0.22	0.11			
Bu1	15—33	4.6	3.7	5.8	0.7	13	0.1	0.3	0.16	0.06			
Bu2	33—60	4.6	3.7	5.8	0.5	9	0.1	0.2	0.14	0.06			
2Bs	60—98	4.7	3.8	5.4	0.4	7	0.1	0.1	0.11	0.05			
2Bsm1	98—142	4.8	3.8	6.1	0.6	9	0.1	0.2	0.18	0.07			
2Bsm2	142—258	4.7	3.8	4.9	0.4	8	0.1	0.1	0.13	0.05			

Horizon	Sol. salts	Organic matter				Particle size analysis %						Flocc. index	Total P ppm
		% C	% N	C/N	% OM	stones	c. sand	f. sand	silt	clay	texture		
							..... *Total*						
Ah		6.0	0.30	20	10.4	24	62.7		3.2	32.0			263
BA		1.8	0.10	18	3.2	70	61.0		4.3	32.1			180
Bu1		1.0	0.10	10	1.7	65	53.7		4.1	41.2			165
Bu2		0.9	0.07	12	1.6	38	42.4		6.0	50.7			152
2Bs		0.7	0.07	10	1.1	24	24.5		21.9	53.2			126
2Bsm1		0.4	0.04		0.6	15	37.7		15.9	44.0			131
2Bsm2		0.3	0.03		0.5		28.0		17.8	49.5			163

RHODIC FERRALSOL	**Fr**
Desaturated ferralitic soil	Madagascar
Reference	F. Bourgeat, *Sols sur socle ancien à Madagascar*, p. 295. Paris, ORSTOM, 1972
Location	Ambositra-Morondava road near the Soavina road turnoff; 20° 30'S, 47°E
Altitude	1 325 m
Physiography	Highly dissected peneplain; profile taken from a broad shelf on the inter-river crests; 5 to 10% slope
Drainage	Good
Parent material	Gabbro
Vegetation	*Hyparrhenia* sp. and *Imperata cylindrica* pseudosteppe
Climate	Tropical contrasted; rainfall about 1 360 mm; average temperature 18.5°C

Profile description

Ah	**0-15 cm**	Red-brown (10R 3/4) moist clay horizon with pseudosands and pseudosilts; moderate coarse crumb structure (10 to 20% of granular elements); very high porosity; good rooting.
BA	**15-40 cm**	Red-brown (10R 3/4) clay horizon, rich in pseudosands and pseudosilts (probably amorphous pectized iron); medium subangular blocky; variable cohesion; high porosity; good rooting; diffuse boundary.
Bu1	**40-90 cm**	Dark red (10R 3/6) clay horizon, powdery when dry, friable when moist; even richer in pseudosands than the preceding horizons; very weak cohesion; some very blunt rounded or blocky elements; harder and more compact (preconcretions); high tubular porosity; medium rooting.
Bu2	**90-200 cm**	Red (10R 4/8) clay horizon; blocky, more distinct structure with some better structured zones and other more continuous zones breaking to fine granular; generally high porosity; rounded compact preconcretions present.
BC	**> 200 cm**	Lighter red; primary minerals present in the vicinity of 460 cm (C horizon).

RHODIC FERRALSOL

Horizon	Depth cm	pH		Cation exchange me %									$CaCO_3$ %
		H_2O	KCl	CEC	TEB	% BS	Ca	Mg	K	Na	Al	H	
Ah	0—15	5.1		19.6				1.06	0.18	0.01			
BA	15—40	5.0		12.1	1.80	14	1.29	0.41	0.09	0.01			
Bu1	40—90	5.2		4.5	0.66	14	0.40	0.23	0.02	0.01			
Bu2	90—200	5.3		3.5	0.63	18	0.43	0.19	tr.	0.01			

Horizon	Sol. salts	Organic matter				Particle size analysis %						Flocc. index
		% C	% N	C/N	% OM	stones	c. sand	f. sand 0.2-0.05	silt 0.02-0.002	clay	texture	
Ah					7.3		10.6	13.6	17.2	48.2		
BA					4.4		11.5	14.3	13.4	53.3		
Bu1							9.8	21.3	15.0	49.6		
Bu2							6.7	19.7	15.8	55.1		

Horizon	Total elements				Amorphous iron %	Triacid attack					
	Ca	Mg	K	Na		Ignition loss	SiO_2	Fe_2O_3	Al_2O_3	TiO_2	$\frac{SiO_2}{Al_2O_3}$
Ah	4.55	8.2	0.47	0.64		18.5	12.0	16.3	29.4	2.3	0.7
BA	2.75	5.6	0.33	0.56		17.1	11.3	17.9	33.6	2.3	0.6
Bu1	1.90	3.8	0.28	0.64	5.6	17.2	14.6	19.3	35.7	2.2	0.7
Bu2	1.15	4.6	0.17	0.40		13.4	25.6	10.7	30.8	0.9	1.4

XANTHIC FERRALSOL	**Fx**
Hygro-Kaolisol, Ferralsol Yangambi series (Y1)	Zaire
Reference	A. van Wambeke & L. Liben, *Carte des sols et de la végétation du Congo belge et du Ruanda-Urundi, 6. Yangambi, (Yambaw)*, p. 30. Bruxelles, INEAC
Location	West of Yangambi; 0° 45'N, 24° 20'E
Altitude	490 m
Physiography	Plateau with slope rarely exceeding 2 to 3%
Drainage	Very good
Parent material	Native aeolian sand of Yangambi, lower Pleistocene
Vegetation	Semideciduous forest with *Scorodophloeus zenkeri, Cynometra hankei, Dialum corbisieri, Celtis soyanxic, Oxystigma oxyphyllum*; *Achornea floribunda* undergrowth
Climate	Köppen Af and Thornthwaite B types; continental characteristics; global radiation and amount of solar heat received are low, being 45% of the solar heat possible; equatorial double periodicity; driest season January-February; annual rainfall 1 800 mm, average annual temperature 25°C

Profile description

O	**0-1 cm**	Shallow layer of organic matter; roots, fine roots and leaves in varying degrees of decomposition.
Ah	**1-20 cm**	Dark brown (7.5YR 4/4) moist humus-bearing horizon; clay sand; strong fine to medium crumb; friable; many fine roots; clear smooth boundary.
AB	**20-45 cm**	(7.5YR 5/6) infiltration horizon; clay sand; weak medium crumb; friable; fewer fine roots; diffuse boundary.
B	**45-65 cm**	(7.5YR 5/8) structural horizon; clay sand; weak medium subangular blocky; firm; few fine roots; diffuse boundary.
C1	**65-110 cm**	Parent material (7.5YR 5/8); clay sand; strong (floury) very fine crumb; friable; few fine roots.
C2	**110-150 cm**	Idem.

XANTHIC FERRALSOL

Horizon	Depth cm	pH		Cation exchange me %									CaCO$_3$ %
		H$_2$O	KCl	CEC	TEB	% BS	Ca	Mg	K	Na	Al	H	
Ah	20	4.6		3.5			1.3	0.14	0.18	0.08			
AB	45	4.5		4.5			0.6						
B	65	4.4		4.6			0.4						
C1	110	4.5		4.3			0.4						
C2	150	4.6		4.6									

Horizon	Sol. salts	Organic matter				Particle size analysis %						Flocc. index	Total Fe$_2$O$_3$	Free Fe$_2$O$_3$	Truog P ppm
		% C	% N	C/N	% OM	stones	c. sand 0.25-2.0	f. sand 0.05-0.25	silt 0.05-0.002	clay <0.002	texture				
Ah		1.15	0.098				55.2	16.4	2.1	26.3			14.4	3.8	4
AB		0.52	0.056				49.9	18.1	2.0	30.0			11.3	3.4	1
B		0.43	0.039				41.8	17.4	2.1	38.7			9.4	3.9	
C1		0.29	0.031				46.8	15.9	1.7	35.6			10.1	3.6	
C2		0.25	0.020				43.1	17.1	2.2	37.6				3.8	

DYSTRIC GLEYSOL **Gd**

Acid Gleysol, Romankne series	Sierra Leone
Reference	A.R. Stobbs, *The soils and geography of the Boliland region of Sierra Leone*, p. 26, 45. Government of Sierra Leone, 1963
Location	Romankne-boli, Lunsar road 1.5 km east of Tabai bridge approximately 9°N, 12° 30'W
Altitude	50 m
Physiography	Flood plain slough
Drainage	Very poor
Parent material	Old alluvia and contemporary colluvium
Vegetation	Dense grassland with short and medium grasses, used locally for rice cultivation
Climate	Annual rainfall about 2 500 mm; almost constant temperature of 25-27°C; dry season from December to April

Profile description

Ap	**0-5 cm**	Silty and fine sandy light loam; greyish (10YR 5/1); slightly humic; weak crumb; loose; abundant roots.
AB	**5-27 cm**	Silty and fine sandy loam; grey (10YR 5/1); slightly firm; structureless; slightly humic; frequent roots.
Bg1	**27-57 cm**	Silty and fine sandy heavy loam; light grey (2.5Y 7/2); firm; slightly compact; structureless; occasional roots.
Bg2	**57-100 cm**	Silty and fine sandy light clay; white (2.5Y 8/0); firm; compact; structureless; rare roots; sandy yellow and pale brown hardening mottles.
Bg3	**100-135 cm**	Idem, but the mottled pattern dominates the profile.
Bsm	**135-180 cm**	Reddish and yellowish reticulate hardening mass of plinthite containing ironstone concretions and gravel; firm compact silty clay of white (10YR 8/2) colour in the interstices.

DYSTRIC GLEYSOL

Horizon	Depth cm	pH		Cation exchange me %									$CaCO_3$ %
		H_2O	$CaCl_2$	CEC	TEB	% BS	Ca	Mg	K	Na	Al	H	
Ap AB	0—27	5.7	4.8	5.1	1.4	27	0.45	0.84	0.09	0.03			
Bg1 Bg2	27—100	5.3	4.5	2.6	0.9	35	0.14	0.69	0.04	0.02			
Bg3 Bsm	100—180	4.9	4.3	3.1	0.5	16	0.15	0.23	0.04	0.03			

Horizon	Sol. salts	Organic matter				Particle size analysis %						Flocc. index
		% C	% N	C/N	% OM	stones	c. sand	f. sand	silt	clay	texture	
Ap AB		1.38	0.09	14.1			19	65	22	10		
Bg1 Bg2		0.40	0.03	11.6			30	53	18	11		
Bg3 Bsm		0.11	0.01	7.2			34	45	15	16		

EUTRIC GLEYSOL	**Ge**
Slightly humus-bearing hydromorphic gley soil	Niger
Reference	Hunting Technical Services, *Etudes en vue de la mise en valeur du Dallol Maouri.* p. 29, 106. Boreham Wood, Herts, 1970. AGS/SF/NER/8
Location	0.7 km northwest of Tounga Zaouri, 11° 46' 35"N, 3° 34' 55"E
Altitude	150 m
Physiography	Slight depression in a flat valley; slope of less than 2%
Drainage	Very poor; water table at a depth of 25 cm; under water much of the year
Parent material	Alluvium of the major bed of the Niger
Vegetation	*Echinochloa pyramidalis* and *stagnina* pasture
Climate	Rainfall 850-900 mm per year; sharp seasonal variations (rain from June to September); considerable evaporation in the dry season (mainly in April)

Profile description

Ah	**0-20 cm**	Very dark grey (10YR 3/1), moist, very heavy clay with many dark brown mottles; weak coarse angular blocky; top 10 cm sticky, plastic, very firm when moist, extremely hard when dry; from 10 to 20 cm sticky, plastic, very firm when moist; some fine tubular pores; abundant fine to very fine roots; diffuse smooth boundary.
ABg	**20-60 cm**	Grey (N5) moist, very heavy clay with many dark brown mottles; massive; sticky and plastic; few fine tubular pores; few very fine roots to 30 cm; abrupt clear boundary.
2C	**> 60 cm**	Light grey (10YR 7/2), coarse sand and fine gravel; single-grain structure; non-sticky, non-plastic; no roots.

EUTRIC GLEYSOL

Horizon	Depth cm	pH		Cation exchange me %									CaCO₃ %
		H_2O	KCl	CEC	TEB	% BS	Ca	Mg	K	Na	Al	H	
Ah	0—20	5.8		19.0		62.9	7.63	3.19	0.61	0.52		7.0	
ABg	20—60	5.7		25.2		61.7	11.83	2.60	0.64	0.47		7.0	
2C	60—100	6.4											

Horizon	EC mmhos/cm	Organic matter				Particle size analysis %						Flocc. index
		% C	% N	C/N	% OM	stones	c. sand	f. sand	silt	clay	texture	
Ah	0.32	1.99	0.09				10	27	23	40		
ABg	0.70	1.20	0.08				10	20	13	57		
2C	0.49	0.27	0.02				92	6	1	1		

Horizon	Soluble cations me/l				Total P %	Total K %
	Ca	Mg	K	Na		
Ah	0.90	0.25	0.13	1.51	1.44	2.17
ABg	2.67	0.72	0.28	2.26	1.83	2.72

CALCARIC FLUVISOL **Jc**

Immature non-climatic alluvial steppe type	Algeria
Reference	T.G. Boyadgiev, *Les sols du Hodna*. Rome, FAO, 1972. (Unpublished)
Location	South of the M'Sila to Barika road, 5 km before entering Barika village, 35° 25'N, 5° 20'E
Altitude	About 480 m
Physiography	Large depression between the hills; flat relief
Drainage	Good; deep-lying water table
Parent material	Alluvium
Vegetation	Degraded pasture of *Alpha* and *Astragalus armatus*
Climate	220 mm of rainfall a year with irregular distribution over the year; very dry summer; annual average temperature 18.5°C, January 8°C, July 30°C

Profile description

A1	**0-15 cm**	(9YR 6/4), loamy, dry; fine to medium subangular blocky; very porous in the first 8 cm and slightly porous below; a few whitish calcareous or gypseous mycelia in the lower part; common animal tunnels and coprolites; clear boundary.
2Ck1	**15-46 cm**	Slightly reddish (10YR 5/6) fresh loam with some sandy patches; medium to coarse subangular blocky breaking to granular; very porous; common calcareous mycelia; gradual boundary.
2Ck2	**46-82 cm**	(10YR 5.5/6) fresh sandy loam; coarse subangular blocky; good intragranular porosity; limestone shell debris; many tunnels and coprolites; calcareous mycelia; some soft limestone nodules; gradual boundary.
2Ck3	**82-122 cm**	Sandy loam with lighter and sandier (10YR 5.5/6) patches; weak medium subangular blocky; moderate root density; many tunnels and coprolites; calcareous mycelia; abrupt boundary.
2Ck4	**122-140 cm**	(10YR 5.5/6) fresh sandy loam; massive; slightly porous; few roots.

CALCARIC FLUVISOL

Horizon	Depth cm	pH		Cation exchange me %									CaCO₃ %
		H_2O	KCl	CEC	TEB	% BS	Ca	Mg	K	Na	Al	H	
A1	0—15	7.9		13			24	5	1.00	1.1			23
2Ck1	15—46	8.2		12			18	5	0.59	1.3			24
2Ck2	46—82	8.1		16			24	6	0.51	1.1			25
2Ck3	82—122	8.1		7			18	5	0.26	1.3			27
2Ck4	122—140	8.2		5			20	4	0.26	0.8			26

Horizon	EC mmhos/cm	Organic matter				Particle size analysis %						Flocc. index
		% C	% N	C/N	% OM	stones	c. sand	f. sand	silt	clay	texture	
A1	1.6	0.50	0.046	11	0.8		7	30	40	20		
2Ck1	0.6	0.22	0.024	9	0.4		9	38	29	21		
2Ck2	0.8	0.37			0.6		7	30	32	27		
2Ck3	1.2						12	44	27	15		
2Ck4	1.1						26	49	15	10		

Horizon	Soluble salts me/100 g							Gypsum %	Apparent specific weight	pF 4.2	pF 3	Hénin index K cm/h	Is
	Ca	Mg	Na	K	Co₃H	So₄	Cl						
A1	0.26	0.05	0.21	0.02	0.04	0.05	0.44	tr.	1.6	10.4	14.7	2.2	11.8
2Ck1								tr.	1.6	9.0	13.5	2.4	5.7
2Ck2	0.15	0.05	0.22	tr.	0.04	0.18	0.19	tr.	1.6	11.1	15.0	2.1	6.2
2Ck3								tr.	1.6	6.5	8.9	4.7	3.2
2Ck4	0.08	0.03	0.28	tr.	0.05	0.18	0.16	tr.		4.0	5.9	4.2	2.4

THIONIC FLUVISOL	**Jt**
Halic thiofibric tropaquent soil	Guinea
Reference	*Etude d'un programme d'aménagement hydro-agricole des terres rizicultivables de la Basse-Guinée*, Vol. 2 Pédologie, Annexes 1-39 and 2-40, Harza Engineering Company International, 1969
Location	500 m from the edge of the Konoban Daboudi river, 3 km from Mafouré village; 9° 12'N, 13° 11'W
Altitude	A few metres
Physiography	Transition between the foot of the old marine terrace flooded by the spring tides and the plain of the middle estuary. Flat surface with crab holes and surface shells
Drainage	Very poor; water table 50 cm down
Parent material	Marine sediments
Vegetation	Transition between open forest of *Avicennia nitida* and dense brush of *Rhizophora harrisonnii*
Climate	Rainy season from May to November and dry season from May to April; precipitation exceeding 4 m; constant temperature of around 27°C

Profile description

Ag1	**0-10 cm**	Grey brown (10YR 5/2) moist sandy loam; friable to plastic; massive with coarse pores and crab holes; very few living roots; clear irregular boundary.
BCg	**10-20 cm**	Very dark grey (5Y 3/1) moist sandy clay; sticky and coherent; some light grey (2.5Y 6/1) sandy pockets and coarse yellowish red (5YR 4/6) nodules partially concreted around root channels; massive with fine pores; many fine living and dead roots; clear irregular boundary.
Cr1	**20-80 cm**	Very dark grey (5Y 3/1) clay with sand pockets; sticky when moist; many (30%) light brown-grey (10YR 6/2) sandy pockets, probably filled-in crab holes; massive but fibrous; some living roots; gradual irregular boundary.
Cr2	**80 to over 120 cm**	Very dark grey (5Y 3/1) moist clay; sticky; coherent; massive; fibrous; no longer any living roots.

THIONIC FLUVISOL

Horizon	Depth cm	pH		Cation exchange me %									CaCO₃ %
		H_2O 1/1	KCl	CEC	TEB	% BS	Ca	Mg	K	Na	Al	H	
Ag1	0—10	4.7		17.5			3.2	6.2	0.7	24.7		40.8	
BCg	10—20	3.2		27.1			4.0	6.3	0.5	21.7		20.9	
Cr1	20—80	2.8		33.7			2.7	12.3	0.4	37.6		23.2	
Cr2	80—120	2.7		33.7			3.7	9.0	0.1	33.4		28.1	

Horizon	EC mmhos/cm	Organic matter				Particle size analysis %						Flocc. index
		% C	% N	C/N	% OM	stones	c. sand 2-0.5	f. sand 0.5-0.05	silt 0.5-0.002	clay < 0.002	texture	
Ag1	63.5				2.1		1.68	60.8	26.2	11.3		
BCg	69.6				3.3		2.15	15.0	31.5	51.3		
Cr1	74.3				3.3		5.95	4.2	15.3	38.5		
Cr2	77.7				3.5		2.28	5.3	39.8	52.6		

Horizon	Extract of saturated soil me/l						Al ppm	S %	P Bray ppm
	SO_4	NO_3	K	Ca	Mg	Na			
Ag1	18.2	0.15	7	65	131	652	tr.	0.71	3
BCg	20.3	0.11	4	60	158	708			2
Cr1	24.5	0.21	1	60	214	882			5
Cr2	18.7	0.42	1	70	214	870	300	3.86	4

CALCIC KASTANOZEM	**Kk**
Calcareous brown	Morocco
Reference	*Rapport du projet Sebou, zone focale Fès-Meknès*, p. 73. Rome, FAO, 1965
Location	About 3 km S/SW of Meknès on the Agourai road; 33° 58'N, 5° 36'W
Altitude	552 m
Physiography	Undulating; 3% slope
Drainage	Good
Parent material	Lacustrine calcareous sediment
Vegetation	Ploughed land
Climate	Wet season from October to May; rainfall 574 mm; average temperature 9.7°C in January, 25.6°C in August; average annual temperature 17°C; potential evaporation 980 mm

Profile description

Ap1	**0-15 cm**	Very dark brown (10YR 2/2) moist clay loam; crumbly; very calcareous.
Ap2	**15-25 cm**	Very dark brown (10YR 2/2) moist clay loam; weak blocky structure; gradual boundary.
ABk	**25-45 cm**	Dark brown (7.5YR 3/2) moist clay loam; nuciform structure due to animal activity; pseudomycelia of $CaCo_3$ on ped faces; gradual boundary.
BAk	**45-65 cm**	Brown (7.5YR 5/6) silty clay loam; nuciform structure due to animal activity; pseudomycelia on ped faces.
BCk1	**65-85 cm**	Brown (7.5YR 5/6) silty clay loam; nuciform; pseudomycelia and hard nodules of $CaCo_3$ (diameter 5 mm, 20% by volume); very calcareous.
BCk2	**85-110 cm**	Ochre red (5YR 4/6) moist silty clay loam; nuciform structure due to animal activity; pseudomycelia and hard nodules of $CaCo_3$; very calcareous.
C	**110-170 cm**	(2.5YR 3/6) moist clay; swelling clay and chalk pockets; hard nodules with highly variable diameters; very calcareous.

CALCIC KASTANOZEM

Horizon	Depth cm	pH		Cation exchange me %									$CaCO_3$ %
		H_2O	KCl	CEC	TEB	% BS	Ca	Mg	K	Na	Al	H	
Ap1	0—15	8.2		30.0	28.6	95.4	24.0	4.0	0.32	0.34			16.7
Ap2	15—25	8.4		37.0	35.9	97.0	32.0	2.4	0.65	0.86			17.6
ABk	25—45	8.5		30.0	27.1	90.3	21.6	4.4	0.37	0.77			42.3
BAk	45—65	8.4		22.0	20.8	94.5	19.2	0.4	0.37	0.86			59.7
BCk1	65—85	8.4		20.0	18.9	94.5	16.8	1.2	0.25	0.68			63.2
BCk2	85—110	8.4		22.0	21.7	99.6	20.4	0.4	0.22	0.68			56.8
C	110—170	8.4		57.5	52.5	91.3	47.0	4.6	0.25	0.64			28.7

Horizon	Sol. salts	Organic matter				Particle size analysis %						Flocc. index	Available P_2O_5 ppm	Active $CaCO_3$ %	Gypsum
		% C	% N	C/N	% OM	stones	c. sand	f. sand	silt	clay	texture				
Ap1			0.20		2.19		13.5	24.7	29.7	35.7			24	11.1	
Ap2			0.20		1.92		14.5	23.1	32.3	31.9			28	12.5	
ABk			0.10		1.33		6.5	18.7	44.5	31.0			30	18.9	
BAk			0.08		0.27		4.8	12.3	63.7	22.2			12	19.8	
BCk1							4.4	10.5	56.5	27.1			6	20.1	0
BCk2							5.0	9.8	65.9	21.3			4	19.0	0
C							3.6	28.0	34.7	45.9			4	13.5	0

CHROMIC LUVISOL	**Lc**
Shortlands form, Glendale series	South Africa
Reference	J.J. van der Eyk, C.N. Macvicar, J.M. de Villiers, *Soils of the Tugela basin*, p. 164. Natal, Town and Regional Planning Commission, 1969
Location	*Dundee;* 28° 09'S, 30° *18'* 30''E
Altitude	1 219 m
Physiography	Ecological region: moist interior basin (northern) undulating topography; profile chosen from top part of relief
Drainage	Normal
Parent material	Dolerite
Vegetation	*Tristachya* and *Digitaria* grassland
Climate	Annual rainfall 835 mm

Profile description

Ah	**0-43 cm**	Dry; dark reddish brown (5YR 3/2) sandy clay; fine to medium subangular blocky; moderately porous; hard; gradual smooth boundary.
Bt1	**43-79 cm**	Dry; dark reddish brown (2.5YR 3/4) clay; moderate fine angular blocky; moderately porous; hard; gradual smooth boundary.
Bt2	**79-142 cm**	Slightly moist; dark red (2.5YR 3/6) clay, strong fine to medium blocky with distinct clayskins; moderately porous; slightly firm; clear smooth boundary.
BC	**142-183 cm**	Moist; dark red (2.5YR 3/6) clay loam with fine yellow and black specks of weathered dolerite increasing in number with depth; moderate fine angular blocky; *moderately porous; friable; diffuse boundary.*
C	**183-193 cm**	Variegated black, yellow, white and red weathered dolerite.

CHROMIC LUVISOL

Horizon	Depth cm	pH		Cation exchange me% — $BaCl_2$ - triethanolamine pH 8.2										$CaCO_3$ %
		H_2O	KCl	CEC	TEB	% BS	Ca	Mg	K	Na	Al	H		
Ah	0—43	5.9		13.1	8.7	67	5.8	2.1	0.6	0.2				
Bt1	43—79	6.0		12.0	9.0	75	4.6	3.4	0.9	0.1				
Bt2	79—142	6.3		11.8	3.8	75	4.4	3.1	1.2	0.1				
BC	142—183	6.4		21.7	18.7	86	9.1	7.7	1.8	0.1				

Horizon	Sol. salts	Organic matter				Particle size analysis %						Flocc. index	CEC clay
		% C	% N	C/N	% OM	stones	c. sand	f. sand	silt	clay	texture		
Ah		1.2	0.11				25	31	6	38			34
Bt1		0.5	0.06				19	27	11	43			28
Bt2		0.4	0.05				33	27	14	44			27
BC		0.2	0.05				12	35	18	35			62

FERRIC LUVISOL	**Lf**
Leached tropical ferruginous soil with mottles and concretions	Senegal
Reference	R. Fauck, Le sous-groupe des sols ferrugineux tropicaux lessivés à concrétions, *Sols africains*, 8(3):399. September-December 1963
Location	Sefa Sedhiou Experiment Station, Senegal, 12° 45'N, 15° 30'W
Altitude	40 m
Physiography	Plateau
Drainage	Drainage impeded in the rainy season
Parent material	Sands and sandstones of the *continental terminal*
Vegetation	Fallow with grasses in the middle of Combretaceae and *Cordyla* forest
Climate	Rainfall 1 350 mm in a season; Henin calculated drainage 360 mm

Profile description

Ap1	**0-6 cm**	Grey-brown (Munsell 5YR 5/3); humus-bearing; sandy texture; fine nuciform; poor compactness; good internal drainage; tubular porosity; many roots and insect tunnels.
Ap2	**6-13 cm**	Light grey-brown (5YR 6/2); slightly clayey sand texture; fine to blocky nuciform; always a certain organic richness; higher average compactness than the previous horizon; good porosity, many roots.
E	**13-31 cm**	Yellowish beige (5YR 6/4); again very slightly humus-bearing; slightly clayey sand texture; nuciform; macroporosity due to roots and insects; moderate to strong compactness.
Bt	**31-79 cm**	Darker beige to reddish yellow (5YR 8/4); sandy clay to clay texture; definite clay accumulation; blocky; fairly strong compactness; low to medium porosity; fine tubular type.
Btg	**79-117 cm**	Beige-yellow (5YR 7/6); sandy clay texture; nuciform to blocky; moderate compactness; incipient individualization of well demarcated red ironstone mottles.
Bcs	**117-150 cm**	Beige (5YR 8/4) matrix colour, variegated red and ochre; sandy clay texture; coarse blocky; moderate compactness; poor to medium ped porosity; plentiful patches and concretions of medium to poor hardness and red to dark red and more rarely dark purple in colour. Near the bottom the ochre mottles become gradually larger with slightly hardened concretions having a slightly hardened ochre centre.
Cg	**> 150 cm**	Continuous variegation; texture with beige matrix; appearance of light grey mottles without distinct boundaries; very numerous concretions of dominant red or rust colour; some can be crushed between the fingers, leaving a harder central point; structure tending toward blocky; moderate to strong cohesion.

FERRIC LUVISOL

Horizon	Depth cm	pH		Cation exchange me %									$CaCO_3$ %
		H_2O	KCl	CEC	TEB	% BS	Ca	Mg	K	Na	Al	H	
Ap1	0—6	6.5	6.1	4.80	3.50	73	2.25	1.05	0.15	0.05			
Ap2	6—13	5.6	5.8	4.05	2.50	62	1.70	0.65	0.10	0.05			
E	15—25	5.6	5.4	4.45	2.80	63	1.70	1.05	0.05	tr.			
Bt	40—60	6.2	5.3	5.15	3.65	71	2.10	1.50	0.05	tr.			
Btg	90—110	6.3	5.4	4.65	3.70	80	1.30	2.30	0.05	0.05			
Bcs	130—150	6.3	5.5	4.85	3.60	74	1.70	1.85	0.05	tr.			

Horizon	Sol. salts	Organic matter				Particle size analysis %						Flocc. index
		% C	% N	C/N	% OM	stones	c. sand	f. sand	silt	clay	texture	
Ap1		1.05	0.07	13.9			26.1	47.1	4.0	9.4		
Ap2		0.68	0.05	13.0			31.1	43.9	4.1	9.4		
E		0.38	0.03	11.7			23.3	38.6	4.9	21.5		
Bt		0.33	0.03	9.4			21.3	28.0	5.3	35.1		
Btg		0.29	0.03	8.4			16.6	23.7	5.3	43.7		
Bcs		0.20	0.03	6.7			17.0	25.0	5.6	40.1		

Horizon	SiO_2	Al_2O_3	Fe_2O_3	Ignition loss	Total P_2O_5 %	$\frac{SiO_2}{Al_2O_3}$	$\frac{SiO_2}{R_2O_3}$	Total iron	Free iron (Deb)	P_2O_5 Truog ppm	Structure		Porosity		
											Is	porosity	pF3	pF4.2	Usable water
	.... *Percent*							... *Percent* ...							
Ap1	4.47	3.30		3.30	0.22	2.32	1.95	2.21	0.83	5	0.87		8.3	5.1	3.0
Ap2	4.53	3.40		2.61	0.12	2.28	1.93	2.59	0.85	tr.	1.34	41.9	7.2	4.6	2.6
E	9.76	8.50		3.78	0.17	1.95	1.78	3.07	0.99	tr.	2.58	45.9	11.1	7.8	3.3
Bt	16.49	14.80		5.75	0.23	1.88	1.74	3.26	1.17	10	2.36	49.6	16.0	12.5	3.5
Btg	19.19	18.00		6.77	0.17	1.81	1.68	3.84	1.29	tr.	2.60	44.4	19.6	15.4	4.2
Bcs	20.47	17.25		7.15	0.18	2.03	1.83	4.90	1.92	13	2.41	44.8	19.5	15.4	4.2

CALCIC LUVISOL	**Lk**
Calcimorphic Siallitic group, Sabi C1 series	Rhodesia
Reference	J.G. Thompson, *The soils of Rhodesia and their classification*, p. 49. Salisbury, 1965
Location	4.8 km from the foot of the hills in the Sabi valley, about 11.2 km NE of the experiment station; 20° 15'S, 32° 25'E
Altitude	
Physiography	Piedmont slope of about 1%
Drainage	Slow through the profile
Parent material	Colluvium from Umkondo sandstone and limestone forming the high hills east of the observed site
Vegetation	*Acacia* and *Euphorbia* veld with a thick grass cover of *Urochloa*; the acacias are mostly *A. tortilis* and the euphorbs *E. ingens*
Climate	Annual rainfall about 400 mm

Profile description

Ah	**0-10 cm**	Brown (7.5YR 4/4) fine-grained sandy loam; moderately moist; friable; structureless; very numerous roots; gradual boundary.
AB	**10-30 cm**	Reddish brown (5YR 4/4) sandy clay loam; slightly moist; hard consistence; medium subangular blocky; very numerous roots; gradual boundary.
Bt	**30-65 cm**	Dark red-brown (5YR 3/4) sandy clay; slightly moist; hard to very hard consistence; medium subangular blocky; very numerous roots; gradual boundary.
Btk	**65-120 cm**	Yellowish red (5YR 4/6) calcareous sandy clay; slightly moist; hard consistence; becoming less hard with depth; many roots; gradual boundary.
Ck	**120-180 cm**	Strong brown (7.5YR 4/6) sandy clay loam as calcareous as the preceding horizon; many roots.

CALCIC LUVISOL

Horizon	Depth cm	pH H₂O	pH KCl	CEC	TEB	% BS	Ca	Mg	K	Na	Al	NA/T	Free CO_2
				Cation exchange me %									
Ah	0—10	6.4		12.2	10.3	84	6.1	3.2	1.0				0
AB	10—30	6.8		16.1	13.7	85	8.6	4.1	1.0				0
Bt	30—65	6.9		17.1	15.9	93	10.3	4.6	1.0				0
Btk	65—120	7.9		16.3	73.5	100	69.6	2.8	0.9	0.4		3	57.2
Ck	120—180	7.9		14.8	64.3	100	54.0	8.8	0.9	0.6		4	49.1

Horizon	EC mmhos/cm	Organic matter % C	% N	C/N	% OM	Particle size analysis % stones	c. sand	f. sand	silt	clay	texture	Flocc. index	CEC clay
Ah	0.64	0.79	0.09	8.2			22	44	17	17			72
AB	0.29						18	40	14	28			58
Bt	0.29						17	37	13	33			52
Btk	0.43						17	38	6	39			42
Ck	0.66						20	41	19	20			74

PLINTHIC LUVISOL **Lp**

Weakly desaturated ferralitic soil, reworked group, indurated subgroup Ivory Coast

Reference SOGETHA, *Etude pédologique dans la région de Ferkessedougou,* Annexes, profile 441. Ivory Coast, Ministère du Plan, 1967

Location About 12 km west of Ferkessedougou, on the Korhogo road; approximately 9° 38'N, 5° 18'W

Altitude

Physiography Glacis

Drainage Medium internal drainage; slightly permeable at depth

Parent material Detritic ironstone crust materials

Vegetation Slightly shrubby savanna

Climate Tropical continental; annual rainfall 1 340 mm; five dry months (November to March); average temperature in March 29.4°C, August 25.3°C, low relative humidity; evapotranspiration about 1 525 mm

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Profile description

Ah	**0-20 cm**	(5YR 3/3) clayey, sandy humus-bearing horizon; fresh; moderate medium granular structure associated with a weak crumb structure; some tunnels and common pores; friable; sparse roots but abundant fine roots; clear smooth boundary.
Bt1	**20-45 cm**	Yellowish red (5YR 4/6) sandy clay horizon; fresh; moderate medium blocky structure associated with a moderate subangular structure; some fissures; common pores; firm; abundant fine roots; quartz; clear smooth boundary.
Bt2	**45-90 cm**	Yellowish red (5YR 4/6) sandy clay; fresh; slightly gravelly; moderate medium subangular; some fissures; common pores; friable; clear smooth boundary.
Bsm	**> 90 cm**	Concretioned indurating horizon; dry; cemented in patches; concretions; some fine roots and quartz gravel.

PLINTHIC LUVISOL

Horizon	Depth cm	pH		Cation exchange me %									$CaCO_3$ %
		H_2O	KCl	CEC	TEB	% BS	Ca	Mg	K	Na	Al	H	
Ah	0—20	6.5		7.0		66	3.3	1.1	0.22	0.03			
Bt1	20—45	6.1		7.2		56	3.0	0.7	0.30	0.06			
Bt2	45—90	5.1		7.4		54	3.1	0.6	0.25	0.06			
Bsm	>90												

Horizon	Sol. salts	Organic matter				Particle size analysis %						Total P ppm
		% C	% N	C/N	% OM	stones	c. sand	f. sand	silt	clay	texture	
Ah		1.19	0.76	15		5	54	24	8	13		613
Bt1						7	35	16	10	38		
Bt2						39	29	14	11	47		

DYSTRIC NITOSOL	**Nd**
Desaturated impoverished ferralitic soil	Madagascar
Reference	F. Bourgeat, *Sols sur socle ancien à Madagascar*, Annexe, p. 302. Paris, ORSTOM, 1972
Location	4 km west of Moramanga; 19° 06'S, 48° 20'E
Altitude	920 m
Physiography	Upper Tertiary plateau dominating old alluvia
Drainage	Impeded at depth
Parent material	Weathered gabbro
Vegetation	Brush with *Helichrysum*, *Philippia*, bracken, *Aristida similis*, *Hyparrhenia rufa*
Climate	Rainfall 1 504 mm a year; average temperature 19.4°C

Profile description

Ah	**0-8 cm**	Dark brown (7.5YR 4/2 dry, 7.5YR 3/2 moist) humus-bearing clay horizon; moderate medium crumb breaking to fine granular; fairly weak cohesion; strong porosity; good rooting.
AB	**8-30 cm**	Yellow (10YR 6/8 dry, 7.5YR 6/7 moist) clay horizon; rich in ironstone concretions which may reach a thickness of 5 to 6 cm and in white root-shaped gibbsitic concretions (10 to 20% of the total mass); structure of very slight blocky tendency; weak cohesion (friable); medium tubular porosity; good rooting.
BA	**30-60 cm**	Reddish yellow (5YR 6/7 dry, 2.5YR 5/8 moist) intermediate clay horizon; rich in ironstone and gibbsitic concretions; poorly individualized blocky structure; weak cohesion; fairly compact *in situ*; medium porosity.
Bt1	**60-150 cm**	Light red (2.5YR 6/8 dry, 2.5YR 4/8 moist) horizon, some gibbsitic concretions; highly developed polyhedral structure; glossy faces on aggregates; strong cohesion; strong porosity between aggregates, little in the inside.
Bt2	**150-500 cm**	Light red (2.5YR 6/6 dry and 2.5YR 4/3 moist) clay horizon with rust mottles; very rich in root-shaped gibbsitic concretions irregularly distributed throughout; even stronger structure than in the preceding horizon.
C	**500-800 cm**	Mottled horizon with purplish red (10R 5/6 dry, 10R 4/6 moist) and white zones with poorly marked boundaries; clayey; cubical structure; strong cohesion when dry, plastic when moist; very low porosity.

DYSTRIC NITOSOL

Horizon	Depth cm	pH		Cation exchange me %										CaCO$_3$ %
		H$_2$O	KCl	CEC	TEB	% BS	Ca	Mg	K	Na	Al	H		
AB	8—30	4.5		4.5	0.35	8	0.12	0.19	0.035	0.015				
BA	30—60	4.5		3.6	0.20	6	0.09	0.11	0.015	0.011				
Bt1	60—150	4.6		3.2	0.35	10	0.10	0.20	0.045	0.005				
Bt2	150—500	4.8		2.8	0.40	10	0.05	0.25	0.080	0.020				
C	500—800	4.9		1.7	0.34	20	1.07	0.25	0.015	tr.				

Horizon	Sol. salts	Organic matter				Particle size analysis %						Flocc. index
		% C	% N	C/N	% OM	stones	c. sand	f. sand	silt	clay	texture	
AB					2.3		7.4	8.0	32.2	48.0		
BA					1.3		4.5	5.5	27.4	58.3		
Bt1							2.9	0.9	10.1	84.9		
Bt2							1.2	0.7	8.1	88.9		
C							10.2	8.4	16.8	62.3		

Horizon	Ignition loss	SiO$_2$	Fe$_2$O$_3$	Al$_2$O$_3$	TiO$_2$	$\frac{SiO_2}{Al_2O_3}$
	Percent					
BA	24.6	11.4	10.6	44.6	2.9	0.4
Bt1	20.4	24.0	10.5	42.9	2.0	1.0
Bt2	15.8	32.1	12.5	36.5	1.8	1.5
C	17.3	24.1	29.9	29.9	1.9	1.4

EUTRIC NITOSOL	**Ne**
Rubrisol-Ochrosol forest soil, Korforidua series	Ghana
Reference	G.K. Asamoa, *Evaluation of Soil Resources in West Africa*, Regional Seminar, Kumasi, Ghana, 1970, World Soil Resources Report No. 40, p. 164-165
Location	Block A, CRI, New Tafo; approximately 6° 30'N, 0° 30'W
Altitude	200 m
Physiography	Gently undulating; slight slope
Drainage	Well drained
Parent material	Weathering of granodiorite
Vegetation	Humid semideciduous secondary forest
Climate	Rainfall 1 650 mm a year in two seasons; August and early September are the driest months; temperature high and almost invariable; absolute minimum 10°C and absolute maximum 33°C; fairly high air humidity

Profile description

Ah1	**0-5 cm**	Very dark greyish brown (10YR 3/2) loamy sand; weak fine granular; many fine roots; abrupt smooth boundary.
Ah2	**5-10 cm**	Dark brown (10YR 3/3) loamy sand; moderate medium and fine granular; very weak fine subangular blocky; friable; common fine roots; clear boundary.
AB1	**10-15 cm**	Dark yellowish brown (10YR 3/4) sandy loam; moderate medium granular and very fine weak subangular blocky; friable; common fine roots; clear smooth boundary.
AB2	**15-21 cm**	Dark yellowish brown (10YR 3/4) sandy loam; moderate medium granular and very weak fine subangular blocky; firm, few fine roots, a little coarse gravel; abrupt smooth boundary.
BA	**21-29 cm**	Strong brown (7.5YR 5/6) sandy loam; massive; firm; much fine quartz gravel and many ironstone concretions (approximately 40% by volume); few quartz stones; few fine roots; clear smooth boundary.
Bt1	**29-38 cm**	Strong brown (7.5YR 5/6) sandy clay loam; massive; firm; much gravel and many concretions (45% by volume); few quartz stones; few fine roots; abrupt smooth boundary.
Bt2	**38-49 cm**	Strong brown (7.5YR 5/6) sandy clay with few fine red (10YR 4/8) and yellow (10YR 8/8) mottles; common fine gravel and ironstone concretions; few fine roots; abrupt smooth boundary.
Bt3	**49-70 cm**	Strong brown (7.5YR 5/6) clay with few fine faint red (10R 5/6) and yellow (10YR 8/8) mottles; massive; firm; common fine quartz gravel and ironstone concretions; root channels with thin clay flows; clear smooth boundary.
Bt4	**70-94 cm**	Strong brown (7.5YR 5/6) clay loam with common medium distinct yellow (10YR 8/8) and few fine faint red (10R 5/6) mottles; massive; firm; a little fine quartz gravel; traces of weathered rock; gradual smooth boundary.
BC1	**94-117 cm**	Strong brown (7.5YR 5/6) clay with common yellow (10YR 7/6) and white (2.5Y 8/2) mottles; few pieces of decomposed rock; tiny mica flakes; gradual smooth boundary.
BC2	**117-143 cm**	Strong brown (7.5YR 5/8) clay with common medium and fine yellow (10YR 8/6) and red (10R 5/8) mottles; massive; firm; many pieces of decomposed rock; hard and soft ironstone concretions; gradual boundary.
BC3	**143-178 cm**	Strong brown (7:5YR 5/8) clay loam with many large prominent yellow (10YR 7/6), white (2.5YR 8/2) and yellowish red (5YR 4/8) mottles; massive; firm; pieces of ferruginized rock and tiny mica flakes; gradual smooth boundary.
BC4	**178-223 cm**	Strong brown (7.5YR 5/8) clay loam with many large and prominent red, yellow and white mottles.
C	**223-246 cm**	Red (10R 4/8) and yellow (10YR 8/6) mottled clay loam; massive; firm; many large pieces of decomposed rock and white mica flakes; thin veins of black (7.5YR 2/0) decomposed rock.

EUTRIC NITOSOL

Horizon	Depth cm	pH H₂O	pH KCl	Cation exchange me % CEC	TEB	% BS	Ca	Mg	K	Na	Al	H	$CaCO_3$ %
Ah1	0—5	6.3		9.45	11.22	100	8.63	1.90	0.31	0.38			
Ah2	5—10	6.2		6.51	6.83	100	5.24	1.12	0.13	0.34			
AB1	10—15	6.2		4.46	4.70	100	3.61	1.71	0.07	0.33			
AB2	15—21	6.2		3.78	3.84	100	2.85	0.61	0.07	0.32			
BA	21—29	6.2		3.88	3.34	86.1	2.65	0.31	0.07	0.31			
Bt1	29—38	6.3		4.70	4.04	86.2	3.22	0.46	0.06	0.31			
Bt2	38—49	6.3		5.55	3.84	68.8	3.30	0.16	0.05	0.30			
Bt3	49—70	5.3		5.54	3.84	69.3	3.15	0.31	0.07	0.31			
Bt4	70—94	5.5		6.14	3.87	63.0	3.17	0.36	0.05	0.29			
BC1	94—117	5.4		5.82	4.40	75.6	3.24	0.82	0.05	0.29			
BC2	117—143	5.6		5.59	4.42	75.5	2.84	1.04	0.05	0.29			
BC3	143—178	5.4		5.25	3.80	72.4	2.17	1.30	0.05	0.28			
BC4	178—223	5.3		5.35	2.74	69.9	2.09	1.23	0.06	0.25			
C	223—246	4.5		5.68	3.12	54.9	1.75	1.09	0.04	0.24			

Horizon	Sol. salts	Organic matter % C	% N	C/N	% OM	Particle size analysis % stones	c. sand	f. sand	silt 0,06-0.002	clay	texture	Flocc. index	Total P ppm
Ah1		2.28	0.126	18.1	3.92		77.7		14.0	8.3			362
Ah2		1.12	0.085	13.1	1.93		82.3		8.9	8.8			263
AB1		0.73	0.054	13.5	1.26		74.3		12.5	13.2			254
AB2		0.51	0.040	12.7	0.88		74.3		12.7	13.0			224
BA		0.32	0.024	13.3	0.55		67.7		15.5	16.8			248
Bt1		0.37	0.023	16.0	0.64		52.5		14.9	34.6			317
Bt2		0.40	0.025	16.0	0.69		47.0		13.0	40.0			392
Bt3		0.34	0.021	16.0	0.58		42.2		17.1	40.7			343
Bt4		0.26	0.002	11.8	0.45		36.2		24.2	39.6			358
BC1		0.25	0.018	13.8	0.43		36.2		22.8	41.0			358
BC2		0.21	0.014	15.0	0.36		33.5		23.9	42.6			338
BC3		0.13	0.014	9.1	0.22		35.8		28.2	36.0			385
BC4		0.14	0.014	10.0	0.24		33.6		28.6	37.8			456
C		0.09	0.008	11.2	0.15		34.0		29.8	36.2			304

CAMBIC ARENOSOL	**Qc**
Subarid red-brown soil	Senegal
Reference	R. Maignien, *Agronomie tropicale*, No. 5, September-October, 1958, p. 545, 549, 553, 559, 560
Location	North Ferlo on the edge of the Tyle-Boubacar Niamarel road, 18 km from the former village; about 15° 12'W, 16° 18'N
Altitude	25 m
Physiography	Gently undulating; flat dunes
Drainage	Well drained
Parent material	Argillaceous sandstone of the *continental terminal*
Vegetation	Open savanna with *Commiphora africana* and *Schoenefeldia gracilis*, clumps of *Aristida mutabilis* and numerous *Blepharis linearifolia*
Climate	Sahelian climate; short rainy season (2 to 3 months) with rainfall of 350 to 500 mm distributed over 30 or 40 days. Long dry season in which the saturation deficit is very low; warm dry wind. Very high temperature at end of dry season. Coldest months (20°C) December and January

Profile description

Ah	**0-25 cm**	Russet grey horizon appearing fairly well provided with organic matter; very sandy texture; rather coarse crumb; slightly hardened at the surface where traces of sheet erosion are observed; abundant root system.
AB	**25-70 cm**	Again a humus-bearing hardened greyish red horizon; very sandy texture; structure of weak nuciform tendency; low stability; large rounded coloured quartz specks; non-porous; roots also develop in this horizon.
Bw	**70-160 cm**	Russet slightly hardened sand; no definite structure because of moisture; some charcoal debris; very weak cohesion; no pores.
C	**160-200 cm**	Red-yellow very slightly clayey sand; no limestone concretions.

CAMBIC ARENOSOL

Horizon	Depth cm	pH		Cation exchange me %									CaCO₃ %
		H_2O	KCl	CEC	TEB	% BS	Ca	Mg	K	Na	Al	H	
Ah	0—25	7.4		9.2	2.16	23.4	1.52	0.50	0.06	0.08			
AB	50—70	7.2		6.3	1.75	27.7	1.21	0.40	0.04	0.10			
Bw	100	7.5		5.1	2.09	40.9	1.28	0.50	0.04	0.27			
C	175				1.83		0.78	0.74	0.06	0.25			

Horizon	Sol. salts	Organic matter				Particle size analysis %						Flocc. index
		% C	% N	C/N	% OM	stones	c. sand	f. sand	silt	clay	texture	
Ah		0.18	0.023	7.8	0.31	0	26.5	67.5	0.3	5.0		
AB		0.08	0.011	7.3	0.14	0	28.0	65.0	2.2	4.3		
Bw			0.011			0	27.5	65.0	2.9	4.1		
C			0.007			0	20.5	69.0	3.1	4.3		

FERRALIC ARENOSOL	**Qf**
Hygro-Kaolisol, Arenoferral on Salonga-type sand	Zaire
Reference	C. Sys, *Notice explicative de la carte des sols et de la végétation du Congo belge et du Ruanda-Urundi*, p. 78. Bruxelles, INEAC, 1960
Location	Lodja region; 3° 30'S, 23° 30'E approximately
Altitude	600 m
Physiography	Plateau covering a vast region of the Kasai-Sankuru as far as 1°S
Drainage	Very good
Parent material	Aeolian sand resting on one of the upper Tertiary levels; fine sand; clay content may vary from 12 to 35%; the clay fraction of kaolinic nature only exceptionally contains traces of gibbsite
Vegetation	Dense humid forest
Climate	Annual rainfall of 1 750 mm per year and average temperature of 25°C

Profile description

O		Highly decomposed layer of organic matter consisting mainly of fine roots mixed with a little black sand.
Ah	**0-8 cm**	Very dark grey-brown (10YR 3/2); very sandy; structureless; loose; many fine roots; many grey sand specks; gradual boundary.
AB	**8-23 cm**	Dark brown (10YR 4/3); very sandy; loose; structureless; lumps and specks of grey sand; gradual boundary.
Bw1	**23-38 cm**	Yellow (10YR 5/6); sandy; structureless; loose; fewer fine roots; few grey grains; diffuse boundary.
Bw2	**38-85 cm**	Yellow (10YR 5/6); sandy; loose; floury; diffuse boundary.
C	**85-200 cm**	Yellow brown (10YR 5/8 to 7.5YR 5/8); sandy.

FERRALIC ARENOSOL

Horizon	Depth cm	pH		Cation exchange me %									CaCO₃ %
		H_2O	KCl	CEC (Ca)	TEB	% BS	Ca HCl N/20	Mg	K HCl N/20	Na	Al	H	
Ah	0—8	4.1		4.25			0.85		0.06				
AB	8—23	4.1		2.95			0.35		0.04				
Bw1	23—38	4.2		2.1			0.80		0.03				
Bw2	38—85	4.3		1.6			0.50		0.06				
C	85—200	4.5		1.5			0.55		0.06				

Horizon	Sol. salts	Organic matter				Particle size analysis %						Flocc. index	Free Fe_2O_3 %
		% C	% N	C/N	% OM	stones	c. sand	f. sand 0.25-0.05	silt 0.05-0.002	clay	texture		
Ah		1.32	0.105				23.2	63.5	1.5	11.8			5.2
AB		0.80	0.055				19.6	67.9	1.4	11.1			6.2
Bw1		0.30	0.024				18.2	62.6	2.1	17.1			8.5
Bw2		0.14	0.015				21.3	61.2	2.0	15.5			8.7
C		0.12	0.013				20.1	60.6	1.7	17.6			9.7

LUVIC ARENOSOL **Ql**

Subarid red-brown soil Senegal

Reference R. Maignien, *Agronomie tropicale*, No. 5, September-October, 1958, p. 546, 549, 553, 559, 560

Location Central livestock raising station, Darha, about 2 000 m from the northwest corner; approximately 15° 30'W, 15° 20'N

Altitude

Physiography Gently rolling

Drainage Well drained

Parent material Argillaceous sandstone of the *continental terminal*

Vegetation Fairly close savanna, but with degraded species of *Balanites aegyptiaca* and *Acacia verek* dominants and some *Grewia bicolor*. Grass cover formed of an association of *Schoenefeldia gracilis* and *Eragrostis tremula* mixed with *Aristida mutabilis* and *Andropogon amplectens*

Profile description

A	**0-28 cm**	Beige moderately humus-bearing horizon; sandy texture; platy structure over the first 2 or 3 centimetres, afterwards becoming crumbly, but weak and not very stable; very few pores; horizon subsequently becomes rather compacted; many roots.
AB	**28-58 cm**	Ochre-grey horizon again fairly well provided with organic matter; very sandy; moderate, slightly angular nuciform; many pores resulting from the arrangement of the peds; weak to medium cohesion; a subhorizontal, slightly hardened iron-stone clay furrow 45 cm down.
Bt1	**58-110 cm**	Ochre-rust horizon; sandy texture; moderately angular nuciform; slightly hardened horizon; many small non-tubular pores; medium to strong cohesion; three slightly hardened iron-enriched furrows.
Bt2	**110-150 cm**	Ochre-yellow horizon; sandy, slightly clayey texture; slightly hardened; ill-defined structure; many rather large pores; strong cohesion, a visible furrow at 150 cm.

LUVIC ARENOSOL

Horizon	Depth cm	pH		Cation exchange me %									CaCO₃ %
		H_2O	KCl	CEC	TEB	% BS	Ca	Mg	K	Na	Al	H	
A	0—25	6.9		7.4	2.24	30.2	1.64	0.50	0.04	0.06			
AB	45—55	5.6		4.1	1.88	45.8	1.28	0.50	0.04	0.06			
Bt1	100	5.3			2.96		2.10	0.74	0.04	0.08			
Bt2	130				2.95		1.91	1.00	0.04	0.10			

Horizon	Sol. salts	Organic matter				Particle size analysis %						Flocc. index
		% C	% N	C/N	% OM	stones	c. sand	f. sand	silt	clay	texture	
A		0.20	0.024	8.3	0.34		32.0	61.0	2.6	5.7		
AB		0.17	0.018	9.4	0.29		30.5	59.0	4.5	7.4		
Bt1			0.017				29.5	55.5	2.1	14.4		
Bt2			0.015									

EUTRIC REGOSOL **Re**

Raw mineral regosolic soil Mauritania

Reference P. Audry, *Observations sur les sols et la végétation en Mauritanie du sud-est et sur la bordure adjacente du Mali*, p. 112-114. Rome, FAO, 1962

Location Middle course of Wadi Initi; 17° 28' 30''N, 7° 15'E

Altitude

Physiography Sandy mound of aeolian origin 20 m from the edge of the wadi; slight current renewal of wind erosion

Drainage Excessive

Parent material Aeolian sand

Vegetation Steppe grassland of *Aristida pallida* and *Panicum turgidum* (mixture of annuals and perennials in patches); profile near a strong tuft of *Panicum*; some shrubs

Climate Saharian climate of Aubreville; average annual rainfall about 100 mm

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Profile description

A **0-10 cm** Very light brown (10YR 7/4 dry, 6/4 moist) sandy horizon showing marked bedding of sands of different sizes (beds from 5 to 10 mm thick) resulting in a structure of platy to granular tendency; very weak cohesion.

C **10-175 cm** Red-yellow to light brown (7.5YR 6/4 dry and 6/6 moist) horizon; fine sand, showing small black trails; structure of granular tendency; dry at 175 cm; many *Panicum* roots throughout the horizon.

EUTRIC REGOSOL

Horizon	Depth cm	pH		Cation exchange me %									CaCO$_3$ %
		H_2O	KCl	CEC	TEB	% BS	Ca	Mg	K	Na	Al	H	
A	0—10	6.7		3.28	1.87	57	1.00	0.72	0.11	0.04			0
C1	60—80	7.6		2.52	1.75	69	1.12	0.52	0.08	0.03			0
C2	150—170	7.5		2.80	1.57	56	1.00	0.48	0.05	0.04			0

Horizon	Sol. salts	Organic matter				Particle size analysis %						Flocc. index	Total P_2O_5 %	pF3	pF4.2	EC mmhos/cm Extract 1/5
		% C	% N	C/N	% OM	stones	c. sand	f. sand	silt	clay	texture					
A		0.03	0.006	6	0.06		57.2	40.6	0.6	0.9			0.16	2.1	0.9	14
C1		0.05	0.005	10	0.09		34.1	62.8	0.9	1.1			0.16	2.8	1.8	18
C2		0.04	0.007	6	0.07		38.2	57.6	0.8	1.1			0.76	2.0	0.8	37

ORTHIC SOLONETZ So

Solonetzic soil, Odendaalsrust profile	South Africa
Reference	C.R. van der Merwe, *Soil groups and subgroups of South Africa*, p. 44, 46, 47, 48, 51. Pretoria, 1941
Location	About 29 km east of Odendaalsrust; 27° 50'S, 26° 50'E
Altitude	1 350 m
Physiography	Gently undulating, almost flat topography
Drainage	Impeded at depth
Parent material	Ecca shales
Vegetation	*Themeda triandra* (" rooigras ") and scattered thorntrees
Climate	500 mm of rain per year; 80% of precipitation falls during the summer months, October to March. Average temperature about 16°C with very strong heat in December-January and severe cold on winter nights with frost

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Profile description

A	**0-15 cm**	Brownish ashy grey sandy loam; slightly dense; cloddy and granular; deficient in humus; abundant roots.
Bn1	**15-35 cm**	Dark brown sandy clay, the fissures of which are filled with dark blackish brown colloidal material; columnar structure and cubical substructure; very few fine roots confined to the cracks; internal colour of the clods lighter than the external colour.
Bn2	**35-70 cm**	Light brown speckled white sandy clay; fairly dense breaking to irregular lumps; no roots; small amount of calcium carbonate.
C	**70-100 cm**	Brown sandy clay with slightly blue tint; mottled white and light brown; fairly compact and cloddy.

ORTHIC SOLONETZ

Horizon	Depth cm	pH		Cation exchange me %										CaCO₃ in CO₂ %
		H_2O	KCl	CEC	TEB	% BS	Ca	Mg	K	Na	$\frac{Na}{T}$	H		
A	0—15	6.3		6.8			3.76	2.88	0.37	0.66	9.7			0
Bn1	15—35	8.1		20.1			12.56	7.42	0.34	3.19	15.8			0.2
Bn2	35—70	8.2		17.7			11.00	7.70	0.38	3.71	20.9			1.2
C	70—100	8.7		18.1			10.62	8.03	0.42	3.85	21.5			2.5

Horizon	Sol. salts	Organic matter				Particle size analysis %						Flocc. index
		% C	% N	C/N	% OM	stones	c. sand 2-0.13	f. sand 0.13-0.05	silt 0.05-0.002	clay	texture	
A		0.77	0.07	11.0			27.0	48.6	10.3	14.4		
Bn1		0.79	0.08	9.9			22.6	35.6	7.3	34.5		
Bn2		0.21	0.03	7.0			20.7	39.3	7.3	30.7		
C							21.1	34.3	7.1	32.2		

Horizon	SiO_2	Fe_2O_3	Al_2O_3	TiO_2	$\frac{SiO_2}{Al_2O_3}$	$\frac{SiO_2}{K_2O_3}$	CaO	MgO	Na_2O	K_2O	P_2O_5
	Percent						Percent				
A	88.5	1.11	5.02	0.50	30.2	26.5	0.46	0.73	0.19	0.72	0.04
Bn1	78.9	2.36	9.13	0.56	14.6	12.6	0.89	1.03	0.39	0.84	0.04
Bn2	80.9	1.79	7.52	0.49	18.3	15.8	1.89	1.13	0.36	0.75	0.03
C	73.9	1.74	7.61	0.48	16.3	14.2	5.79	1.37	0.33	0.71	0.03

CHROMIC VERTISOL	**Vc**
Typic Chromustert	Sudan
Reference	J. Buursink, *Soils of central Sudan*, p. 86 and 94. Schotanus and Jens, Utrecht, 1971
Location	Valley of the Blue Nile northwest of Er-Roseires, 7 km north of Damazin; 11° 52'N, 34° 21'E
Altitude	474 m
Physiography	High terrace of the Nile, flat, but gilgai relief with an amplitude of 12 cm and wavelength of 5 m, 5 to 10% of the soil surface being filled with cracks
Drainage	Fairly low permeability of the subsoil; dry from 0 to 150 cm, very slightly moist below; depth of water table unknown
Parent material	Calcareous alluvia of the Blue Nile
Vegetation	Dry region woodland savanna, with *Acacia seyal* dominant but no grasses
Climate	Tropical semiarid with summer rainfall of 776 mm; average monthly temperature ranges from 26.1°C (August) to 32.1°C (April). Potential evapotranspiration (Thornthwaite) 1 798 mm

Profile description

Ah1	**0-1 cm**	Loose granular surface mulch; clear wavy boundary.
Ah2	**1-18 cm**	(2.5Y 4/2 dry, 2.5Y 3/2 moist), clay with small streaks of brown (10YR 5/4 dry) sand; medium angular blocky; sticky and plastic; hard; very small (5 mm) hard black rounded iron nodules; non-calcareous; some cracks 3 cm wide partly filled with surface mulch; very fine roots; very few large tree roots; clear wavy boundary.
AC	**18-60 cm**	(2.5Y 4/2 dry, 2.5Y 3/2 moist) clay, with some irregular streaks of brown sand which sometimes fill cracks; fairly fine angular blocky structure with some wedge-shaped aggregates; sticky and plastic; hard when dry; some pressure faces increasing in number and size with depth; very small hard black rounded iron nodules; slightly calcareous; the cracks generally finish at the base of the horizon, some large cracks continue down to 90 cm, and there are still some 2 cm wide at 50 cm depth; very few fine roots and very few large tree roots; gradual wavy boundary.
CA	**60-150 cm**	(2.5Y 4/2 dry, 2.5Y 3/2 moist) clay, with some sand streaks; angular structure with slickensides; very sticky and plastic; extremely hard; frequent slickensides with grooved surface up to 20 cm in diameter; pressure faces also frequent; very few iron nodules; very few small hard limestone concretions; the whole slightly calcareous; very few fine roots along slickensides; gradual wavy boundary.
C	**150-200 cm**	Equal mixture of clay of colours 2.5Y 4/2 and 2.5Y 4/1; structureless; very hard; some not clearly visible pressure faces and slickensides; very few small hard white limestone concretions; slightly calcareous as a whole; very few very fine roots.
Cck	**200-275 cm**	Accumulation of large (2 to 3 cm) white limestone concretions in 2.5Y 3/2 clay.

CHROMIC VERTISOL

Horizon	Depth cm	pH		Cation exchange me %									$CaCO_3$ %
		H_2O 1/5	KCl	CEC p.H 8.2	TEB	% BS	Ca	Mg	K	Na	Al	H	
Ah1	0—1	6.8		45.2	40.4		22.6	16.5	1.3	tr.			
Ah2	1—18	7.5		50.1	46.3		26.4	19.2	0.7	tr.			
AC	18—60	7.9		50.0	42.6		23.7	18.1	0.7	0.1			
CA	60—90	8.6		50.4	46.3		26.4	18.7	0.8	0.4			0.1
CA	90—120	8.7		45.8	45.1		25.3	18.6	0.8	0.4			0.2
CA	120—150	8.8		54.1	51.3		29.2	20.7	0.8	0.6			0.6
C	150—175	8.8		56.0	54.1		31.4	21.2	0.9	0.6			0.5
Cck	200—250	9.0		48.1	55.5		33.5	20.9	0.8	0.3			7.5

Horizon	Sol. salts	Organic matter				Particle size analysis %						Flocc. index
		% C	% N	C/N	% OM	stones	c. sand	f. sand	silt	clay	texture	
Ah1		1.29		22			16.1	23.3	10.7	49.8		
Ah2		0.64		19			16.4	22.5	7.3	53.8		
AC		0.48		22			14.6	21.7	9.6	54.1		
CA							13.5	19.6	11.2	55.7		
CA							15.2	20.6	8.8	55.4		
CA							12.2	18.3	9.0	60.5		
C							12.4	17.3	12.7	57.6		
Cck							10.1	16.4	10.9	62.6		

Horizon	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	Ignition loss	$\frac{SiO_2}{Al_2O_3}$	$\frac{SiO_2}{R_2O_3}$	Co	Mn	Ni	Sr	Zn	Clay minerals			Apparent density
													Mt	K	Q	
	Percent							ppm								
Ah1	61.2	14.6	7.6	1.3	7.0			26.0	510	36.5	312	63.0	xxxx	x	tr.	1.56
Ah2	58.2	14.9	8.2	1.4	6.3			17.0	718	35.5	306	70.0				1.75
AC	58.8	15.2	7.9	1.4	5.9			18.5	860	31.0	291	63.5				1.78
CA	63.8	15.2	8.1	1.4	6.0			19.0	850	40.5	279	84.5				1.82
CA	58.5	15.1	7.6	1.3	5.9			20.0	625	40.0	270	58.5				1.82
CA	58.5	15.4	8.2	1.4	6.4			23.5	580	40.5	234	68.5				1.79
C	59.9	15.5	8.4	1.4	6.3											
Cck	54.9	14.5	7.8	1.4	9.1											

PELLIC VERTISOL	**Vp**
Vertisol Chisumbanje, B1 series	Rhodesia
Reference	J.G. Thompson, *The soils of Rhodesia and their classification*, p. 43. Salisbury, Government Printer, 1965
Location	Near Chisumbanje, east of Sabi river; 20° 50'S, 32° 15'E
Altitude	About 550 m
Physiography	Flat topography, slight gilgai microrelief
Drainage	Normal drainage
Parent material	Basalt
Vegetation	Grasses in clumps, especially *Urochloa* on mounds, but the soil is generally bare in microdepressions
Climate	Approximately 405 mm annual rainfall between November and March; the higher temperatures and lowest humidities occur in September-October

Profile description

A1	**0-3 cm**	Variable depth, dark grey (N 2/0 moist) heavy clay; very moist; very friable *in situ* but true consistence is very firm; very fine granular microstructure discernible even in the moist state but the wide vertical cracks normally evident in the dry state have closed up; despite moisture status soil mass takes up water readily; some isolated very small hard carbonate concretions; numerous roots; irregular and very gradual boundary.
A2	**3-25 cm**	Very dark grey (N 2/0 moist) heavy clay; very moist; similar to preceding horizon but some of the larger granules show slickenside surfaces; some small hard carbonate concretions; numerous roots; rather abrupt boundary.
AC1	**25-70 cm**	Very dark grey (N 2/0 moist) heavy clay; slightly moist; the horizon consists of huge blocks up to 30 cm across separated by vertical cracks 5 to 7.5 cm wide; the blocks themselves have a moderately angular structure which is irregular owing to internal movements; intersecting slickensides are prominent; some hard carbonate concretions up to 1.25 cm in diameter and some isolated quartz and agate pebbles; dry consistence is very hard and the soil mass takes up water slowly, swelling visibly in the process; fairly numerous roots which in the vicinity of the wide cracks have been broken and torn apart by shrinkage on drying out; fairly clear boundary.
AC2	**70-100 cm**	Black (N 2/0 moist) heavy clay; slightly moist becoming moderately moist with depth; irregular moderate angular blocky; pronounced intersecting slickensides; vertical cracks narrow to a width of less than 0.25 cm; consistence, because of moisture status, is somewhere between very hard and extremely firm; soil mass takes up water very slowly, swelling in the process; fairly numerous small carbonate concretions becoming more numerous with depth; fairly numerous roots; clear boundary.
Cck	**100-140 cm**	Highly calcareous gravelly weathering basalt; numerous hard carbonate concretions in addition to soft powdery free carbonate; several tongues and thin stringers of black clay occur mainly in the first 5 to 7.5 cm of this horizon; the general colour is slightly yellowish; some isolated fine roots.

PELLIC VERTISOL

Horizon	Depth cm	pH		Cation exchange me %									CO_3 %
		H_2O sat.	KCl	CEC	TEB	% BS	Ca	Mg	K	Na	Al	H	
A1 / A2	0—17	7.3		65.5	100.7	100	66.0	34.7	2.1	0.7			35.2
AC1	30—45	7.4		65.1	102.1	100	65.6	36.5	2.0	1.2			37.0
	57—75	7.4		67.8	102.0	100	64.2	37.8	2.0	2.0			34.2
AC2	85—100	7.6		72.2	109.6	100	70.1	39.5	2.1	2.8			37.4

Horizon	Sol. salts	Organic matter				Particle size analysis %						Flocc. index	CEC clay
		% C	% N	C/N	% OM	stones	c. sand	f. sand	silt	clay	texture		
A1 / A2							4	8	12	76			86
AC1							3	10	10	77			85
							3	8	11	78			87
AC2							2	7	11	80			90

Horizon	pF3	pF4.2	Area m²/g		Hydraulic conductibility in cm/h		Nature of the clay
			total	external	initial	final	
A1 / A2	64	43	587	224	1.4	1.0	
AC1	64	44	557	250	0.9	1.0	montmorillonite
	66	44			0.7	0.7	
AC2	68	48	567	260	0.6	0.5	

EUTRIC PLANOSOL **We**

Estcourt form, Enkeldoorn series	South Africa
Reference	J.J. van der Eyk, C.M. Macvicar, J.M. de Villiers, *Soils of the Tugela basin*, p. 152. Natal, Town and Regional Planning Commission, 1969
Location	Dundee; 27° 57'S, 30° 13'E
Altitude	1 219 m
Physiography	Gently undulating; ecological region: dry interior basin; profile taken from the upper parts
Drainage	Alternating surface moisture and dryness; virtually impermeable B horizon
Parent material	Ecca sandstone
Vegetation	*Tristachya* and *Digitaria* grassland
Climate	Rainfall 720 mm a year, June-July-August practically dry; average temperature 18°C; 23.5°C in January, 11.5°C in June

Profile description

AE	**0-41 cm**	Dry, dark grey (10YR 4/1) fine sandy loam becoming lighter in colour just above the B horizon; no visible structure; moderately porous; slightly hard; abrupt smooth boundary.
Bg	**41-71 cm**	Slightly moist; variegated dark grey and dark grey-brown (10YR 4/1-4/2) sandy clay, with very dark grey-brown (10YR 3/2) coatings on ped surfaces; strong medium prismatic structure; very dense, very firm and very hard angular substructure; gradual wavy boundary.
Cck	**71-127+ cm**	Slightly moist; grey brown (2.5YR 5/2) sandy clay with some distinct coarse yellowish brown mottles and some dark brown ped coatings, the latter decreasing with depth; strong medium angular structure; very dense; very firm to very hard; some black ironstone and manganese concretions; infrequent lime nodules; horizon appears to have been gleyed at one time.

EUTRIC PLANOSOL

Horizon	Depth cm	pH		Cation exchange me % $BaCl_2$ - triethanolamine pH 8.2									$CaCO_3$ %
		H_2O	KCl	CEC	TEB	% BS	Ca	Mg	K	Na	Al	H	
AE	0—41	5.7		6.2	3.7	60	1.5	1.9	0.2	0.2			
Bg	41—71	6.8		17.6	15.7	89	5.1	7.3	1.7	1.6			
Cck	71—127+	7.3		18.7	18.7	100	5.8	8.8	2.0	2.0			

Horizon	Sol. salts	Organic matter				Particle size analysis %						Flocc. index	CEC clay
		% C	% N	C/N	% OM	stones	c. sand	f. sand	silt	clay	texture		
AE		0.5	0.06				22	58	4	15			41
Bg		0.3	0.07				13	39	4	44			39
Cck		0.1	0.05				12	41	3	44			42

SOLODIC PLANOSOL	Ws
Solonetz on sandy clay material derived from granite	Upper Volta
Reference	R. Boulet, *Etude pédologique de la Haute-Volta, région centre-nord*, p. 259. Dakar-Hann, ORSTOM, 1968
Location	Tassamakat; 14° 18' 30"N, 0° 19' 35"W
Altitude	
Physiography	Denudation slopes of less than 1% not dominated by relief; crest line with so large a radius of curvature that is is difficult to situate it on the terrain
Drainage	Poor at the surface at certain times of the year; severe rapid drying at the beginning of the dry season; drainage impeded deep down.
Parent material	Calco-alkaline granite
Vegetation	Thorny steppe: *Acacia seyal*, *Acacia raddiana*, *Balanites*
Climate	Annual rainfall 540 mm; average temperature in May 34°C, January 23.5°C, evapotranspiration 3 582 mm; very irregular rainy season from mid-June to mid-September.

Profile description

		Surface appearance: thin blackish grey crust eroded into channels (1 cm deep) revealing denuded light brown surfaces.
E1	**0-8 cm**	Light grey (10YR 6/1) horizon with anastomosed linear ochre (10R 6/6) mottles often located around the pores; fine sandy texture; massive structure; medium to strong cohesion; very low tubular porosity; rooting system situated in this horizon; abrupt wavy boundary.
E2	**8-9 cm**	Thick (2 to 5 mm) coating of the same colour as the preceding horizon but almost entirely without ochre mottles; sandy texture; vesicular porosity; this coating is linked physically to the columns in the next horizon which it covers.
Bn1	**9-14 cm**	Juxtaposed columns of polygon section with dome top; the top of the columns is composed of a horizon 5 cm thick; brown, slightly red (7.5YR 4/4) with reticulate grey (10YR 5.5/1) mottles; clay sand texture; massive structure; excessive cohesion; very hard; very low tubular porosity.
Bn2	**14-21 cm**	Red-brown (5YR 4/4) sandy clay horizon, same structure.
Bn3	**21-40 cm**	Bottom of the columns ochre-brown (7.5YR 4.5/4); diffuse faint yellow mottles; appearance of friable feldspars; at about 40 cm the columns disappear and give way to a horizon with a somewhat finer prismatic structure; clear boundary.
Bn4	**40-60 cm**	Light ochre-brown (7.5YR 5/5) with diffuse beige (10YR 6/3) zones; some likewise diffuse red mottles; many feldspars; sandy clay; prismatic structure; substructure of small horizontal platelets 1 to 3 cm thick; very hard horizon; very low porosity; abrupt boundary.
BC	**60-140 cm**	Variegated horizon with whitish grey (10YR 6/2) matrix; diffuse beige (10YR 5.5/4), ochre (10YR 6/5) and red (5YR 5/4) mottles; black concretions with red edges; sandy clay; massive structure breaking to blocky; excessive cohesion; very hard; very low porosity; slightly calcareous.
Bck	**140-180 cm**	Beige-grey (10YR 5.5/4) with yellow-ochre (10YR 6/5) mottles; abundant large calcareous accumulations set in a less calcareous matrix; sandy clay; massive structure with oblique cracks; some polished faces; excessive cohesion; very hard; very low porosity.

NOTE: The analysis given relates to a neighbouring profile.

SOLODIC PLANOSOL

Horizon	Depth cm	pH		Cation exchange me %									CaCO$_3$ %
		H_2O	KCl	CEC	TEB	% BS	Ca	Mg	K	Na	Al	$\frac{Na}{T}$	
E1	0—8	6.4		7.55	5.25	70	2.76	2.11	0.16	0.12		1.6	
Bn1	9—14	6.5		7.85	5.50	70	3.02	2.08	0.10	0.32		4.1	
Bn2	14—21	7.1		10.40	9.20	88	5.54	2.86	0.08	0.71		6.8	
Bn3	30—40	7.6		13.00	12.30	95	7.85	3.35	0.11	1.00		7.7	
Bn4	40—60	7.7		11.80	12.30	100	8.39	2.81	0.12	1.02		8.6	
BC	100—120	7.8		12.70	12.60	100	9.54	2.12	0.08	0.90		7.2	0.10
Bck	170—180	8.7		19.20	19.70	100	16.60	2.00	0.09	1.02		5.7	1.10

Horizon	Sol. salts	Organic matter				Particle size analysis %						Flocc. index
		% C	% N	C/N	% OM	stones	c. sand	f. sand	silt.	clay	texture	
E1			0.05	14.2	1.35		25.5	37.4	22.1	13.6		
Bn1			0.04	11.2	0.81		25.8	35.6	22.4	15.4		
Bn2			0.03	10.9	0.61		22.5	33.3	16.3	27.3		
Bn3			0.02	9.0	0.49		21.4	30.9	14.6	32.6		
Bn4				6.0	0.24		22.6	31.3	10.9	35.0		
BC					0.15		28.3	32.8	9.0	29.7		
Bck					0.13		21.7	31.8	14.0	32.4		

Horizon	pF3	pF4.2	Usable water %	Apparent density	Porosity cm^3/100g	Permeability K	Structural instability Is	Free iron %	Total iron %	Free iron / Total iron
E1	10.6	4.5	6.1			0.7	3.77	1.83	2.50	23
Bn1	10.0	4.8	5.2	1.92	12.0	0.4	5.33	2.02	2.66	76
Bn2	13.4	7.7	5.4	1.96	10.9	1.1	3.71	2.49	3.12	80
Bn3	16.6	10.5	6.1	1.97	10.7	0.9	4.33	2.59	3.25	80
Bn4	18.4	11.1	7.3	1.99	10.2	0.2	6.89	2.15	3.10	69
BC	16.1	9.4	6.7	1.98	10.6	0.6	4.55	1.86	2.83	66
Bck	17.1	10.6	6.5	2.00	10.0	1.4	3.26	2.08	3.10	67

CALCIC XEROSOL Xk

Semiarid and desert soil, Loeriesfontein profile	South Africa
Reference	C.R. van der Merwe, *Soil groups and subgroups of South Africa*, p. 30, 33, 34, 37. Pretoria, 1941
Location	17 km southwest of Loeriesfontein, 31°S, 19° 20'E
Altitude	750 m
Physiography	Undulating topography; profile taken from slight slope
Drainage	Excessive
Parent material	Dwyka tillite
Vegetation	" Asbos " (genus *Psoculon*) and *Mesembrianthemum*
Climate	Rainfall 200 mm per year; average temperature around 17°C

Profile description

Ah	**0-15 cm**	Light brown loamy sand; friable to crumbly; some fairly thick roots; low humus content.
A	**15-25 cm**	Light brown, mottled white, fairly loose loamy sand; some thin roots.
Bwk1	**25-45 cm**	Similar to A but containing limestone lumps.
Bwk2	**45-75 cm**	White calcareous sandy loam; slightly dense.
		All these horizons contain waterworn stones derived from the Dwyka formation, scattered through the soil section.
Ck	**> 75 cm**	Partly decomposed shale with veins and streaks of calcium carbonate; not sampled.

CALCIC XEROSOL

Horizon	Depth cm	pH H₂O	pH KCl	CEC	TEB	% BS	Ca	Mg	K	Na	Al	H	CO_2 %
		pH		Cation exchange me %									
		H_2O	KCl	CEC	TEB	% BS	Ca	Mg	K	Na	Al	H	
Ah	0—15	8.1											1.92
A	15—25	7.8											7.16
Bwk1	25—45	7.7											25.5
Bwk2	45—75	7.9											14.1

Horizon	Sol. salts	Organic matter				Particle size analysis %						Flocc. index
		% C by combus-tion	% N	C/N	% OM	stones	c. sand	f. sand	silt	clay	texture	
Ah		0.61	0.07	8.2		13.7	33.3	32.0	19.5	14.4		
A		0.42	0.06	6.9		21.9	33.8	32.5	19.9	14.6		
Bwk1		0.41	0.04	10.2		7.6	31.7	27.5	22.8	18.4		
Bwk2		0.13	0.02	6.5		30.8	28.6	19.5	28.4	24.1		

Horizon	SiO_2	Fe_2O_3	Al_2O_3	TiO_2	$\frac{SiO_2}{Al_2O_3}$	$\frac{SiO_2}{R_2O_3}$	CaO	MgO	Na_2O	K_2O	P_2O_5
	Percent						Percent				
Ah	72.1	5.07	11.54	1.06	10.6	8.3	1.44	1.55	1.70	2.19	0.09
A	57.2	3.75	10.41	0.78	9.3	7.6	11.09	1.91	1.49	2.25	0.16
Bwk1	27.4	2.23	4.76	0.29	9.8	7.5	31.76	3.52	0.37	0.70	0.18
Bwk2	45.9	2.65	6.87	0.55	11.4	11.1	19.41	4.24	0.91	1.09	0.15

GYPSIC XEROSOL	**Xy**
Gypsum crust	Tunisia
Reference	M. Pouget, *Contribution à l'étude des croûtes et encroûtements gypseux de nappe dans le sud tunisien,* Cahiers de l'ORSTOM, Vol. VI, No. 3-4, p. 341, 1968
Location	Island of Djerba on the edge of the sea between Sidi Mahrez and the Tourgueness lighthouse, 33° 50'N, 11°E
Altitude	10 m
Physiography	Rolling topography with small coastal dunes
Drainage	Water table 130 cm deep in February, 140 cm in May, originating in oolitic limestone
Parent material	Very calcareous dune sand on oolitic limestone of the Tyrrhenian
Vegetation	*Imperata cilindrica* and palms
Climate	Arid but alleviated by the sea influence of the Gulf of Gabes; rainfall between 100 and 200 mm; violent precipitation in the cold season; average temperatures January 11.5°C and July 26.8°C; the warm season lasts about three months. Potential evapotranspiration about 1 410 mm

Profile description

Ah	**0-20 cm**	Pale brown (10YR 7/4) coarse sand.
A1	**20-45 cm**	Pale brown (10YR 6/4) coarse loose sand; many *Imperata* roots.
A2	**45-70 cm**	Pale brown (10YR 7/4) coarse loose sand; palm roots.
Bym	**70-90 cm**	Very pale brown (10YR 7/3); indurated gypsum crust resulting from water table evaporation; very finely microcrystallized; slightly porous; pseudogley; clear boundary with the lower horizon.
Cy	**90-115 cm**	Light grey (10YR 7/2) loamy sand; weak consistence; gypsum accumulation.
Cg	**115-140 cm**	Loose sandy gley.

GYPSIC XEROSOL

Horizon	Depth cm	pH H₂O	pH KCl	CEC	TEB	% BS	Ca	Mg	K	Na	Al	H	$CaCO_3$ %
		pH		Cation exchange me %									
Ah	0—20	8.9											44.5
A1	20—45	8.5											41.5
A2	45—70	8.4											41.9
Bym	70—90	8.3											24.2
Cy	90—115	8.2											29.2
Cg	115—140	8.2											38.4

Horizon	EC mmhos/cm	Organic matter				Particle size analysis %						Flocc. index
		% C	% N	C/N	% OM	stones	c. sand	f. sand	silt	clay	texture	
Ah	1.2				0.47		56	42	0.5	0.0		
A1	0.9				0.26		42	52	0.0	3.5		
A2	1.3				0.26		52	43	0.0	4.5		
Bym	4.5				0.15		44	31	8.0	12.5		
Cy	3.8				0.15		37	41	7.0	11.5		
Cg	4.1				0.10		39	50	2.5	9.0		

Horizon	Soluble salts — Saturation extract in me/l					Gypsum %
	Cl	CO_3H	Ca	Mg	Na	
Ah	1.6	1.7	5.5	4.0	2.3	0.7
A1	2.4	2.4	3.0	3.0	5.1	0.8
A2	5.0	2.4	4.5	4.5	7.1	0.4
Bym	17.0	1.8	35.5	4.5	35.6	40.1
Cy	9.0	0.9	32.5	4.5	17.4	27.8
Cg	14.0	1.3	32.0	6.0	21.3	14.6

Horizon	Dry residue g/l	EC mmhos/cm	pH	me/l					
				Ca	Mg	Na	Cl	SO_4	CO_3
Water table in Feb.	3.68	4.1	8.0	31.6	9.2	14.3	11	40.1	2.4
Water table in May	3.5	4.0		31.6	7.6	16.1	13	35.0	3.0

CALCIC YERMOSOL	**Yk**
Sierozem with limestone nodules	Algeria
Reference	T.G. Boyadgiev, *Les sols du périmètre de l'Atouta* (*Hodna*). Profile No. 15. Algeria/FAO, 1971. (Unpublished)
Location	South of the M'Sila-Barika road, 7.2 km from Barika, 35° 26'N, 5° 17'E
Altitude	470 m
Physiography	Undulating topography with gravelly hills
Drainage	Good
Parent material	Tensiftian glacis; loamy matrix containing considerable gravel
Vegetation	Gypso-calcarophilous with *Anabasis cropediorum* and *Arthrophytum scoparium*
Climate	220 mm rainfall per year with irregular distribution over the year; very dry summer; average annual temperature 18.5°C, January 8°C and July 30°C

Profile description

Au1	**0-11 cm**	(9YR 6/4 dry) sandy loam; stony, almost massive; cloddy locally; very porous; rich in roots and fine roots; some limestone shells; clear boundary.
Au2	**11-28 cm**	(9YR 6/4) very sandy fresh loam; fine subangular blocky breaking to small granules; very porous; many tunnels and coprolites; shell debris; common fine roots; small whitish mottles; clear boundary.
AB	**28-37 cm**	Same as the preceding with slightly gravelly lenses; clear boundary.
BA	**37-48 cm**	(9YR 5/5) sandy loam; fine subangular blocky; very porous; many tunnels and coprolites; some stones; some fine roots; calcareous mycelia; clear boundary.
Bk	**48-67 cm**	(10YR 5/6) slightly clayey, slightly sandy loam with many limestone accumulations and nodules; subangular to angular blocky breaking to small granules; very porous; many tunnels and coprolites; clear boundary.
BCk	**67-78 cm**	Same as the preceding but with gravel and stones; limestone nodules; clear wavy boundary.
Ck1	**78-90 cm**	Loamy, slightly gravelly; clear boundary.
Ck2	**90-128 cm**	(10YR 6.5/6) loam; almost massive structure with limestone accumulations and nodules; porous but less so than the preceding horizons.

CALCIC YERMOSOL

Horizon	Depth cm	pH		Cation exchange me %									CaCO$_3$ %
		H$_2$O	KCl	CEC	TEB	% BS	Ca	Mg	K	Na	Al	H	
Au1	0—11	8.2		8			20	2	0.87	0.90			24
Au2	11—28	8.2		11			20	3	0.87	0.98			27
AB	28—37	8.2		10			18	3	0.87	0.94			28
BA	37—48	8.1		11			18	3	0.81	0.89			32
Bk	48—67	8.1		12			20	3	0.67	0.91			
BCk	67—78	8.1		13			18	3	0.40	0.91			39
Ck1	78—90	8.3		11			18	4	0.26	1.00			44
Ck2	90—128	8.2		10			20	4	0.26	1.10			46

Horizon	EC mmhos/cm	Organic matter				Particle size analysis %						Flocc. index
		% C	% N	C/N	% OM	stones	c. sand	f. sand	silt	clay	texture	
Au1	0.5	0.38	0.035	11	0.6		23	41	20	14		
Au2	0.6	0.26	0.026	10	0.4		20	34	22	18		
AB	0.6	0.25	0.023	11	0.4		20	35	22	19		
BA	0.6	0.24	0.022	11	0.4		19	36	22	19		
Bk	0.7						13	32	22	23		
BCk	0.6						17	30	26	24		
Ck1	0.6						18	25	28	24		
Ck2	0.9						20	27	32	20		

Horizon	Mineral reserves	P$_2$O$_5$ available ppm	K$_2$O available ‰	Active limestone %	Gypsum %	Apparent specific weight	pF 4.2	pF 3	K Index Hénin cm/h	Is
	Total P$_2$O$_5$ %									
Au1	0.80	43	3.8	11	tr.	1.6	6.9	9.9	3.6	6.2
Au2	0.80	35	4.0	14	tr.	1.6	7.2	10.4	5.0	3.9
AB	0.70	31	3.0	14	tr.	1.6	7.5	10.6	4.1	4.1
BA				15	tr.	1.6	8.1	12.1	5.4	3.5
Bk				15	tr.	1.6	8.0	12.3	4.0	2.7
BCk				16	tr.	1.8	8.1	12.8	3.7	3.4
Ck1				15	0.33	1.7	8.3	13.1	2.2	3.8
Ck2				15	0.40		9.3	13.3	2.8	3.9

GLEYIC SOLONCHAK Zg

Halomorphic soil with undegradable structure, saline group	Algeria
Reference	T.G. Boyadgiev, *Les sols du Hodna.* Rome, FAO, 1972. (Unpublished)
Location	Middle of the Hodna sebkha about 35 km south of M'Sila 35° 24'N, 4° 35'E
Altitude	392 m
Physiography	Bottom of water-collecting depression
Drainage	Very poor
Parent material	Quaternary alluvial deposits
Vegetation	None
Climate	About 220 mm of annual rainfall; average annual temperature 18.5°C, 8°C in January and 30°C in July

Profile description

Az	**0-5 cm**	Light yellowish brown (10YR 6/5 dry) silty clay; very sticky, plastic; massive structure in the shape of fine porous polygons; many salt crystals; clear boundary.
AC	**5-14 cm**	Olive brown (10Y 5/4) silt loam; sticky, plastic; lenses of stratified clay locally, with whitish mottles and coatings on ped surfaces; very slightly porous; some rust mottles; clear boundary.
Cz1	**14-38 cm**	Olive brown silty clay with stratified clay; more numerous rust mottles; diffuse boundary.
Cz2	**38-80 cm**	Idem, but very massive structure; diffuse boundary.
Cz3	**80-116 cm**	Idem, without stratified clay and with few rust and greyish mottles; some crystal accumulations; diffuse boundary.
Cz4	**116-154 cm**	Idem, with stratified clay; small crystals; very slightly porous; rust mottles; diffuse boundary.
Cz5	**154-190 cm**	Silty clay; sticky, plastic; massive structure; slightly porous; stratified clay in places; rust and grey mottles; whitish coatings in places.

GLEYIC SOLONCHAK

Horizon	Depth cm	pH		Cation exchange me %									$CaCO_3$ %
		H_2O	KCl	CEC	TEB	% BS	Ca	Mg	K	Na	Al	H	
Az	0—5	7.4											14
AC	5—14	7.8											23
Cz1	14—38	7.6											12
Cz2	38—80	8.1											14
Cz3	80—116	8.0											14
Cz4	116—154	8.1											13
Cz5	154—190	8.0											15

Horizon	Sol. salts	Organic matter				Particle size analysis %						Flocc. index
		% C	% N	C/N	% OM	stones	c. sand	f. sand	silt	clay	texture	
Az		0.9	0.08	11.4	1.5		3.3	0.3				
AC		0.7	0.08	9.1	1.2		3.8	8.4	54.0	17.0		
Cz1		0.8	0.07	11.4	1.4		0.8	0.9				
Cz2		0.6			1.0		0.8	1.3				
Cz3							0.2	0.1				
Cz4							0.2	0.6				
Cz5							0.1	0.7				

Horizon	Soluble salts me/100 g								Gypsum %
	EC mmhos/cm	Co_3H	So_4	Cl	Ca	Mg	Na	K	
Az	177	0.3	5.7	175.2	7.0	8.8	147.4	0.6	3.4
AC	3	0.4	0.6	1.2	0.4	1.0	0.8	0.1	tr.
Cz1	136	0.2	9.5	138.9	9.2	7.2	124.1	0.6	8.4
Cz2	76	0.3	10.0	92.8	8.0	4.8	82.5	0.5	7.0
Cz3	102	0.2	12.0	110.7	7.4	6.6	97.6	0.6	4.3
Cz4	90	0.3	13.3	132.8	8.3	6.8	122.0	0.5	3.6
Cz5	106	0.2	11.3	103.4	6.6	6.9	94.2	0.5	1.4

TAKYRIC SOLONCHAK **Zt**

Halomorphic soil with undegraded structure, saline alkali group	Algeria
Reference	T.G. Boyadgiev, *Les sols du Hodna.* Rome, FAO, 1972. (Unpublished)
Location	25 km south of M'Sila, boundary with the sebkha; 35° 30'N, 4° 28'E
Altitude	401 m
Physiography	Salt depression or chott
Drainage	Imperfect
Parent material	Quaternary alluvial deposits
Vegetation	*Salsola tetrandra* and *Atriplex halimus*
Climate	About 220 mm of annual rainfall; very dry summer; average annual temperature 18.5°C, 8°C in January and 30°C in July

Profile description

Az	**0-8 cm**	Pale brown (10YR 6/3 dry), yellowish brown (10YR 5.5/4 moist) clay; sticky, plastic; degraded platy structure breaking to polygons at the surface; salt patches and accumulations; clear smooth boundary.
Bz1	**8-35 cm**	Idem, but with weak coarse blocky structure with clear small and medium whitish mottles; very few roots and very slightly porous; diffuse boundary.
Bz2	**35-58 cm**	Slightly lighter-coloured, silty clay loam; massive; some rust-coloured mottles; many salt and gypsum patches; gradual boundary.
By	**58-84 cm**	Clay loam with light-coloured sediment lenses associated with distinct, small but fairly sharp rust-coloured mottles; small clear salt and gypsum patches; clear boundary.
C	**84-104 cm**	Silt loam.

TAKYRIC SOLONCHAK

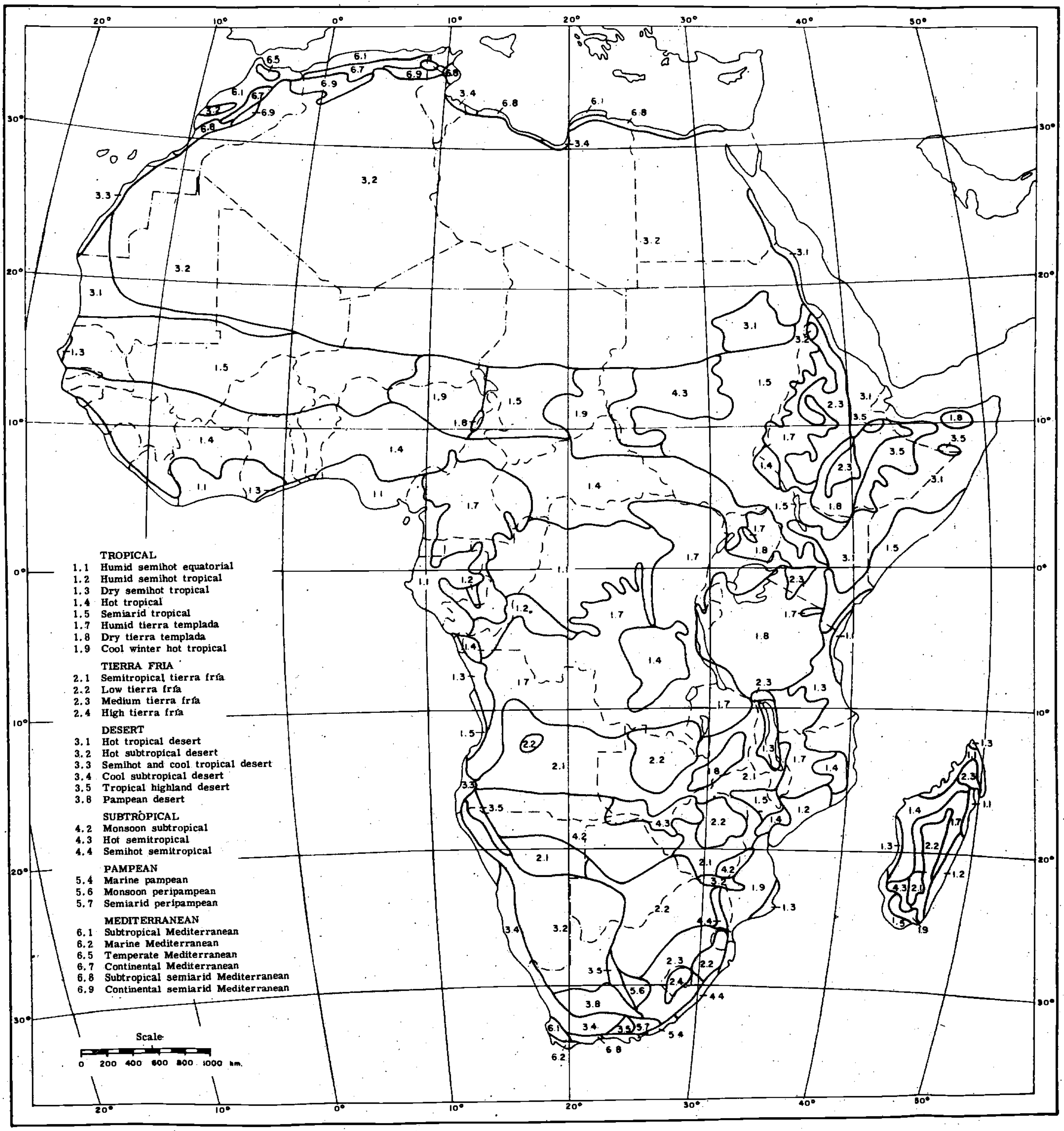
Horizon	Depth cm	pH		Cation exchange me %									$CaCO_3$ %
		H_2O	KCl	CEC	TEB	% BS	Ca	Mg	K	Na	Al	H	
Az	0—8	7.1											27
Bz1	16—26	7.7											23
Bz2	40—51	7.8											25
By	58—84	7.8											29
C	89—99	7.9											34

Horizon	Sol. salts	Organic matter				Particle size analysis %						Flocc. index
		% C	% N	C/N	% OM	stones	c. sand	f. sand	silt	clay	texture	
Az		0.59	0.07	7.5	1.0		0.3	1.8	50.7	41.1		
Bz1		0.79	0.11	7.1	1.3		0.4	0.7	41.4	52.1		
Bz2		0.60	0.09	6.3	1.0		6.7	0 4	50.2	34.4		
By		0.55			0.9		0 0	0 6	65.1	27.5		
C		0.36			0.6		0 0	14 9	68.5	15.2		

Horizon	Soluble salts me/100g						EC mmhos/cm
	Co_3H	So_4	Cl	Ca	Mg	Na	
Az	0.12	1.27	61.9	28.0	10.1	29.2	78
Bz1	0.14	3.11	33.1	10 4	6.5	21.6	51
Bz2	0.18	4.29	27.3	6.6	5.6	19.1	41
By	0.24	4 31	23.9	4.5	5.2	18 5	40
C	0.18	4.17	16.6	3.1	3.2	14.4	41

1. CLIMATES

1. CLIMATIC REGIONS

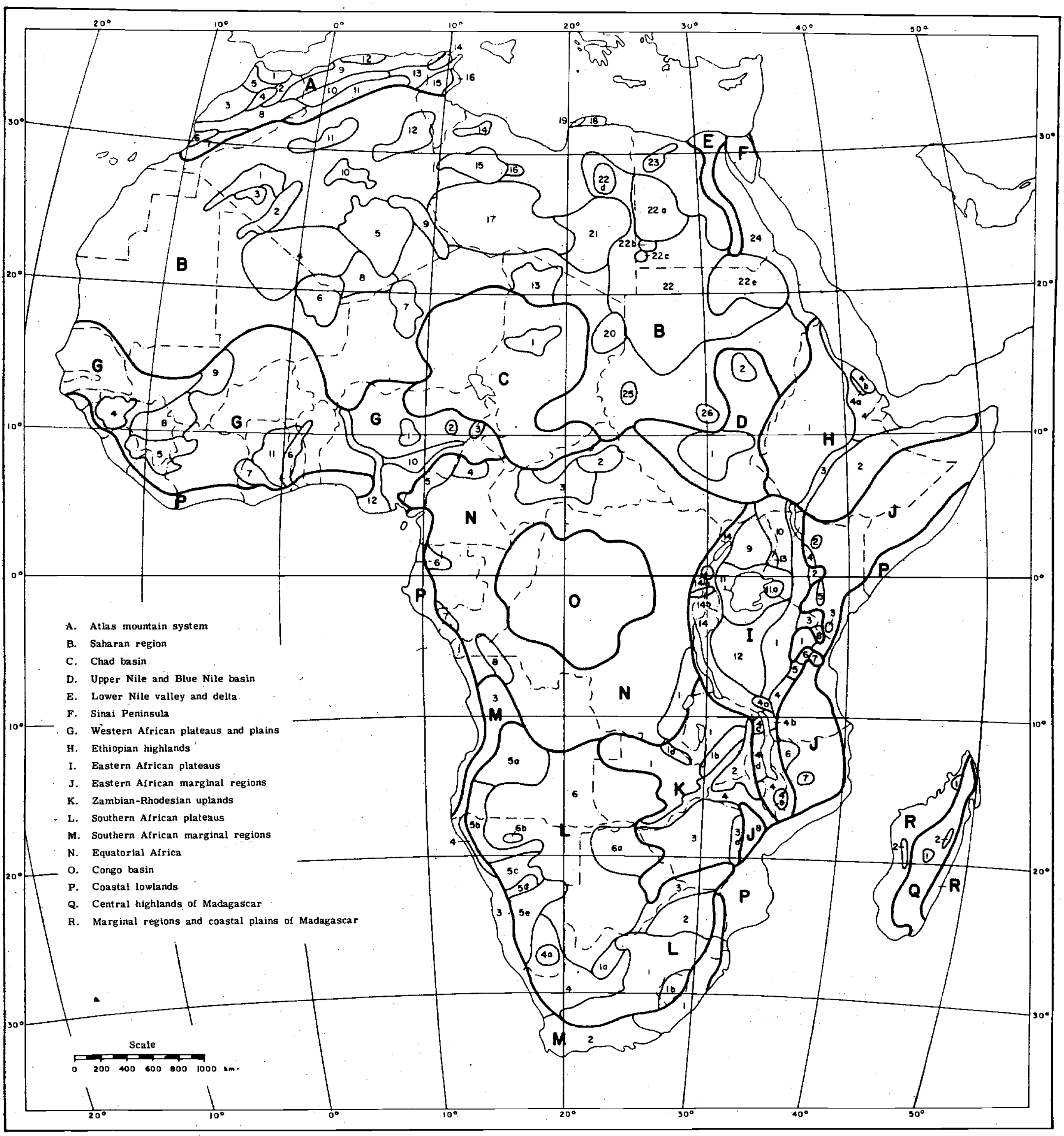


2. VEGETATION


1. TROPICAL WET EVERGREEN FOREST
a. Tropical lowland rain forest
b. Regularly inundated tropical forest
c. Tropical swamp forest
d. Tropical montane rain forest
2. TROPICAL DECIDUOUS AND SEMIDECIDUOUS FORESTS
a. Tropical semideciduous rain forest
b. Tropical semideciduous montane forest
c. Large-leaved rain-green dry forest (Myombo)
d. Small-leaved rain-green dry forest with umbrella trees
3. TROPICAL INUNDATED COASTAL FORMATIONS
a. Mangroves
4. SAVANNA
a. Large-leaved semideciduous tree savanna
b. Open rain-green thorntree savanna
c. Moist savanna
d. Inundated savanna
e. Dry savanna
f. Highland dry savanna
g. Thornbush savanna
h. Reed swamps
5. MEDITERRANEAN MACCHIA AND FORESTS
a. Hard-leaved shrub bushes (macchia)
b. Partly evergreen thorny shrubs
6. TEMPERATE AND MEDITERRANEAN WOODS AND FORESTS
a. Coniferous montane forest
b. Mediterranean laurel forest
c. Open hard-leaved forest
d. Evergreen oak and pine forest
e. Coniferous dry forest
7. STEPPE
a. Subtropical highland grass steppe
b. Temperate dry short-grass steppe
c. Tussock steppe
8. SEMIDESERT FORMATIONS
a. Thorntrees and succulents
b. Very open shrubby succulents
c. Tropical and subtropical semidesert low vegetation
d. Succulent semidesert
e. Halophyte semidesert
9. DESERT FORMATIONS
a. Subtropical desert with cushion plants
b. Desert with isolated bushes
c. Sand desert
d. Tropical montane desert
e. Halophyte desert
f. Oasis vegetation
Scale
0 200 400 600 800 1000 km.

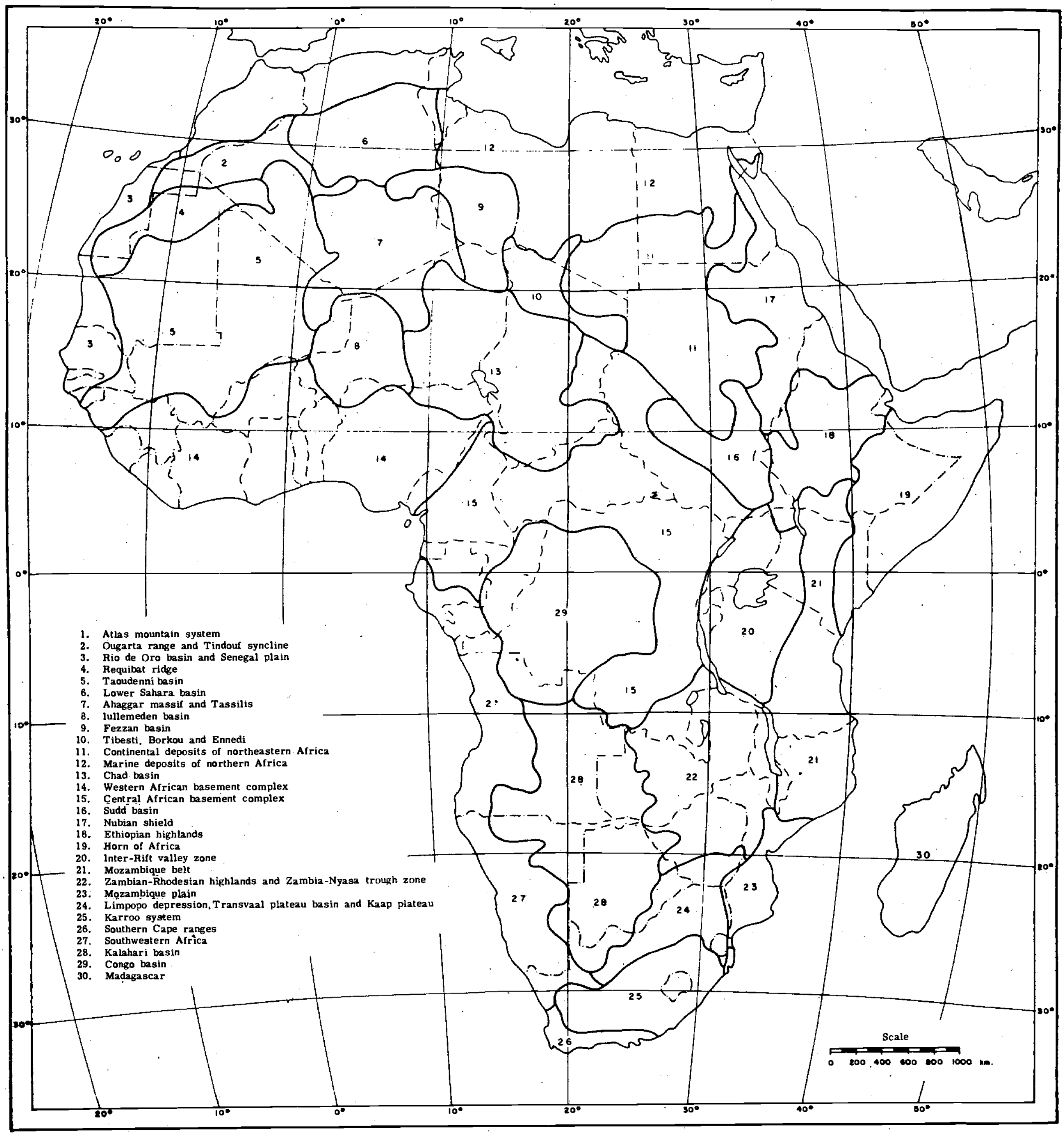
3. GEOMORPHOLOGY

3. GEOMORPHOLOGICAL REGIONS



4. GEOLOGY

4. GEOLOGICAL REGIONS



5. LITHOLOGY

5. BROAD LITHOLOGICAL REGIONS

6. SOILS


Scale
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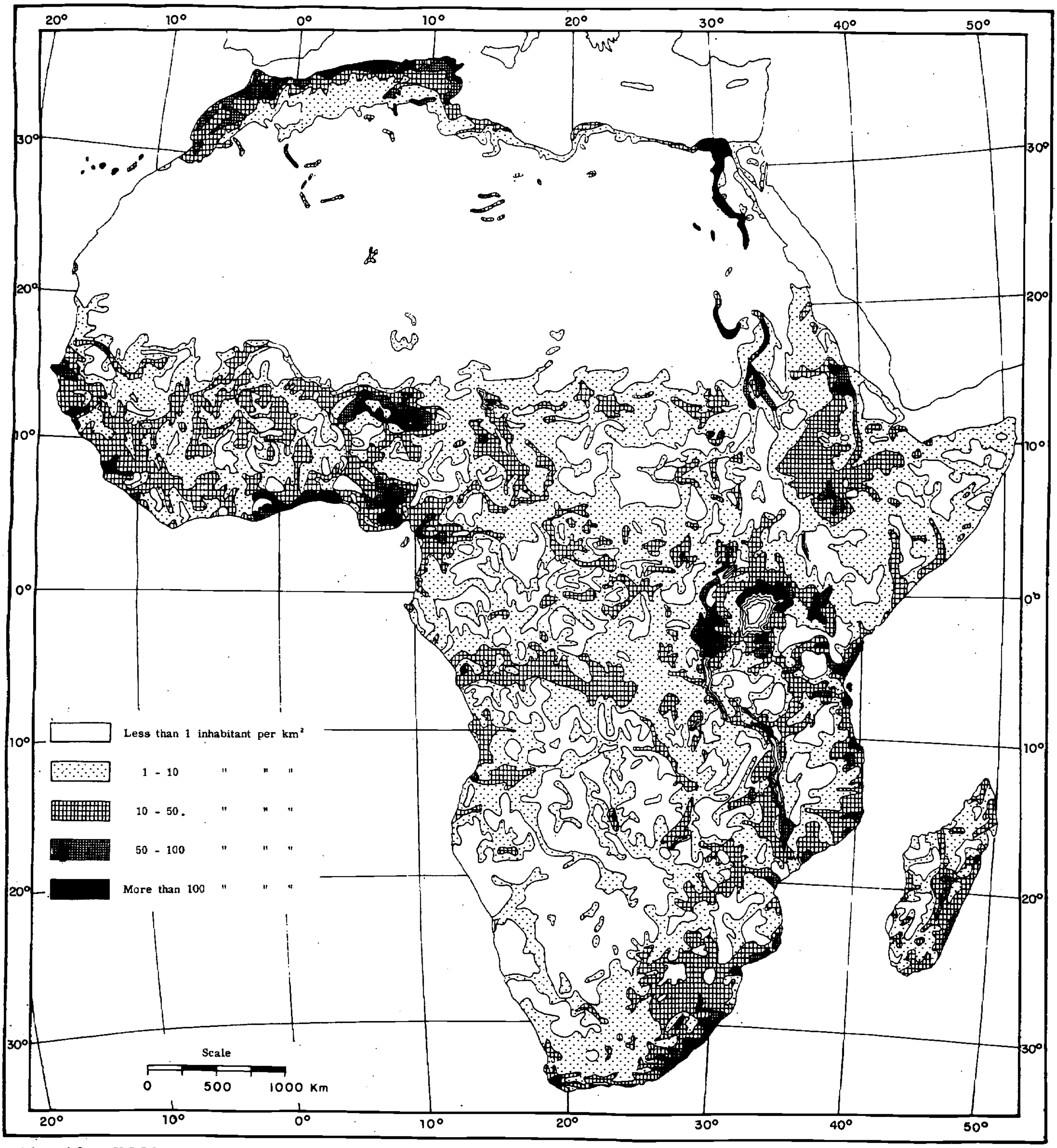
7. POPULATION



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