ANNUAL REPORT 1981

International Soil Museum - Wageningen - The Netherlands

ISM was born out of an initiative of the International Society of Soil Science, and was adopted by Unesco as one of its activities in the field of earth sciences. It was formally founded on 1st January 1966 by the Government of the Netherlands, upon assignment by the General Conference of Unesco in 1964.

Most of the ISM working funds are provided by the Dutch Ministry for Education and Sciences, and are accountable to the Directorate of Technical Assistance (DTH) of the Ministry of Foreign Affaires.

The constituing members of the Board of ISM are the International Institute for Aerial Survey and Earth Sciences (ITC) in Enschede, the Agricultural University of Wageningen (LH) and the Dutch Directorate of Agricultural Research (DLO).

Advise on the programmes and activities of ISM is given by an Unesco-FAO appointed International Advisory Panel (IAP) and by a Netherlands Advisory Council (NAC).

The financial-administrative responsibility for the working funds and for the permanent staff of ISM rests formally with the Board of Governors of the ITC.

Erratum

ISM Annual Report 1981.
Last paragraph on p. 44 should follow after the ninth line on p. 46.

INTERNATIONAL SOIL MUSEUM
9 Duivendaal / P.O. Box 353, 6700 AJ Wageningen, The Netherlands.
Tel. 08370 - 19063. Cable address: ISOMUS, Wageningen, The Netherlands.
Bank account: AMRO-Bank Wageningen, nr. 41 31 03 196.

ANNUAL REPORT 1981

ISM

International Soil Museum - Wageningen - The Netherlands

CONTENTS

1 INSTITUTIONAL DEVELOPMENTS

1981 was the third year that ISM operated in and from its permanent premises in Wageningen. Most activities were maintained at the level of the previous years. For the first time a formal course in the establishment of soil reference collections has been held, which will henceforth constitute a fixed element in the ISM programme. Noteworthy is also the considerable number of guest researchers that has worked at ISM during 1981. However, guest researchers usually deal with specialized subjects and their activities do compete to some extent with the execution of the ISM core programme. A case in point is the build-up of a systematic documentation on soils and soil-related subjects, which should be developed if ISM is to function as an international reference centre on soils of the world and their use. This and other functions could not be developed to its required level due to serious shortage of core personnel. At the same time there is a need for more working space and storage facilities.

Faced with the insufficiency of the staffing and the housing facilities, and in view of the commitment of the Dutch government vis-à-vis the international organizations to foster ISM, requests were submitted already in 1980 asking for an increase of the Netherlands contribution to ISM, to allow it to become fully operational.

As a follow-up the Dutch government invited Unesco and FAO to appoint a high-level Evaluation Mission for ISM. This mission took place from 7 to 11 December 1981 and its members were:

Dr. F. di Castri, Director, Division of Ecological Sciences, Unesco
Dr. R. Dudal, Director, Land and Water Development Division, FAO
Dr. F. Fournier, Consultant to the Division of Ecological Sciences, Unesco.

Its terms of reference were to make recommendations on the aims and scope of the future work of ISM; its organizational structure, and the requirements for personnel, type of management, buildings and other material facilities. In addition, an indication should be given of the relevance of the ISM's activities for developing countries. The conclusions of the mission are to be used as a point of departure for a decision by the Netherlands Government in consultation with the appropriate international organizations on the financing and management of ISM in the future.

In preparation for the mission, discussion topics included the possible growth of ISM towards a more independent and formally established institute, under the guarantee that the status and rights of its present personnel will be secured. Also it was felt that the present name did not express clearly enough the function of ISM as an international reference and information centre.

Results of the Mission's activities may take quite some time to materialize, because of complicated Dutch inter-Ministerial consultations on the subject.

Some progress was made in strengthening the ties with international organizations, and towards increased international funding. Unesco pledged support for the course on the establishment of soil reference collections, UNEP has identified ISM in its draft Plan of Action for a World's Soil Policy/GEMS programme, possibly to be followed by programme support. Contacts were maintained on the establishment of an International Board of Soil Resources Management.

Use for soil classification and correlation

Once a national soil survey organization has been established and an exploratory inventory of a country or region has been made, it is particularly useful to start building up a soil reference collection. This helps soil classification, correlation and soil interpretation. The collection also forms a basis for discussion and co-operation between the soil surveyor and the soil scientists and laboratory technicians working at headquarters. Foreign soil scientists on a short visit to the country, may exchange useful information about the classification of the soils on display and their production potential.

A collection of soils also enables specific research programmes to be set up. These may be of a comparative character (e.g. the study of Nitosols in various environments) or may be problem-oriented (e.g. salt-affected soils). An important research application is the use of collections of soil monoliths for the transfer of agro-technology.

Use for planning purposes

Although in many instances the nature and behaviour of the soil is taken into account in the planning process, there is room for improvement in the communication between the soil scientist and agronomist, the extension officer, the land use planner, the farmer, the policy maker, and the administrator.

Soil monoliths and related data and information on climate, physiography, land use, and other ecological factors can convey convincingly the differences in soil characteristics and their use limitations, especially if the collection is accompanied by a series of maps, schematic cross-sections, colour photographs, etc.

Planners are not easily enticed to join the soil surveyor/land evaluator on extensive field travel, and to dirty their clothing by jumping in and out of pits. Agronomists and conservationists working in a certain area will want to have a quick overview of conditions in other parts of the country for comparison. In the case of large countries with underdeveloped transportation facilities and at the same time a great variety of natural regions and farming systems, it is often impossible to organize guided tours to field reference sites. A national soil reference collection at a centrally located site is the next best source of soil information.

Use for educating the general public

In many developed and developing countries there is an increasing awareness of the importance of soil as a natural resource that merits conservation. The media, especially television, can play a major role in making the public more 'soil-conscious'. To arouse public interest, soil reference collections should be established, and material from them conveniently displayed. Such collection could form part of a natural history museum, either integrated with other aspects of the environment or presented as a separate topic. Or a national soil museum could be established, especially if a large collection of monoliths is available.

Attention should not only be focussed on the soils as such but also on the place of soil in the physical and biotic environments, and the link between soil and farming system. As well, aspects of soil conservation and soil degradation features such as salinization and desertification can be very instructively illustrated in a collection cum exhibition.

Contents of a soil reference collection

Items that could be included in a soil reference collection are mentioned below. Obviously, the aims and purposes of the collection (see earlier) will largely determine what the collection contains. The aims do change, however, and some of the items mentioned below may be not have an immediately obvious purpose, but could be very useful at a later date.

Monoliths or lacquer profiles

Monoliths are soil profiles, collected in boxes and impregnated indoors. They are usually 25 cm wide and 125 to 150 cm long, The thickness of the impregnated soil varies, but is usually from 2 to 5-8 cm. Monoliths show many of the natural soil characteristics such as colour, structure, horizonation, rooting depths.

Lacquer profiles are soil profiles impregnated in the field. They may be the same size as a soil monolith but are usually much thinner and the structural characteristics of the soil cannot be observed as well as in a monolith.

Both methods of taking soil profiles and the resulting impregnated products have theirs advantages and disadvantages. Details are given in ISM Technical Paper 1 (Van Baren & Bomer, 1979). To allow physical, chemical, mineralogical, and micromorphological analysis to be done, samples of the soil should be taken (bulk samples, pF samples, and undisturbed micromorphological samples). If the soil is taken to show a specific feature, (for example, laterite, plinthite, a cemented pan, a surface crust, or carbonate nodules) specimens of these features should also be collected.

As a matter of course, a complete description of site and soil has to be made according to internationally accepted standards (e.g. FAO Guidelines for Soil Profile Description; FAO, 1977). This description includes data on climate, vegetation and land use, farming systems, landforms, parent material and other data important for assessing soil-related land qualities.

Publications and photographs

To give a complete picture of site and soil it is very useful to assemble publications (including maps) on the soil and on the geology, vegetation, land use, climate, and other relevant subjects. Yield data, infiltration rates, hydraulic conductivity of the substratum and other data should also be collected. Obviously, colour photographs and/or colour slides are very helpful in showing the landscape, vegetation, land use, etc. Also, the site where the profile was collected should be photographed. For information about photographing soil profiles and landscapes, see ISM Technical Paper 2 (Ragg & Creutzberg, 1981).

Presentation

There are many ways in which the material collected can be presented. The method chosen depends on such aspects as the aim and purpose of the collection, the number of monoliths/lacquer profiles, facilities available, the staff available to present and maintain the display, etc. Some examples are given below

- A collection of soils for education/study at an agricultural university, soil survey institute, or similar.
This collection should be displayed in a permanent set-up. The monoliths and/or lacquer profiles shoulds be tilted backwards some 10-15 degrees, with their bases on a table or, preferably, on specially designed staging equipped with bench-hooks. Since the lacquers used for the impregnation usually decompose under the influence of ultraviolet light, the monoliths should not be exhibited in full daylight. Aim for the best artificial illumination. It is very useful to present colour photographs of the landscape and site, graphs, tables and other relevant information near the monolith. The soils can be arranged in various ways, e.g. by region, or by catena, or by soil-related land qualities, or by taxonomic aspects.

-A collection of soils for the information of the general public.
A soil collection is regarded as a useful addition to natural history and earth science museums. Since soil profiles, especially soil monoliths, are unfamiliar items, they need explanation. It is also useful to show the place of soil science in relation to other natural sciences and to point out the variety of uses that can be made of soil data. The soil can then be presented as an important part of the ecosystem, highlighting aspects such as the formation of the soil from the parent material by the action of soil-forming factors. Different kinds of rocks and soil material can be shown for comparison. Soil material is also used for manufacturing various types of bricks and earthenware and is needed for the construction of roads and even of mud-houses, and therefore these aspects could also be touched on, as they emphasize the general utility of soil material.
The soil monolith or lacquer profile itself should be supplemented with relevant information about vegetation, land use, location in the landscape, and other geographical information. Agricultural aspects such as the crops grown and the various land qualities are also to interest many visitors. If feasible, free hand-outs should be available on the material presented.

If there are too many monoliths for the exhibition space, adequate storage facilities should be available. Lacquer profiles can be hung on walls or hooked onto runners sliding along a track fixed to the ceiling or onto wooden beams, thereby considerably increasing the storage capacity of a room. Soil monoliths, which are much heavier, are best stored horizontally in sturdy wooden or metal racks. The maximum weight that the floor can bear must be taken into account. It is best to keep the soils in the dark. For further information see ISM Technical Paper 1 (Van Baren & Bomer, 1979).

The role of the International Soil Museum

Since its inception and especially since the establishment of a formal annual course, ISM has given written and oral information, advice and training on taking and preserving soil profiles and on the use of soil reference collections. This information ranges from the technical aspects of displaying and storing soils and data, to the best ways of providing different types of information to people who visit such collections.

a. It can advise on
   - taking and preserving soil monoliths and collecting relevant information and data (including which chemicals and equipment to use, etc.).
   - how to display soil reference collections and the associated relevant information and data on soils (including advise on illumination, handling of photographs, etc.).
   - Storage of soil monoliths.

Visitors to the ISM (preferably by appointment) can receive this advice verbally. Written information can also be given, but this is normally of a more general nature, unless the question is specific. The advise is usually provided free of charge, especially to people from, or working in developing countries.

b. At the request of some developing countries and with the support of Unesco, the ISM now gives a short course every year entitled: 'International Course on the Establishment and Use of Soil Reference Collections'.
   The course is given during 4-5 weeks in April/May of each year. Preference is given to participants from developing countries who will be engaged in setting up soil reference collections. Some Unesco fellowships are available for persons attending this course. After the course, participants will be able to set up a soils collection and be familiar with all the related activities mentioned earlier. The ISM can provide further technical back-up to such projects.

c. ISM personnel have had practical experience in collecting and preserving soils and setting up soil reference collections in a number of countries and they are available for consultancy work.

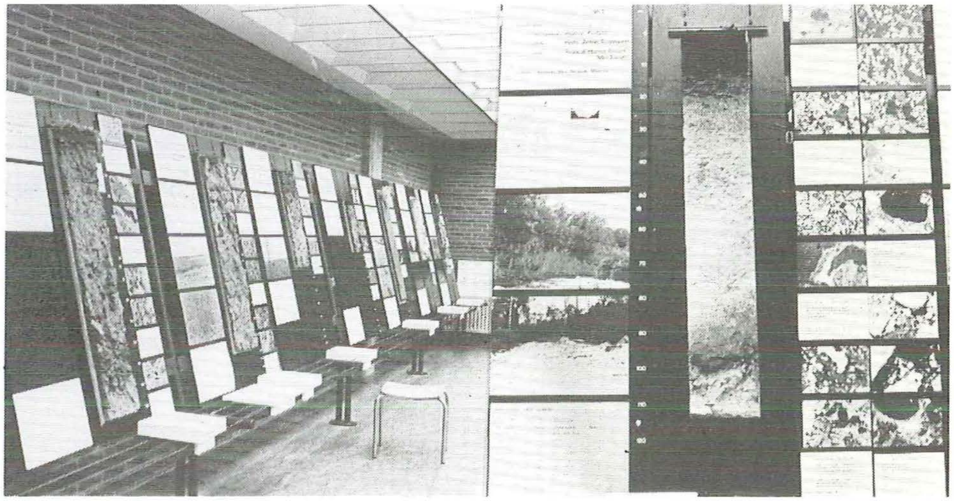
References

FAO, 1977: Guidelines for soil profile description. 2nd ed. Rome, 66 pp. ISBN 92-5-100508-7, also available in French and Spanish.

Ragg, J.M. and D. Creutzberg, 1981: The photography of soils and associated landscapes. ISM Technical Paper 2, Wageningen, 12 pp. ISBN 90-6672-005-0

Van Baren J.H.V. and W. Bomer, 1979: Procedures for the collection and preservation of soil profiles. ISM Technical Paper 1, Wageningen, 23 pp. ISBN 90-6672-004-2.

Examples of soil profile display.
Soil Museum of the Nanking Institute of Soil Science, China *(above)*.
Exhibition Hall of the International Soil Museum, Wageningen, The Netherlands *(below)*.



2.2 NITOSOLS, A QUEST FOR SIGNIFICANT DIAGNOSTIC CRITERIA

W.G. Sombroek and W. Siderius

Abstract

Nitosols constitute some of the most productive soils of the tropics and the subtropics and cover about 15 per cent of the total land area in those regions. Although their specific properties and characteristics were recognized at an early stage of soil mapping, their proper classification remained problematic because of vague definitions and loose application of the original Nitosol concept.

This paper reviews the most salient properties of the Nitosols in relation to their natural environment and outlines some aspects of their formation. To facilitate easier recognition the term Nitisols is introduced for those soils that correspond to the origional concept, and criteria for a nitic B horizon are presented.

Proposals are made for the application of the Nitisol concept in the FAO-Unesco legend of the Soil Map of the World, while a niti great group is suggested for the Alfisol and Ultisol orders of the U.S. Soil Taxonomy.

In addition, attention is given to the agricultural potential of the soils, especially with regard to the uptake and availability of K, P and N under conditions of rainfed arable farming by small-holders.

Introduction

Throughout the tropics and subtropics, tracts of land occur with well drained, very deep, dusky red to dark reddish brown clayey soils, that have a strongly developed fine blocky structure with shiny surfaces. They have a high stability, friable consistence, high porosity, good moisture storage capacity, and deep rooting. The soils are usually found on weathering-prone basic parent materials, or other types of rocks or sediments with basic volcanic ash enrichment. The crushed soil material tends to be magnetic and often reacts to hydrogen peroxide fluid.

The tracts of land concerned have been much sought after for exacting plantation crops like cocoa, coffee, and pineapple. In regions with traditional peasant occupation, they stand out as having near-permanent food crop production, sustained with little or no chemical fertilizers This contrasts with the shifting cultivation practice on surrounding lands with apparently poorer soils and has often resulted in high local population densities (for instance: southern Cameroon; the highlands of Kenya; Java; cf photo 1). The process of preferential and stable agricultural occupation can still be witnessed locally along the recently opened-up Brazilian Trans-Amazon highway.

The specific features and the intensive use of the soils led to the early need to separate them at a high level of classification, even if the areal extent per country or region was often small. In older soil classification systems they were called Krasnozems (USSR), Reddish Brown Lateritic soils (USA), Euchrozems (Australia), Reddish Brown Latosols or Terre Rouge (Indochina), Terra Roxa Estruturada (= structured purple soils, Brazil), Chocolate Brown Soils (East Africa). Many local names exist, of which the "Kikuyu Red Loam" of Kenya may be the most known internationally.

The problem

During the preparation of the FAO-Unesco Soil Map of the World the need for high-level separation of the above described soils was felt, too. Because of their shininess *(Lat. nitidus)* and apparent high fertility *(Lat. nitidissimus annus)*, the project coordinator proposed to give them the name *Nitosols* (Dudal, 1968), to separate them from the chemically poorer Ferralsols and the physically less favourable Luvisols and Acrisols. This was accepted by the international scientific advisory panel for the project, however with a broadening of the concept. This was presumably done to obtain conformity with some of the diagnostic criteria of the "Pale"-great groups of the Ultisols and Alfisols in the USA system of soil classification which was being developed concurrently. In the final definition the Nitosols require only "an argillic B-horizon with a clay distribution where the percentage of clay does not decrease from its maximum amount by as much as twenty per cent within 150 cm of the surface" (and lacking vertic or ferric properties, and plinthite within 125 cm of the surface). They have an ochric or umbric epipedon but lack a mollic A horizon, an albic E horizon, and tonguing as diagnostic for the Podzoluvisols (FAO-Unesco, 1974). Any mention of dark reddish colours, shininess, strong blocky structure, high porosity and high stability, etc., was deleted in the final definition. Also, the soils were placed towards the rear in the classification key, in contrast to other very deep and strongly weathered soils of the tropics, e.g. the Ferralsols (with which they were often grouped together in the past as "Lateritic Soils").

As a result, the Nitosols of the final FAO-Unesco legend can now also include: soils of rather sandy texture; soils with a pronounced textural change from the A to the B horizon; soil with a very firm consistence; soils with a low porosity (compact); soil with a very low inherent fertility; and/or soils with any colour other than dusky red or dark reddish brown.

It should be noted that the Nitosol areas of the Soil Map of the World still rather strongly conform to the narrow concept of the unit as originally proposed, apparently because these areas were largely delineated on the various sheets when the definition was still "floating". Soil correlators however who nowadays use the FAO-Unesco legend terminology as a provisional system of reference for classification at small-scale soil surveys are experiencing many problems because of the broad and little specific formal definition of the Nitosols. In fact it is often quite difficult to find representative soil profiles for areas delineated as Acrisols or Luvisols on tropical parts of the World Soil Map, because they key out earlier as Nitosols.

On the other hand, quite a number of soils with apparent "nitic"properties have to be classified otherwise, for instance with the Phaeozems of the prairies (because of the relatively high organic matter content); with the Cambisols of young landscapes (because the vertical clay-increase and/or the laboratory-confirmed percentage of argillans does not quality for an argillic-B horizon); or with the weaker structured and/or more differentiated Acrisols and Luvisols (because they have CEC-clay values below 24 me/100 g, one of the elements of the excluding "ferric properties").

The authors, both with field experience in several tropical countries, share the concern of many colleagues at the application of the formal FAO-Unesco legend definition and keying-out of the Nitosols, while appreciating the need for separation of the soils at the highest level of classification because of their prime agricultural value. This had led them to search for characteristics that are quantifiable and at the same time form a better reflection of the original concept of the Nitosols as outlined in the Introduction. The results may be taken into account at any revision of the FAO-Unesco legend, e.g. through the elaboration, by an inter-institutional Working Group, of an International Reference Base for soil classification (IRB: cf ISSS 1980, 1981). The search has been done through a critical examination of the characteristics of those soil profiles that are exemplary in the older classification systems, or that by the consensus of participants in the field examinations during four recent international soil classification workshop (1977-1981) should key out as Nitosols, *sensu stricto*. Many data is included from Brazil and Kenya, where the soils concerned are relatively frequent, and where one or both of the authors were co-workers with the national soil survey organization for several years. The Kenyan Soil Survey employed the "Nitosols, Kenyan Concept" for several years (c.f. Sombroek and Siderius, 1977; Sombroek and Muchena, 1979) and recently coined them as "Nitisols" to avoid further misunderstandings (Sombroek et al., 1982). The latter term will also be used at the detailed discussions in this article on the characteristics and properties of these soils.

Global extension of Nitosols

According to Volumes II to X inclusive of the Soil Map of the World (FAO-Unesco, 1971 to 1981) Nitosols occur extensively in the tropics and the subtropics. They constitute in these regions major areas for agricultural production (Buringh, 1979).

The total global extension amounts to 208,243,000 ha or about 2.1 million sq. km.. Most Nitosols occur on the African continent (55.5 per cent of the world's total), particularly in Kenya, Zaire, and Cameroon. A second region of major occurrence is Asia (22.2 per cent), followed by South America (12.3 per cent), Mexico and Central America (5.2 per cent) and Australasia (4.5 per cent).

Nitosols cover 15.4 per cent of the total land area in the humid and subhumid tropics and subtropics. Among them, the Dystric Nitosols are most extensive (55.5 per cent), followed by the Eutric (38.5 per cent) and Humic Nitosols (6.0 per cent).

According to the FAO-Unesco Volumes II and V (respectively 1975 and 1981), no Nitosols occur in North America and Europe. However, their limited presence has been reported in the Mediterranean region, notably in Italy (Remmelzwaal, 1978; Spaargaren, 1979). In North America the Davidson, Haiwassi and Corenaca series would meet the requirements for both the Nitosols of the FAO key and the Nitisols of the present paper (Simonson, pers. comm.)

Materials and methods

The background information used for this article is taken from a number of publication covering the following areas:

- *Brazil* (Camargo and Beinroth, 1978, profiles BR 2,4,6,8,12,13,23,24,25 and 28).
- *Kenya* (Siderius and Muchena, 1977, profiles CK 7,19,21,28,51,56,63,67,95 and

Photo 1. Intensive small-holder rainfed farming of tea and foodcrops on the Mollic Nitisols of the uplands of Southwestern Kenya (photograph by courtesy of W.G. Wielemaker).

99; Wielemaker and Boxem, 1982, profiles WK 13,14,16,17,18,20 and 21).
- *Malaysia* (Beinroth and Paramananthan, 1979, profiles M 1 and 3.
- *Thailand* (Beinroth and Panichapong, 1979, profiles T 1 and 14.
- *Indonesia* (Buurman and Subagjo, 1980, profiles KB 1,2 and 3; Dai et al., 1980, profiles ST 10 and 11).

Additional data is obtained from the *United States* (ISM collection USA 3, Davidson series), from *Australia* (Isbell, 1980, Pin-Gin and Malanda series) and *Italy* (Spaargaren, 1979 profiles SP 122 and 186; Remmelzwaal, 1978, profiles 307, A57, A96 and A100).

For a number of the profiles concerned additional laboratory analyses were carried out, viz. determination of the specific surface area and water dispersable clay percentage, in comparison to several non-Nitisol profiles of the ISM collection. A complete profile description, with full analytical data and land evaluation criteria, is given in ISM Soil Monolith Paper 4 (Siderius et al., in prep.).

Characteristics and properties of Nitisols

Drainage conditions

Nitisols have well drained pedons. There is no evidence of a (perched) watertable within 150 cm from the soil surface. Mottles and/or concretions or nodules formed as a result of seasonally impeded drainage are absent within that depth. The free vertical and/or lateral movement of water through the soil is considered essential to its development and properties.

Depth

The depth of the solum (i.e. A and B horizons) is normally 150 cm or more. In many Nitisols this depth requirement is met easily and the C horizon is often not reached within 200 cm from the soil surface.

Horizon sequence

The soils have the following horizons: A, AB, Bt, BC and C. Depending on the land use and percentage of organic matter an Ap or Ah may be recognized. The A horizon is usually not thicker than 20 cm; the combined A and AB horizons may reach 50 cm. The Bt horizon has a thickness of 100 cm or more.

In some Nitisols the BC horizon overlies a thick saprolite (C horizon), in other cases the C horizon may be less than 10 cm thick, and rests directly over the hard rock.

The boundaries between the A and the B and the B and C horizons are gradual to diffuse.

Colour

Most Nitisols have moist and dry colours in the 2.5YR and 5YR hue; yellower hues like 7.5YR or 10YR and redder hues like 10R occur less often. Colour values and chromas in the A horizon vary with the organic matter content. In the B horizon both are relatively low: in moist condition the values range between 3 and 5 (occasionally 6), and the chromas between 3 and 4 (occasionally 6); these figures do not become measurable higher in dry condition, except after crushing of the fine earth. In the Munsell terminology the colours are therefore mostly red, dusky red, reddish brown or dark reddish brown; for the layman they eye as purple or chocolate brown.

Vertical colour changes in the profile are gradual to diffuse. Mottles are absent, or few and weak and the overall appearance of the profile is quite homogeneous.

The red colour is mainly caused by a predominating presence of hematite; yellower hues may be indicative for a higher amount of goethite in relation to hematite.

Structure

The overall structural development is moderate to strong. In the topsoil crumb structures are common, while moderately and strongly developed fine and medium subangular blocky structures may occur, too.

In the subsoil between 50-100 cm depth moderate, fine and medium subangular blocky structures are most common.

An angular blocky structure dominates in the deeper subsoil. The peds are nutty rather than scalloped and are sometimes described as polyhedral. Individual peds tend to break down upon pressure almost indefinitely to ever smaller entities, showing shiny ped surfaces on all sides that are especially apparent in moist
3 condition (photo 2). These lustreous ped surfaces are smooth and /or show slight striation; their occurrence is considered critical for the identification of Nitisols.

During dry periods the soil material can shrink to such an extent that cracks are formed, resulting in weak coarse prismatic super structures. Crack development occasionnally meets the criteria for "vertic" nomination.

The aggregate stability is high in all soil horizons as is shown by the very low percentages of water-dispersable clay in the absence of considerable percentage organic matter. The degree of flocculation (fi = 100 x (1- % dispersed clay/% total clay), is more than 90, i.e. the proportion of water-dispersable clay relative to total clay is less than 10%.

The stability of the structural elements is well observed at the foot of road cut exposures, where they accumulate after being loosened from the soil face at its
2 drying-out (photo 3). The high grade of stability of Nitisols was, also reported by Jayawardane and Beattie (1978), is evidenced by the fairly constant pore size index in nitic soil material subjected to a wide range of salt solutions.

Texture

The texture class, based on the weighted average of the percentage clay from 0-150 cm depth, is clayey (35-60 % clay) or fine clayey (more than 60 % clay) for all profiles.

When the variation in the clay percentage is calculated for fixed depths, it becomes evident that Nitisols show a remarkable uniformity in trend with regard to clay increase and decrease (figure 1).

The typically stretched clay bulge is a significant criterion for the recognition of Nitisols and emphasizes two points: 1) the very gradual increase in clay with depth from the topsoil to the subsoil and 2) the very gradual decrease, if any, of the clay percentage in the subsoil. Pronounced vertical changes in the clay percentage resulting in a definite clay bulge as is common in other soils that have an argillic B horizon like the Luvisols or Acrisols, are absent.

The gradual change in clay percentage is also expressed in the low textural ratios* between the B and the A horizon. The ratio varies between 1.1 and 1.2 for East African Nitisols, and between 1.1 and 1.3 for those in Southeast Asia, while in Brazil the ratio is between 1.1 and 1.6. In general the ratio is often too low to fit the concept of the "kandic horizon" of the ICOMLAC Commission (Moormann et al., in preparation) which requires a ratio of 1.4 or more. Although the clay percentage is very high, the field texture is often estimated as loamy. The apparent higher percentage of coarser fraction is mainly due to the aggregation of the clay under influence of the presence of sesquioxides, particularly hydrated ferric oxide. However, the difference between the deferrated and non-deferrated clay fraction is not nècessarily high or may even be non-existent, as much iron occurs as finely divided crystalline entities in the fraction smaller than 2 micron.

Silt/clay ratio

This ratio is an indication of the weathering stage of the soil material. The silt/clay ratio usually decreases with depth as follows: East Africa 0.41-031-0.20-0.17, South America 0.61-0.35-0.32-0.39, Southeast Asia 0.65-0.39-0.28-0.24. The decrease with depth should at least partially be attributed to incomplete dispersion of the humus-rich topsoils at textural analysis. Nevertheless the data as a whole indicates a weathering stage not as advanced as in Ferralsols (Oxisols) for which values of less than 0.20 are common.

Consistence

In dry condition the soil material is hard; when moist the consistence is very friable to firm; when wetthe material is sticky and plastic. In Nitisols that have a volcanic ash influence the consistence may also be slightly smeary when wet.

Some Nitisols loose their stickiness when the soil moisture content drops below 35-40 % by volume, hence at a soil moisture content drier than the field capacity.

Porosity and moisture storage capacity

Nitisols are known for their high porosity and moisture storage capacity, but actual measurements are scarce.

Some data from East Africa and Indonesia illustrate these characteristics as follows: the average pore space as a percentage of the total volume, in some Kenyan Nitisols from 30 to 150 cm depth at intervals of 30 cm, was respectively 60.9- 56.3- 57.9- 57.0 and 56.0 (Nyandat, 1976). For the same soils the available water in mm/cm soil ranges between 1.1 and 1.5. Additional data on Nitisols from western and central Kenya shows that the available water - in weight percentage and

* the mean of the clay percentage of the subhorizons of the B (exclusive of the BC) divided by the mean of the clay percentage of the subhorizons of the A.

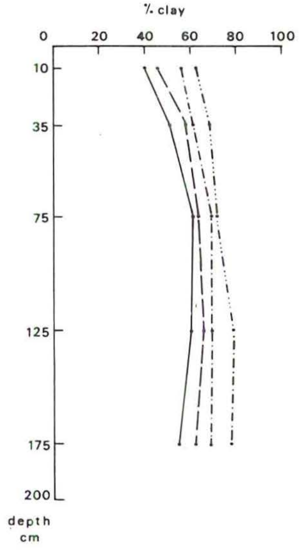


Fig.1 clay profiles

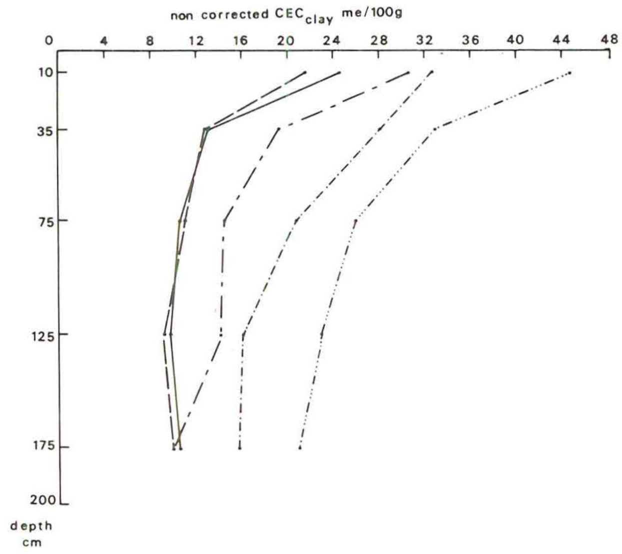


Fig.2 CEC-clay profiles, calculated from CEC soil and % clay not corrected for organic matter

Key:
W. Kenya
C. Kenya
Brasil
Malaysia & Thailand
Indonesia

Figure 1. Clay profiles of selected Nitisols.

Figure 2. CEC-clay profiles of selected Nitisols.

Photo 3.

The occurrence of distinct shiny ped surfaces, especially near the point of the hammer; Humic Nitisol, Bt, 190 cm depth of the volcanic footridges in Central Kenya (photograph by courtesy of H.M.H. Braun).

Photo 2.

Deep road cut in a Humic Nitisol in Central Kenya. Note the accumulation of small structural elements at the base of the profile, formed upon drying out of the exposed soil face (photograph by courtesy of H.M.H. Braun).

calculated as the difference in water held between tensions of pF 2.3 and pF 4.2 - varies between 29% in the topsoil of a Mollic Nitisol to 8% in the subsoil of a Dystric Nitisol. Commonly the Kenyan Nitisols hold between 8 to 12% available water from 50 to 150 cm depth.

These data are somewhat higher than those obtained for a Dystric Nitisol in Indonesia (Buurman and Subagjo, 1980), in which the available water (between pF 2.5 and pF 4.2) decreased from 8.7 % in the topsoil to 5.6 % at 95 cm depth.

The permeability of some Nitisols in East Africa is described as moderately rapid (50 - 160 mm/hr) to moderate (16 - 50 mm/hr) in the deeper subsoil.

Tests with regard to the workability reveal that on most Nitisols tillage operations may be carried out 24 hours after the soil is moistened, without having a destructive effect on the soil structure (Van Alphen, pers. comm.).

Exchange capacities

In most of the Nitisol profiles under discussion the CEC is determined at pH 7.0 by NH_4OAc method. As direct measurements on the CEC of the clay fraction are almost absent, the CEC-clay was calculated from the CEC-soil but not corrected for organic matter.

The considerable contribution of the organic matter to the CEC of tropical soils in general and to Nitisols in particular is amply demonstrated by differences of up to 50 % in the CEC especially of the topsoils. As a result the CEC values drop drastically below 20 cm depth to remain fairly constant in the subsoil (Figure 2).

A further subdivision of the data according to region shows the non-corrected CEC-clay in the subsoil to vary between 8-16 me/100 g clay in Brazil and Southeast Asia,while the value ranges between 16-24 me/100 g clay for Nitisols in East Africa. If a correction factor of 1 % C = 4.5 me is applied the CEC-clay is always below 16 me/100 g, except for the Nitisols from Central Kenya (16-20 me/100 g clay).

According to some data from East Africa the permanent charge or PC (sum of bases and Al, at the pH of the soil) may be equal to about half of the variable charge (i.e. the difference between CEC pH 8.2 and PC values). On the exchange complex Ca is the dominant bivalent cation followed by Mg, of the monovalent cations K is important while the presence of Na is almost negligible. Consequently all Nitisols are non sodic.

The amount of exchangeable Al may attain considerable values, as reported on Nitisols in Southeast Asia and may be greater than the sum of bases. In addition the exchange acidity (H in me/100 g soil) may be equal to the permanent charge of the soils.

The base saturation (BS) percentage varies widely in each pedon from very low (less than 10 percent) to very high (more than 90 percent). If the FAO criterion is applied concerning the base saturation (i.e. eutric if BS is 50 percent or more and dystric if BS is less than 50 percent) it appears that in East Africa 65 percent of the Nitisols are Eutric and 35 percent Dystric and/or Humic. In South America half of the Nitisols studied are Dystric, 30 percent are Eutric, and Humic Nitisols occupy 20 percent (average base saturation 29 percent). In Southeast Asia all quoted Nitisols belong to the Dystric unit.

The pH H_2O usually varies between 5.0 and 6.5.

Clay and sand mineralogy

From various studies on Nitisols it is apparent that the silicate clay minerals are predominantly of the 1:1 lattice type.

In most soils kaolinite is dominant, followed by (meta-)halloysite. The occurrence of low-activity clays is reflected in the low CEC-clay values that are reported for all Nitisols. The presence of hematite and goethite has been reported from Africa, while the occurrence of gibbsite is observed in Nitisols of Southeast Asia. Minor percentages of illite, chloritized vermiculite and randomly interstratified minerals occur also. The crystallinity of the minerals varies from moderate to very good. Amorphous materials have been detected in Nitisols influenced by volcanic ash.

The mineralogical composition of the sand fraction depends very much on the nature of the parent material, and possible admixture of allochtone components like volcanic ash. In East African Nitisols an assemblage of quartz, orthoclase, and anorthite is common, occasionally mixed with variable quantities of volcanic glass, apatite, and ilmenite.

Data from Southeast Asia indicate the dominancy of quartz over plagioclase (acid and weathered) and mica in the light mineral fraction (S.W. less than 2.89).

In the heavy fraction zircon is most common, followed by variable quantities of amphibole, rutile, garnet and tourmaline. The proportion of weathering-resistant minerals often exceeds 90 % in the 100-200 mm sand fraction.

Sesquioxides

In general the percentage of sesquioxides (Fe and Al) in the clay fraction is high, which is attributed to the composition of the parent materials (high content of ferro-magnesian and aluminium bearing minerals).

The high iron contents are striking in particular and may attain values of 15 % or more of "total" iron (boiling with HC1 or H_2SO_4). Determination of "free" iron (by extraction with citrate dithionite) results in about 10 % Fe_2O_3; similarly, $A1_2O_3$ may be 2 % or more. A small but significant amount of these percentages appear to be amorphous (as determined by oxalate extraction) viz, 0.5-1.3 % Fe_2O_3 and 0.5-1 % $A1_2O_3$.

Speaking generally the rations of the oxalate extractable ("active") sesquioxides to the dithionite extractable ("free" or "redundant") sesquioxides in Nitisols are relatively high in comparison to the Ferralsols (Oxisols). For example, a value of 0.065 is reported for Nitisols in the USA (Davidson series) in contrast to 0.030 for various Ferralsols in Brazil.

In addition to the presence of Fe and Al oxides a relatively high amount of titanium oxides as determined by total analysis was found to be characteristic for Nitisols in Brazil. In many cases values of more than 3 % TiO_2 occur, often associated with the presence of ilmenit in the fine sand fraction. In the Davidson soil significant percentages of "free" Mn and Ti oxides in the clay fraction were detected (0.1 % and 0.2 % respectively). Other observations on the crushed soil material agree with the presence of manganese, viz. reactions to 10 % H_2O_2 in absence of organic matter.

As to the type of iron oxides that occur in Nitisols hematite and goethite are dominant, but the relative amounts may differ considerably.

It should be noted that the dry soil material is commonly magnetic, which indicates the presence of magnetite and/or maghemite.

Phosphorus retention

Most Nitisols have characteristically both a high amount of "total" phosphorus (in the order of 0.25%) and high values for P-fixation or rather P-sorption.

For Australia a P-sorption value of about 0.5 mg P/g of soils is reported (at an equilibrium supernatant concentration of 0.2 ppm P). Likewise data from West Africa indicate a P-sorption of 5.50 mug/g at 0.05 ppm equilibrium.

Thus, although in general the addition of phosphate fertilizers results in substantial yield increases, the measured increase in "available" phosphorus after fertilizing is usually slight.

Specific surface area

Data on this soil characteristic is scarce. Grohman and Camargo (1974) studied 5 Latossolo Roxo (Rhodic Ferralsols) and 5 Terra Roxa Estruturada (mainly Nitisols) profiles from Sao Paulo estate, Brazil. In the A horizons of the first group the specific surface was 78 m^2/g soil on the average (variaton 52-96) and in the B horizons 79 (61-95). For the second group the data was significantly higher viz. for the A horizons 132 (70-170) m^2/g soil and for the B horizons 133 (90-185).

A number of Nitisols were recently analysed in the ISM laboratory by the same ethylene-glycol-monoethyl-ether method (EGME; Heilman et al., 1965), in comparison with some other strongly weathered soils from the tropics and subtropics. The total specific surface area in 13 Nitisols turned out to be 100 m^2/g of soil on the average, with a variation between 61 and 155. For 6 Acrisols the values were 54 (42-86) and for 9 Ferralsols 68 (12-127) m^2/g of soil.

The specific surface area of the deferrated silicate clay minerals in the Nitisols concerned was only 10-30 m^2/g. It is therefore thought that the presence of "active" sesquioxides in appreciable percentage, especially of ferri-oxides, contributes strongly to the high total values. This supposition is strengthened by data for a Nitisol from Nigeria (Ikom series of Gallez et al., 1976; Juo, 1981) where a surface area derived by N_2 adsorption method of averagely 275 m^2/g of Fe_2O_3 was calculated. This is 5.5 times higher than the values obtained for the iron oxides in two non-Nitisols of similar weathering stage. This compares fairly well with the data given by Grohman and Camargo (loc.cit.): their 5 Latossolo Roxo profiles had 129 m^2/g Fe_2O_3 on the average (variation 79-226), 3 of their 5 Terra Roxa Estruturada profiles 295 m^2/g (variation 132-399). The other 2 Terra Roxa Estruturada profiles had however even lower values than the Latossolo Roxo group, viz. 64 (46-78), which was explained by micro-aggregate cementation and associated inertness of the iron oxides. The latter two soils were apparently much stronger weathered and would not fall in the Nitisol group as proposed.

Even though there is considerable variation in values for total specific surface area within the Nitisols - in part related to a variation in parent materials - the overall difference with Ferralsols, Acrisols and low-activity-clay Alfisols would appear to be sufficiently large to propose EGME value determination as one of the means to distinguish Nitisols from the other low-activity-clay soils in the laboratory. More EGME values are being determined at present at ISM, in cooperation with the Federal Soils Laboratory of Lincoln, USA.

For the time being, 90 m^2/g of soil (or 150 m^2/g of clay, taking 60 % as the average clay percentage of Nitisols) is proposed as a boundary value for testing.

Micromorphological features

Research on the microphorphology of the Nitisols has been conducted in a rather unsystematic manner, resulting in descriptions that vary widely in detail.

However, this gap has been partially filled by detailed information given by Sleeman and Lepsch (in preparation) on the micromorphology of red basaltic soils from North Queensland, Australia, and Sao Paulo, Brazil: the fabrics of the studied soil materials are complex and include components that can be related to the various stages in the fagmic, natroganic and porphyroskelic continua. The plasmic fabric would be mainly undulic or inundulic. The low degree of anisotropy of the fabric is attributed to a) masking by iron oxides, b) masking by humic compounds and c) the adsorption of humus and non-humus compounds at the clay particles, producing a disordered scaly structure.

Other studies have been concentrated on the occurrence of certain pedological features, in particular various cutans, e.g. (ferri-)argillans, papules, stress cutans, diffusion cutans. Illuviation cutans are usually not common in horizons above those with strong angular blocky structure. If present in these horizons (A, AB, Bt1) they are often not continuous and occur as fragments of cutans (papules).

The destruction or fragmentarisation of cutans by the soil flora and fauna is well known and especially relevant in the main rooting zone (0-80 cm). Evidence of high activity of the soil fauna, mainly termites, is deducted from the presence of various tubules of the agro- and iso- type. The obliteration of cutans through these processes may cause considerable confusion if field evidence of clay translocation is looked for.

In the deeper subsoil cutans, mainly (ferri)argillans, are continuous and thick and comprise at least 2 % illuviated clay. The occurrence of clay cutans reveals however little about the origin of the clay and the distance it moved through the pedon prior to sedimentation.

In the deeper subsoil also stress cutans occur, which may show striation caused by the presence of coarser non-weatherable minerals like quartz grains.

A dominancy of 1:1 layer silicate clay minerals does not normally favour the development of swell and shrink, features due to alternative wetting and drying of the soil material. The presence of stress cutans may therefore point to the presence of some 2:1 layer silicates, or amorphous materials.

A large portion of the Fe-oxides may occur as very fine cluster particles which in some cases have been described as ''diffusion ferrans''. In other cases they occur as tiny iron or iron-manganiferous nodules which may be considered as *in situ* features, inherited from the initial stages of weathering of the Nitisols.

Environmental conditions

Climate

On a global scale the development of Nitisols seems restricted to (sub)-tropical climates. Their occurrences in drier climates such as the Mediterranean and some parts of Australia is considered a paleo-feature.

The most extensive occurrence of Nitisols is under ustic soil moisture regimes. They occur however also under perudic moisture regimes, e.g. Indonesia (Buurman and Subagjo, 1980) and a xeric soil moisture regime, like Italy (Remmelzwaal, 1978). The temperatures are usually isothermic or isohyperthermic, occasionally mesic in Mediterranean environment.

Physiography

Nitisols are encountered in a large variety of landscapes ranging from isolated hills to dissected peneplains or gently rolling volcanic uplands. They do not normally occur on flat plateau remnants of old age. Their largest acreage is reported on slightly undulating to dissected surfaces of early to middle Pleistocene age.

In East Africa the occurrence of Nitisols is often closely linked to volcanic landscapes, viz. gently sloping foothills or volcanic footridge areas at an altitude of 1000 m or more. In South America and South East Asia they are commonly encountered at altitudes not exceeding 500 m.

Geology

The soils are developed on intermediate to basic* parent rock or colluvium-alluvium thereoff. Exceptions in East Africa are probably caused by the admixture of non-acid volcanic ash (Wielemaker and Boxem, 1982).

The weathering products of the mentioned rock types are generally considered to be "rich" in plant nutrients and notably in trace elements. Consequently most Nitisols compare favourably to other (sub)tropical soils, developed on more acid rocks, with regard to their natural fertility.

Vegetation and land use

Environmental conditions are suited for the development of luxuriant vegetative growth ranging from wooded grasslands to rain forest.

Because of the wide adaptability to crops and farming systems the soils are used for a multitude of land uses ranging from small-holders mixed farming (photo 1) to high-technology plantation farming under rainfed conditions or with supplementary irrigation.

In addition Nitisols under natural or improved pasture are used for the production of beef and dairy products.

* The terms acid, intermediate and basic indicate SiO_2 weight percentages of respectively more than 65, 65-54 and less than 54 percent.

Definition of a niti-argillic horizon and of nitic properties

In the Legend of FAO-Unesco (1974) Nitosols are defined as soils that have an ochric or umbric epipedon, overlying an argillic B horizon. They lack 1) a mollic horizon, 2) an albic E horizon, 3) tonguing as diagnostic for the Podzoluvisols, 4) ferric* and 5) vertic properties, 6) plinthite within 125 cm of the surface and 7) an aridic soil moisture regime.

As has been outlined in the Introduction a more refined definition is called for. This implies the recognition of a nitic B horizon or niti-argillic horizon. The *niti-argillic B horizon* may be considered as a variant of the argillic horizon and is hereby tentatively defined as follows (cf Sombroek and Muchena, 1979, for an early version):

1. a clay content above 35 percent, with a silt/clay ratio of less than 0.40;
2. a gentle clay bulge extending beyond 150 cm depth with only a gradual increase in clay percentage from the A to the B horizon (clay ratio B/A horizon is usually between 1.0 and 1.3); and none or a very gradual decrease in clay percentage from the B to the C horizon;
3. shiny ped faces, especially in the deeper part (below 100 cm from the surface) of the B horizon that constitute more than 25 percent of the surface area, and which can only partly be ascribed to illuviation argillans;
4. dominantly (more than 50 % of the area) moderately to strongly developed, very fine to medium angular blocky structure (polyhedral);
5. very friable to friable consistence when moist;
6. high aggregate stability (practically no water dispersable clay in horizons with low organic matter content), resulting in a flocculation index of more than 90;
7. CEC-clay less than 24 me/100 g clay, corrected for organic matter where necessary;
8. a specific surface area by EGME method of more than 150 m^2/g clay in the main part of the B horizon, associated with more than 5 % free iron oxides by dithionite extraction (these parameters in particular are subject to further tests).

Nitic properties comprise those characteristics which are diagnostic features of soils that do not fulfill all of the requirements for a niti-argillic horizon, notably the minimum depth of 150 cm. They are:

1. dominant part (more than 50 %) of the area moderately to strongly developed, very fine to medium angular blocky structure (polyhedral),
2. shiny ped surfaces in at least part of the B horizon, which can only partly be ascribed to illuviation argillans,
3. CEC-clay values of less than 24 me/100 g, corrected for organic matter, but a specific surface area of the clay of 150 m^2/g or more.

Soil material may be called *nitic* if the three above mentioned criteria are met.

* according to Dudal (pers. comm.) the ferralic part of the ferric properties definition (CEC at pH 7 of less than 24 me/100 g clay) should not apply in the case of Nitosols.

Considerations on the genesis of Nitisols

Information on the environmental conditions that lead to the development of Nitisols may be summarized as follows:

- the presence of intermediate or basic igneous or metamorphic rocks, or the sedimentary products thereoff; or of rather acid rocks with an admixture of non-acid volcanic ash;
- ustic or (per)udic soil moisture regime and iso-(hyper)thermic temperature regime;
- favourable drainage conditions allowing the free movement of soil mineral and organic constituents in an oxidised system;
- a stable but not very old landscape where time has allowed for the formation of deep pedons, without total depletion of the soil nutrients;
- active soil fauna communities.

Under these conditions a number of soil processes may take place simultaneously, although one may be dominating the others because of seasonal variations in the climate (effect of rainfall and soil fauna).

Relevant processes include: 1) formation of low-activity clay minerals, 2) translocation of clay, 3) homogenisation by the soil fauna, and 4) nitidisation.

ad.1 Kaolinite and sesquioxides are the main clay minerals. Data on the SiO_2/Al_2O_3 molar ratio of the soil material (V 2 mm) varies between 2.1-2.4 and shows little variation with depth. In addition the silica/sesquioxides ratio varies between 1.5-1.9 and decreases slightly with depth. This implies the early stages of the ferralitisation or lateritisation process.

ad.2 Evidence of clay translocation may be more evident in soils that have an ustic soil moisture regime than an udic one. Clay deposition is observed in voids, along channels and on ped surfaces (photo 3). Under conditions of free drainage the clay is transported to considerable depth in the profile, thus creating the attenuated or stretched clay curve which is so typical for all Nitisols.

ad.3 The homogenization process is active in all Nitisols and Pedo-turbation is mainly caused by termites, ants, worms, spiders, beetles, small rodents, etc. and also by root action. This process is particularly evident in the top 100 cm and causes the destruction and deformation of cutans (formation of papules), in addition to the formation of a crumb to subangular blocky structure in the upper part of the solum.

ad.4 The term nitidization is coined for that process that causes the formation of the remarkable angular blocky (polyhedral) peds with their shiny surfaces, which may be smooth or slightly striated. Although research of this particular phenomenon is rudimentary it appears that several factors play a part in the development of this type of structure. These include the clay mineralogical composition, the variation in moisture conditions in the profile, and the original structure of the parent rock. Micromorphological evidence points to the presence of argillans on peds, while the striation on the same surfaces indicates that micro-swelling and -shrinking may result in pressure faces or micro-slickensides. While macro-swelling and -shrinking leads to the coarse parallellopiped structure as observed in most Vertisols, the same basic process, but on micro-scale, apparently leads to the formation of polyhedral peds in the Nitisols case.

Nitisols and nitic properties in soil classification schemes

If Nitisols, as defined above, are to replace the present Nitosols of the FAO/Unesco soil units then it may be considered to place them relatively early in the key to its Legend, just before or just after the Ferralsols. This would also facilitate the creation of a "Mollic" second-level unit in addition to the present Humic, Dystric and Eutric ones. Soils with a well- defined niti-argillic horizon which happen to have a non-acid humic topsoil - as prevalent in parts of Western Kenya -now have to be grouped with the Phaeozems where they are odd bedfellows both genetically and property-wise.

The introduction of "nitic properties" would allow the distinction of second and/or third level units in a number of major units like the Cambisols, Phaeozems, Luvisols and Acrisols. Thus accomodation is provided for those soils that have affinity with Nitisols without having all of its diagnostic features (notably the depth requirement, or the only gradual increase in clay from A to B horizon). Nitic properties may in fact find a place in-between "ferric" and "ferralic" properties of the present Legend.

In the USA "Soil Taxonomy" system of classification most of the Nitisols as defined fall in the "Pale" (for old) Great Groups of the Alfisols and Ultisols, and those with nitic properties largely in the "Rhodic" Great Groups of the same Orders. A "Nitisols" Order and/or "Niti" Great Group can be conceived, the latter just before the "Pale" and the already officially proposed "Kandi" (for kaolinitic) Great Groups in the USA classification key.

In the proposed new classification system developed by an ORSTOM working group (Fauck et al., 1979), the Nitisols would largely fall in the "Fermonosialsols", groupe "bulgique" (for clay bulge), sous-groupe "brillant". Upgrading in the system may be considered.

The scope of the present article does not call for the formulation of detailed proposals - with all its quantifications, ramifications and consequences - for placement of Nitisols and Nitisol-like soils in the classification systems mentioned. Such proposals may however be tabled in fora like the international committees for the improvement for "Soil Taxonomy" (e.g. ICOMLAC), and the ISSS international working group on the elaboration of an International Reference Base for soil classification (IRB) whith the present FAO/Unesco Legend as starting point.

Some considerations on fertility of the soils

The apparent high fertility of the Nitisols, as mentioned in the Introduction, at first seems rather anomalous in view of the relatively low CEC-clay, and the variable base saturation percentage.It is true that because of the clayiness and the fair to high organic matter contents the CEC on whole soil basis is fairly high. The rapid rainfall intake, the fair to high moisture storage, and the deep rooting also contribute to good plant growth even in regions with marginal rainfall conditions. This does not fully explain however why subsistence farming with no or little chemical fertilizing is apparently so successful in many instances. The aspect of inherent chemical fertility therefore warrants further discussions, be it largely speculative.

Micronutrients

The steady supply of micronutrients is likely to be guaranteed by the continuous weathering of the mafic parent materials, with their relatively high percentages of S, Co, Cu, Mn, Fe, Mo, Bo, and Zn. The lack of these elements, which often constitutes a constraint for permanent agriculture in the tropics, is therefore not relevant for the Nitisols. The deeply rootable soil profile aids in the uptake of these nutrients from great depth.

Potassium

Similar behaviour may apply to the uptake of potassium. This was studied by Verwey (1975) on two Nitisols from the Kisii region in West Kenya. The soils were developed on basalts and andesite with volcanic ash under a udic soil moisture regime. He showed that potassium uptake was much higher than the loss of exchangeable K, implying that non-exchangeable K is withdrawn from potassium-bearing minerals during crop growth. Also Hinga (1977) reported on only fair correlation between exchangeable K and K-uptake in three Kenyan Nitisols.

Phosphorus

For phosphorus a steady supply would seem anomalous, in view of the reported high P-retention of the exchange complex. The answer may be in a less than absolute fixation by the soil of the ample phosphorus of the parent material, due to the high specific surface of the iron-kaolinite/halloysite complex.

In any case the supply of phosphorus by weathering of the parent rock seems sufficiently to counteract the prevailing leaching conditions. The well- developed root system would be able to satisfy the plant demands for P and support subsistence cropping at a fair level. The role of the high specific surface area of the clay compounds in relation to the retention and release of phosphorus has yet to be fully assessed.

Nitrogen

The supply of nitrogen is a different matter altogether. For any soil this nutrient's supply solely depends on allochthonous sources, viz. through fertilizing or by fixation of atmospheric nitrogen, biologically or otherwise.

Nitrogen may be partly supplied by potentially N-fixing leguminous crops like beans and peas which are common in many traditional farming systems in the tropics. Their actual fixing capacity may however be limited due to the absence of Rhizobia. Also, the microbiological production of N by decomposition of the organic matter can only be short-lived because (green) manuring and composting are cultivation practices not normally carried out in small-holder farming in the tropics. To explain the relatively high amount of nitrogen available by other than the above mentioned processes, research by Meiklejohn (1959) in Uganda receives attention. The results suggest that an extra amount of NO_3 of about 200 ppm is available at the beginning of the rainy season in the upper few centimeters of the bare red soil (Kawande series near Kampala), apparently caused by some kind of photochemical process.

Although no follow-up was given to this research the information may be related to the work of Schrauzer and Guth (1977). They report on a new industrial process of ammonia production at almost room temperature and at normal atmospheric pressure, with sunlight and water in the presence of finely divided iron, and with titanium oxide as a catalist. These conditions have a striking resemblance with surface conditions of Nitisols at the end of the dry season. In fact the industrial process was successfully simulated on titanium and iron rich red soils of the California desert, following correspondence between the first author and the reporters of the industrial process (Anon., 1979).

It may therefore be worthwhile to test the hypothesis of atmospheric N fixation in Nitisols by a photo-chemical process at the first rains after the dry season when the soil surface is bare and temperatures in the upper few centimeters are still high.

Notwithstanding these speculative considerations it should be stipulated that sustained healthy crop growth on Nitisols needs a steady supply of artificial fertilizers, be it nitrogen or else. Fertilizing Nitisols will however be relatively efficient in comparison with nearby other soils, if only because of the favourable physico-chemical retention properties of the soil over great depth.

For completeness sake it should be mentioned that these favourable properties diminish in the soils that follow the Nitisols in the weathering sequence, through further ferralitization - i.e. the Rhodic Ferralsols (Terra Roxa Legitima, or Dusky Red Latosol). Although they may show magnetism, they lack the strong blocky structure, the shininess and the associated high specific surfaces. Actually the worse for agricultural production may be the soils on basic parent materials at the extreme end of the weathering process, because of the occurrence of appreciable amounts of gibbsite, high exchangeable aluminium, sterility of the iron oxides, and/or toxicity of manganese and certain micro-elements (basaltic high plateaus of Madagascar and Sabah, Kuantan and Kiniya series of the Malaysian peninsula - Sys, pers. comm.).

Acknowledgements

Several soil scientists have given their comments on early versions of the above paper, and have provided valuable information and/or sample material. Mention should be made of R. Dudal (FAO, Rome), A. Herbillon (Louvain-la-Neuve, Belgium), F.R. Moormann (Utrecht, Netherlands), S. Buol (Raleigh, USA), M.N. Camargo (Rio de Janeiro, Brazil), R. Isbell (Townsville, Australia), A. Juo (Ibadan, Nigeria), U. Schwertmann (Freising, BRD), N. Nyandat and S. Mugambi (Nairobi, Kenya).

References

Anon., 1979: Sun and sand can fix nitrogen. New scientist 8-02-1979. p. 383.
Beinroth, F.H. and S. Paramananthan (Eds.), 1979: Proceedings of Second International Soil Classification Workshop, Part I: Malaysia.
Beinroth F.H. and S. Panichapong (Eds.) 1979: Idem, Part II: Thailand. Soil Survey Division, Land Development Department, Bangkok, Thailand.
Bennema, J. and M. Camargo, 1979: Some remarks on Brazilian Latosols in relation to Oxisols, in: Beinroth and Paramananthan (Eds.), Proceedings etc. see above, p. 233-261.
Buringh, P.; 1979: Introduction to the study of soils in tropical and subtropical regions. 3rd edition PUDOC, Wageningen, the Netherlands.
Buurman, P. and Subagjo, 1980: Soil formation on granodiorites near Pontianak (West Kalimantan), in: Red Soils in Indonesia (Ed. P. Buurman), PUDOC Agric. Res. Paper **889**, Wageningen, the Netherlands p. 107-118.
Camargo, M.N. and F.H. Beinroth (Eds.), 1978: Proceedings First International Soil Correlation Workshop. EMPRAPA- SNLCS. Rio de Janeiro, Brazil.
CPCS, 1967: Classification des Sols, Travaux CPCS 1963-1967, Edition 1967. Laboratoire de Géologie-Pédologie de l'ENSA. Grignon, France.
Dai, J., Permadhy Soedewo and P. Buurman, 1980: Soils on acid metamorphic and rocks in Southeast Sulawesi, in: Red Soils in Indonesia (Ed P. Buurman), PUDOC, Agric. Res. Paper **889**, Wageningen, the Netherlands p. 121-139.
Dudal, R., 1968: Definitions of soil units for the soil map of the world. World Soil Resources Reports **33.** FAO. Rome, Italy.
FAO, 1970: Elements of the Legend for the Soil Map of Europe at scale 1:1,000,000. ECA Working Party. FAO. Rome, Italy.
FAO-Unesco, 1974: Soil Map of the World, Vol. I. Legend. Unesco. Paris, France.
FAO-Unesco, 1971-1981: Soil Map of the World, Vols II-X, Unesco. Paris, France. II: North America (1975); III: Mexico and Central America (1975); IV: South America (1971); V: Europe (1981); VI: Africa (1977); VII: South Asia (1977); VIII: North and Central Asia (1978); IX: Southeast Asia (1979) and X: Australasia (1978).
Fauck, R., M. Lamouroux et al, 1979: Projet de classification des sols. ORSTOM, Services Scientifiques Centraux. Bondy, France.
Gallez A, A.S.R. Juo and A.J. Herbillon, 1976: Surface and charge characteristics of selected soils in the tropics. Soil Sci. Soc. Am. J.**40**: 601-607.
Grohmann F. and O.A. de Camargo, 1974: Superficie especifica dos oxidos de ferro do Latossolo Roxo e da Terra Roxa Estruturada. Anais do XIV Congr. Bras. Ciência do Solo (Santa Maria, RS. Brasil).
Heilman, M.O., O.L. Carter and C.L. Gonzalez, 1965: The ethylene-glycol monoethyl ether technique for determining soil surface area. Soil Sci. **100**: 409-413.
Hinga, G., 1977: Phosphate sorption capacity in relation to properties of several types of Kenya Soil. East African Agriculture and Forestry (EAAFRO) Journal **38**: 400-404.
Isbell, R.F., 1980: A comparison of the red basaltic soils of tropical North Queensland and those of Hawai, Mauritius, Brazil and Natal. In: Proceedings conference on classification and management of Tropical Soils 1977 (ed. K.T. Joseph). Kuala Lumpur, Malaysia.
ISSS 1980, 1981: Bulletin of the International Society of Soil Science **57**: 19-20 and **59**: 10. Wageningen, the Netherlands.
Jayawardane, N.S. and J.A. Beattie, 1978: Effect of Salt Solution Composition on Moisture Release Curves of Soil, Aust. J. Soil Research **17**: 89-99.
Juo, A.S.R., 1981: Mineralogical groupings of soils with variable charge in relation to soil management and classification. Paper Int. Conf. Soils with Variable Charge; Massey Univ., Palmerston North, New Zealand; Feb. 11-18, 1981.
Meiklejohn, J., 1953: The microbiological aspects of soil nitrification. EAAFRO Journal **19**: 36-38.
Nyandat, N.N., 1976: Nitisols and Rhodic Ferralsols in Kenya, morphological and chemical properties, use and management. Kenya Soil Survey, Miscellaneous Soil Paper M9, Nairobi, Kenya.
Remmelzwaal, A., 1978: Soil genesis and quaternary landscape development in the Tyrrhenian Coastal Area of South and Central Italy. Publ. Fys. Geogr. Bodenk. Lab. Univ. Amsterdam. **28**: Amsterdam, The Netherlands.
Schrauzer, G.N. and T.D. Guth, 1978: Photolysis of water and photoreduction of nitrogen on titanium dioxide. J. Am. Chem. Soc. **99**: 7189-7193.
Sleeman, J.R. and I.F. Lepsch (in prep.): Micromorphology of basaltic soils from North Queensland in Australia and Sao Paulo, Brazil. CSIRO publ. Canberra, ACT, Australia.
Siderius, W. and F.N. Muchena, 1977: Soils and environmental characteristics of agricultural research stations in Kenya. Kenya Soil Survey. Miscellaneous Soil Paper M5, Nairobi, Kenya.

Siderius, W. et al. (in prep.): Humic Nitosol. Soil Monolith Paper **4**, Int. Soil Museum. Wageningen, the Netherlands.
Sombroek, W.G. and W. Siderius, 1977: Nitosols and their genesis. World Soil Resources Reports, **47**: 84-86. FAO. Rome, Italy.
Sombroek, W.G. 1978: Variants of the argillic horizon Appendix to ICOMLAC News Letter no. 10, November 1978. Utrecht. Univ., Dept. of Soil Science. Utrecht, the Netherlands.
Sombroek, W.G. and F.N. Muchena, 1979: LAC Alfisols and Ultisols in Eastern Africa, some problems to their identification and classification. Proceedings of Second International Soil Classification Workshop. Part II (see Beinroth and Panichapong, 1979) p. 129-139.
Sombroek W.G., H.M.H. Braun and B.J.A. van der Pouw, 1982: Exploratory Soil Map and Agro-climatic Zone Map of Kenya, scale 1: 1M. Kenya Soil Survey, Expl. Soil Survey Rep. E1. Nairobi, Kenya.
Spaargaren, O.C., 1979: Weathering and soil formation in a limestone area near Pastena (Fr., Italy). Publ. Fys. Geogr. en Bodemk. Lab. Univ. of Amsterdam, **30**. Amsterdam, the Netherlands.
Soil Survey Staff, 1975: Soil Taxonomy, USDA Soil Conservation Service, Agric. Hdbk. US. no. 436. Government Printing Office, Washington DC, USA.
Verwey, H.E., 1975: A potassium quantity-intensity study of some selected Kenyan soils. Internal Report, Dept. of Soils and Fertilizers, Agric. Univ, Wageningen, the Netherlands.
Wielemaker, W.G. and H.W. Boxem, 1982: Soils of the Kisii area (quarter degree sheet 130). Reconnaissance Soil Survey Report R4. Kenya Soil Survey, Nairobi and Agric. Univ., Dept. of Soil Science Wageningen, the Netherlands. Publ. by PUDOC, Wageningen, the Netherlands as Agric. Res. Rep. **922**.

3 ACTIVITIES OF THE SECTIONS

3.1 Soil monolith collection and exhibition

During the reporting period the number of soil monoliths has increased with 50 to 521. The complete list of monoliths per country is given in a table at the end of this section.

Contacts with nearly 30 countries exist about the collection of soils for ISM and on the supply of additional information on soils already sampled. It is worth mentioning that there is a growing interest in the establishment of national and regional soil reference collections. This work is partly carried out concurrently with that of the sampling for ISM. In particular mention may be made of China, Colombia, Ghana, and Kenya.

Acquisitions in 1981

Colombia: In close cooperation and active support of the Instituto Geografico Agustin Codazzi (IGAC) in Bogota, 18 soil profiles have been collected in Colombia (see section 4.2 for further details).

Denmark-(Greenland): Mr. H.T.M.P. Albers and Mr. F.J.A. Daniels, State University Utrecht, collected four profiles in Greenland. In the early seventies Mr. Daniels was also involved in taking two soil profiles from this island for ISM.

Indonesia: Mr. C.G.G. van Beek, State University Utrecht, collected six soil profiles in the Gunung Loser National Park, North Sumatra. A study for a PhD. thesis is being prepared on the morphology, vegetation and soils in this rather remote area. The soils form a toposequence from near sea-level up to about 3100 meters altitude.

Jamaica: Following a suggestion of ISM, Mr. W. Andriesse and Mr. J.J. Scholten, Rural Physical Planning Unit, Ministry of Agriculture, collected three representative soils. They will be subject of Soil Monolith Papers (see section 5.1 for furthers details).

Kenya: In close cooperation with and active support of Kenya Soil Survey (KSS) soils were sampled for a national soil reference collection, for ISM and for the Department of Soil Science and Geology, Agricultural University Wageningen. This work will be carried out in the years 1981-1983 during three travels of 4-6 weeks each. In 1980 four soils were collected for KSS, sixteen for ISM and seven for the Agricultural University. In 1981 six profiles were taken for KSS. They were also impregnated and made ready for display. For ISM seven soil profiles were collected. Part of this work was carried out with Mr. H.W. Boxem, staff member Training Project in Pedology, Kilifi. Furthermore four profiles were made from soils in the study area of Unesco's Integrated Project in Arid Lands in Chalbi desert, northern Kenya. This part of the project was carried out with Mr. A.J. van Kekem, Unesco associate expert in Nairobi and IPAL. It may be added here that in-service training was given to a technician in impregnation techniques, display, etc. and that some soils belonging to the Kenyan collection were cleaned and re-impregnated for a better conservation.

Mali: Ms. P. Banga, State University Utrecht, collected one profile in Mali. This soil is representative of large areas in the drier parts of West Africa.

United Kingdom: Following the post-meeting excursion of the Sixth International Working Meeting on Soil Micromorphology, London, August 1981, eleven soil profiles were collected. These soils are well-selected to represent large areas of England and Wales and are fully described and analyzed.

U.S.A.: Dr. D.L. Mokma, Michigan State University, East Lansing, and guest researcher at ISM, collected one soil profile. This soil forms part of the basic collection of Spodosols/Podzols from North America and Western Europe used for a comparative study of the classification and characteristics of these soils.
Dr. H. Ikawa, University of Hawaii, Honolulu, collected six soils partly belonging to the Benchmark Soils Project. It is the idea that ultimately the ISM collection of soils will also comprise soils from the other BSP sites in a number of tropical countries, e.g. Indonesia, Brazil, Philippines. The only soil at ISM from Cameroon belongs also to this series.

For the completion of background information and data on the existing soil monolith collections of a large number of countries, contacts have been established or renewed with several institutions and a number of individuals. This has partly resulted in favourable reactions and new materials, and information and data were made available to ISM.

Future acquisitions

Arrangements for collecting soil profiles have been made with a number of countries. These plans are in various stages of implementation. In the near future it is expected to collect or receive soils from:

China: Arrangements are now being concluded with the Soil Science Society of China about the training of a Chinese soil scientist in building up a national soil reference collection, including the techniques of conservation. After this training, a concurrent building up of collections of soils for ISM and the Chinese Institute of Soil Science will take place. It is planned that both activities can be held in 1982.

Ghana: It was already mentioned in Annual Report 1980 that an additional number of soil profiles would be collected. This work will possibly be carried out in 1982 or 1983 in cooperation with the Soil Research Institute in Kumasi. This institute now houses a collection of soil monoliths from Ghana and it is envisaged that it will form the nucleus of an African Soil Museum.

Indonesia: It has already been stated that the collection of soils from Indonesia will contain soils of the Benchmark Soils Project sites. Mr. H. van Reuler, Unesco associate expert will also sample a few additional soils, including soils under long-lasting wetland rice cultivation on Java. Part of this work will be carried out in cooperation with Mr. G.W. van Barneveld, Department of Soil Science, Brawijaya University in Malang.

Japan: As may be read in the section on guest researchers, two Japanese soil experts will spend six months each at ISM in 1982 and 1983. For their comparative study on Andosols and Paddy soils it is planned to have from each type two monoliths of soils representative for large areas in Japan. The profiles will probably be sampled in 1982.

Kenya: See the notes under Kenya in the preceding part.

Philippines: There are several reasons to collect soil profiles in the Philippines. Firstly, it has already been mentioned that ISM would like to have all soils included in the Benchmark Soils Project. Secondly, to enable the comparison with characteristics of some other soils under long-lasting wetland rice cultivation, it is envisaged to have one or a few of such soils as well. It is hoped that these soils can be collected in 1982 as a joint effort of the Bureau of Soils, the Benchmark Soils Project and IRRI.

Rwanda: In cooperation with the 'Project Carte Pédologique de Rwanda' a few soils will be sampled, probably in 1983. This country will be visited from Kenya, where a larger collection is being built up.

Sri Lanka: Through the good offices of Prof. Dr. F.R. Moormann, State University Utrecht, Dr. S. Somasiri, Department of Agriculture, has offered to collect for ISM a few profiles of soils under long-lasting rice cultivation. This work will probably be carried out in 1982.

Sudan: It is planned to collect in 1983 a few soils in the region of Bor, South Sudan, where Ilaco, International Land Development Consultants, Arnhem, Netherlands, carries out a project. The region will be visited from Kenya, where a larger collection is being built up.

Uruguay: Mr. R.F. Breimer, Unesco-associate expert in Montevideo, will collect a few soil profiles in Uruguay and possibly in Argentina.

U.S.A.: From continental U.S.A. about 28 soils were selected for the ISM collection. It was already mentioned that three of these arrived in 1980 and it is foreseen that others will follow in 1982 and subsequent years.

General

Definitive and tentative arrangements for collecting soil profiles have been made with institutions and individual experts in a large number of countries. These include both countries which are not yet represented in the ISM collection and countries from which soils are needed for filling up gaps. In order to keep costs for soil collection at a minimum, ISM is stimulating the other institutions and persons to do the sampling work by themselves as much as possible, preferably by persons who have followed the ISM training course. It has already been mentioned that a part of the countries build up concurrently national soil reference collections for their own purpose. Besides the countries mentioned before, ISM is in contact with several other countries which have plans to build up or expand national soil reference collections. They include: Brazil, Israel, Pakistan, Syria and Venezuela.

Preparation of monoliths

During the reporting period about 40 profiles have been impregnated and prepared for the exhibition. The procedures set out in Technical Paper 1 were followed with minor changes. It has been found more practical to cut the soil to its proper exhibition size before the impregnating lacquer has hardened. Formerly this was done with fully hardened soils. The new method can only be applied if the soil is put in a fume-chamber to exhaust benzene and toluene. These toxic substances occur in the hardening lacquer and are both known for their carcinogene effects.

Towards the end of the year a programme for the selection of less dangerous chemicals has been drawn up. This will be carried out in cooperation with Dr. R.F. Hammond, Peatland Experimental Station, Kildare, Ireland, who has experience with the conservation of thin peat profiles by submerging them in a poly-ethylene-glycol with a molecular weight of 1500. An adapted method seems also promising for the impregnation of mineral soils.

Exhibition

In 1981 some changes have been made in the set-up of the soil monolith exhibition. An additional seven profiles can now be shown. Usually, the number of soils which are shown at any one time is between 60 and 70.
Major changes in the soils on display will be made in 1982, giving more attention to soils from tropical and subtropical regions.

Monolith collection, December 1981 Within brackets: acquisitions in 1981.

Australia	33	Malaysia	10
Belgium	4	Mali	1 (+ 1)
Botswana	7	Namibia	11
Cameroon	1	Netherlands	19
Canada	21	New Zealand	5
Colombia	19 (+18)*	Nigeria	14
Czechoslovakia	8	Norway	3
Denmark (Greenland)	6 (+ 4)	Romania	11
F.R. Germany	17	South Africa	20
Finland	5	Spain	18
France	11	Sweden	17
Ghana	4	Syria	4
Greece	14	Thailand	13
Hungary	20	Turkey	13
India	30	United Kingdom	11 (+11)
Indonesia	10 (+ 6)	U.S.A.	10 (+ 7)*
Ireland	11	U.S.S.R.	62
Italy	17	West Samoa	5
Jamaica	3 (+ 3)	Yugoslavia	3
Kenya	27 (+ 7)*	Zambia	10

Total: 528 (+57)
* still to arrive: 18 from Colombia, 7 from Kenya, 6 from U.S.A. (Hawaii).

3.2 Laboratory

Analytical work

This year's analytical work was, to a large extent, concentrated on monoliths worked on by guest researchers (re. chapter 5). Dr. D.L. Mokma, assisted by a regular ISM analyst, a temporary analyst and a student of the Agricultural University Wageningen, (partly) analyzed some 300 samples of 35 Spodosols, 20 of which were present as monoliths at ISM (among them five belonging to the Glinka Memorial Collection).

A Kenyan profile (monolith EAK 16) was analyzed for guest researcher Dr. W. Siderius who is preparing a Soil Monolith Paper on it.

With the same purpose three profiles were analyzed for guest researchers Messrs. J.J. Scholten and W. Andriesse who brought the soils along from Jamaica.

For Mr. C.G.G. van Beek of the State University Utrecht, five profiles of N. Sumatera (Indonesia) were analyzed in return for the monoliths. the same was done with a profile from Mali, collected by Ms. P. Banga also from the Utrecht University.

The remaining time was spent on small projects such as backstopping of the MAB associates, ITC analyses and not in the least on catch-up work of the existing monolith collection so that, not considering the recently acquired ''Glinka Memorial Collection'', the back-log in analytical work did not increase.

Research

This year, the time spent on applied research was very limited. Worth mentioning is:

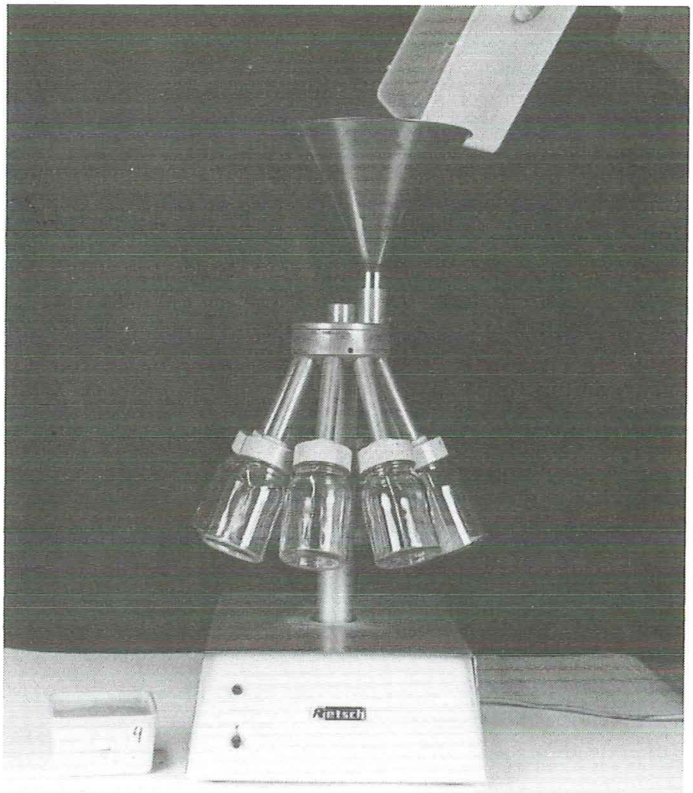
- Carbon determination. The method for inorganic carbon determination as developed last year, was improved and successfully applied to a large number of samples. The manuscript is ready for publication (Van Oostrum & Mokma). The organic carbon section of the method only needs testing with soil materials.
- As an early outcome of the laboratory method and data exchange programme (LABEX) it appeared that the pretreatment of the samples has a strong influence on the particle size analysis, i.e. on the effectiveness of dispersion. An investigation is presently undertaken to compare the effect of different pretreatments e.g. deferration, milk-shake treatment, ultrasonic treatment. To give the results some weight, a large number of samples of widely varying character and origin is included.
- For characterization of ''low activity clays'' (LAC), the determination of specific surface area seems to be of importance. The Ministry of Social Affairs has made available an analyst for half a year, who will work on setting up a routine method for determining the specific surface area of soils. This is done in cooperation with the Technical Centre for the Brick Industry, a technician of this Centre being seconded at the neighbouring Department of Soil Science and Geology of the Agricultural University.

Programme on comparison of methods, procedures and results of laboratory analysis for classification purposes (LABEX)

By the end of the year, 20 participants (all but one) had sent in their results of analyzing the ten reference samples distributed to them. The evaluation of these data has been commenced and ISM appreciates very much that Mrs. C.H.M. Duijkers-van der Linden has offered her good services in this matter.

As for the second part of the programme, analysis of samples sent in by participants, the last lot came in by the end of November so that the Royal Tropical Institute at Amsterdam, cooperating in the scheme, could commence analysis in December.

In June, Dr. J.M. Kimble of the National Soils Laboratory, Soil Conservation Service, Lincoln, Nebraska, visited ISM. With him, and with Dr. F. van de Pol of the Royal Tropical Institute, details were discussed of procedures according to which samples are analyzed in the USA for classification with Soil Taxonomy.



Splitting soil samples for dispatch to Labex participants.

3.3 Micromorphology

Technical work

The preparation of thin sections is carried out by the technician of ISM at the laboratory of the Netherlands Soil Survey Institute. Most of the work in 1981 concerned samples for the project: 'Micromorphological analysis and characterization of Benchmark Soils of India'. In 1981, 297 thin sections have been prepared for this project. Work still continues and will be finalized early 1982.

77 thin sections were made for the regular ISM collection and concern five soils from Canada (33 sections), one from the Netherlands (5 sections), four from Indonesia (19 sections), three from Kenya (18 sections) and one from the USA (2 sections). An additional 22 thin sections were prepared for small projects.

In 1981, 119 samples were received for treatment, most concerning the regular ISM collection, viz. six soils from the USSR (44 sections), one from Cameroon (8 sections), three from Jamaica (12 sections), four from the USA (9 sections), eleven profiles from England (42 sections) and 4 special sections, sampled in a paddy soil from China.

A new sawing machine for the laboratory was purchased at the expense of ISM. The machine is at present being installed.

Investigations

A total of 124 descriptions have been prepared of thin sections pertaining to 23 monoliths of the regular ISM collection. These concerned six soils from Malaysia (34 thin sections), two from Sweden (5 sections), three from Spain (15 sections), one from South Africa (4 sections), one from Norway (1 section), one from Namibia (9 sections), one from the Netherlands (3 sections), two from Hungary (18 sections), two from Zambia (14 sections), one from Finland (3 sections), one from Greece (5 sections), two from the USSR (11 sections).

For the description an ISM devised system (adapted after Brewer's Fabric and Mineral Analysis of Soils) is at present being used, in anticipation of the ISSS Handbook for the description of thin sections, which will be published next year.

An inventory is being made of specific micromorphological phenomena in thin section, in view of a forthcoming standard set of slides showing representative features, to be on sale at ISM. The procedures for taking photomicrographs have been standardized, resulting in high quality diapositives and colour enlargements.

Three introductory texts were prepared for the purpose of courses and incidental teaching and training, viz. an introduction to Brewer's descriptive system, an introduction to Kubiena's descriptive system and an introduction to Sander's system of description of fabrics. The drafts are ready and will be mimeographed after final corection.

3.4 Documentation

Map collection and library

During 1981 ISM received regularly newly published maps and reports on reconnaissance soil maps as well as samples of more detailed surveys and survey coverage maps from many soil survey institutes.

A very significant addition to the collection of soil maps is formed by a set of photonegatives of all 600 sheets of the 1:1 million 'World Soil Map' of the USDA World Soil Geography Office in Lanham, USA. ISM highly appreciates the permission granted by the Director of Soils, USDA Soil Conservation Service that these copies be prepared for ISM for consultations by interested visitors, as general reference material and for special purposes like inventory and evaluation of hydromorphic lands in the tropics, empolderable areas, etc. The soils information on the said sheets is given in the terminology of the 1949 system of US soil classification. Active incorporating of new soil survey data into these sheets ceased in the early seventies, when the US ''Soil Taxonomy'' system of classification became operative. Nevertheless, the maps have a priceless value; in addition to Great Soil Groups, Complexes and Land types, the legend contains also symbols for Terrain types and Land forms and for Parent materials.

Other memorable 1981 additions to the collection of soil- and related thematic maps and the accompanying technical reports were some large sets made available free of charge by ORSTOM (Bondy, France), by SERDAT, the former INEAC (Brussels, Belgium), by Hunting Technical Services Ltd. (London, U.K.) and by ITC (Enschede, Netherlands). From CIAT (Colombia) the ISM received computer print-outs of its regional land resources assessment programme for the northern part of South America.

The library continued to receive a substantial number of new publications on all aspects of soil science, mostly received free of charge. These were sent to the editor of the section 'New Publications' in the Bulletin of the ISSS. The number of subscriptions to journals of soil science was only slightly increased.
It should be stated that the further development, an active acquisition policy, the upkeep and the day-to-day running is seriously hampered by the lack of a regular librarian/documentalist. During 1981 this work was carried out by Miss E.C.M. Schouten during a half year contract.

Sales section

The ISM continued to be a selling agent for the FAO-Unesco Soil Map of the World. The same applies to several publications of the International Rice Research Institute (IRRI) of the Philippines. Some other publications of interest to soil scientists, which would be rather difficult to obtain otherwise, are on sale as well. Special mention may be made of the ISM-prepared ''Field Extract of Soil Taxonomy'' of which a second printing of another 1000 copies has become necessary.

Since about four years ISM has 75 different slides on sale of major soils, and related landscapes and land use/vegetation. It forms the first part of a standard collection, especially prepared for lecturing purposes, that will ultimately contain about 150 slides with explanatory texts. Over the period about 6000 copies were sold, directly to visitors or through order.

A special set of 153 slides on soils inspected during three International Soil Classification Workshops (Brazil, Malaysia-Thailand, Syria-Lebanon) was put up for sale in the course of the year.

3.5 Education and information

In 1981 the number of visitors to ISM remained slightly below the level of the preceding years. This is mainly due to a decrease in the number of groups of non-professional visitors and of students from Dutch Agricultural Schools. The number of students of higher level education institutes both from the Netherlands and abroad, as well as the number of individual visitors remained at the same level.

Group visits

About 1250 people visited ISM in groups, mainly from educational institutions (universities, teacher courses, agricultural and technical colleges, high schools) and from international training courses and congresses (see Appendix A). The ISM soil exposition has been incorporated in the courses on regional soil science of the Agricultural University and the M.Sc. course in Wageningen, of the Tropical Section of the Agricultural College of Deventer, and of international courses held in the Netherlands. In addition, regularly groups of students are received from Germany and England. Noteworthy was also the visit of the Belgian Soil Science Society who had chosen the ISM for its annual excursion.

Individual visits

The number of people coming alone or in very small groups that have signed the guestbook in the Exhibition hall after their visit amounts to 220 in 1981. It has been experienced that only a part of the visitors do sign their name in this book. Most visitors are professional soil scientists. Two third of them comes from abroad. No systematic records have been kept of visitors, who come for consulting the library and map collection or for discussions with ISM staff.

Totals of groups visitors

	national	international	total
professional	529	395	924
non professional	274	56	330
total	803	451	1254

4 PROJECTS

4.1 Unesco-ISM cooperative programme for soil studies in MAB project areas

This cooperative programme proceeded well during the year. The three associate experts concerned established many contacts in the regions of their respective assignments, while concentrating actual survey work in a few biosphere reserves:

Africa region (Mr. A.J. van Kekem, based at ROSTA, Nairobi). Orientation and programme planning trips were made for Mount Kulal in Kenya, Tai forest in Ivory Coast, Makokou in Gabon, Yangambi in Zaire and Dimonika in Congo. Actual field work concentrated on the Mount Kulal-Chalbi-Marsabit area of the Unesco/UNEP Integrated Project on Arid Lands (IPAL). Field work in Ivory Coast and Gabon is planned to start in 1982. In the near future orientation visits will be made to the Omo reserve and the Kainji Lake area in Nigeria and Basse Lobaye in the Central African Republic.

Latin America and the Carribean region (Mr. R.F. Breimer, based at ROSTLAC, Montevideo).
Orientation and programme planning trips included Argentina (Pampa de Achala area), Chile (Andes regions), Colombia (expert meeting on erosion processes in the northern Andes), Mexico (Mapimi reserve) and Peru (Iquitos project). Actual field work concentrated on the Mapimi biosphere reserve, a semi-desertic area in northern Durango, Mexico, and on the Pampa de Achala area in the Sierra de Cordoba, Argentina. Future orientation visits will possibly include the San Carlos de Rio Negro project in Venezuela and an erosion study project is planned to be implemented in the Chilean Andes in 1982.

Southeast Asia (Mr. H. van Reuler, based at ROSTSEA, Jakarta)
Orientation and programme planning trips were made to Thailand (Sakaerat reserve, Mae Sa-Kog Ma reserve), the Philippines (Puerto Galera reserve) and Malaysia. In addition the International Conference on Phosphorus and Potassium in the Tropics, held in Kuala Lumpur, was attended. Actual field work was carried out in the Gunung Gede - Pangrango National Park on West Java, Indonesia.
In the near future field work is planned in the Sakaerat Environmental Research Station in Thailand.

The three soil scientists were also instrumental in the collection of some representative soil monoliths for ISM, the promotion of establishment of national soil reference collections, and the stimulation of international soil correlation in their respective regions.

At the occasion of the major Scientific Conference and Exhibit on ten years of MAB research, held in Paris from 22-29 September 1981, whith as theme ''Ecology in practice: Establishing a Scientific Basis for Land Management'', the work of the

MAB soil scientists and the involvement of ISM were highlighted through a series of posters, and a short exposé of the ISM director.

Some time in 1983 an international workshop will be organized by Unesco and ISM, reviewing the results of the programme. It is hoped that soil scientists in other regions with MAB reserves and research sites, notably in North America and Europe, will then be stimulated to present their soil data in comparable ways.

4.2 Cooperation with India on soil micromorphology

The project ''Establishment of a soil micromorphological unit and micromorphological analyses and characterization of Benchmark Soils of India (cf Annual Reports 1979, 1980)'' was formally approved by both the Indian and the Dutch Government towards the end of the year. In the meantime all thin sections required were prepared by an ISM technician, while Dr. M. Kooistra of the Dutch Soil Survey Institute carried out most of the scientific descriptions and interpretations. She also visited the National Bureau of Soil Survey and Land Use Planning (ICAR) in Nagpur, India for detailed discussions on the progress of the project, and inspected most of the benchmark soils concerned.

Training of Indian soil scientists on micromorphology and the installation of a micromorphological facility at Nagpur is to start early 1982.

4.3 Cooperation with Colombia in the establishment of a national soil reference collection

A request voiced by the Instituto Geografico 'Agustin Codazzi' (IGAC) at Bogotá led to a programme of cooperation with the International Soil Museum (ISM) for the establishment of a national soil reference collection in Colombia. The purposes of this collection, to be housed at IGAC are:

1. to serve as a source of factual information to a broad public on the major soils of the country,
2. to increase the knowledge of the soils on all levels of education,
3. to stimulate better usage of the soils, and
4. to promote the transfer of knowledge on a national and international level.

To carry out this programme Dr. W. Siderius was contracted on DGIS funds to liaise between IGAC and ISM, in the training of a Colombian soil scientist at ISM for a period of six weeks in the methodology of soils monolith collection, preparation and exhibition; in addition to the actual collection of the soil monoliths in Colombia.

During a three months period five field trips were made in Colombia and a total of 18 soils were collected. A similar number was also collected for the ISM concurrently with the Colombian collection. The soils are collected according to the major physiographic regions, concentrating in first instance on the Colombian Amazone region, the Llanos and the South Andes area.

At the workshop of IGAC a start was made with the preparation of the soil monoliths and at the end of the year a part of the seven monoliths were finished for exhibition. The presentation includes texts photographs and figures accompanying the soils concerned.

During the programme period from 15 April till 31 December 1981 between IGAC and ISM the way has been paved for the continuation of the soil reference collection by IGAC to increase the collection of the soil monoliths to a further 50 in the foreseeable future, covering the major soils in the country.

4.4 Small projects

Small projects include activities that do not form part of the regular work programme and that are carried out on regular ISM funds on request. It should be mentioned that only a part of the requests received can be honoured and that priority is given to work for developing countries.

Bangladesh. Preparation of thin sections and analyses for soil classification purposes (Dr. K.M. Edris, Soil Survey of Bangladesh).

Cape Verde. Organic carbon determination in 19 soil samples (on request of Mr. J.H. de Vos tot Nederveen Cappel of ITC, Enschede, Netherlands).

China. X-ray diffraction of 27 samples of the cold desert area to check the presence of palygorskite.

Colombia. Characterization of 42 soil samples for cross-checking local analyses: CEC, texture and X-ray diffraction. These samples were supplied by IGAC Bogotá through Dr. W. Siderius and belong to soil monoliths he collected this year for ISM.

Indonesia. Texture, CEC, pH and X-ray diffraction of 5 samples (on request of Mr. H. van Reuler, Unesco, Jakarta, Indonesia: MAB backstopping).

Indonesia. A poster has been prepared with colour photographs, diagrams and explanatory texts on a toposequence from North Sumatra. The poster has been on display at the Unesco-MAB Exhibit in Paris and will be shown at other exhibitions as well (Mr. C.G.G. van Beek, State University Utrecht, Netherlands).

Kenya. X-ray diffraction of 141 samples from selected areas of Kenya to check the presence of palygorskite in cooperation with National Agricultural Laboratories, Nairobi).

Malaysia. X-ray diffraction of clays in 21 soil samples from Kalingan (on request of Professor D. Goosen, ITC).

Spain. X-ray diffraction and Guinier photos, including interpretation of 51 soil samples for MSc students of ITC.

Spain. Preparation of thin sections, analyses for soil genetic processes and discussion with MSc students in soil survey, ITC.

Spain. Preparation of thin sections, investigation of stress phenomena in vertic soils (Mr. E. Nieuwenhuis, ITC).

5 GUEST RESEARCH AND TRAINING

5.1 Guest research

In 1981 there has been a large response to ISM's open invitation to soil scientists to spend some period for either laboratory research, desk research or studying literature. ISM has received a number of experts who returned from their assignments with bilateral Dutch development cooperation and who are entitled to some months study leave. For scientists from OECD countries there is a possibility to obtain grants for board and lodging in Wageningen. Although ISM has no funds of its own to pay a salary or travel costs, it can be instrumental in solliciting such outside funding.

Another possibility, though the least attractive, is for soil scientists to come to ISM as guest researcher entirely on their own expenses, as sometimes occur. In any case ISM provides laboratory and office facilities, as well as supporting personnel services. ISM hopes that guest researchers will make contributions to its programme through comparative research on similar soils from different regions, to result in the publication of a soil correlation monograph, or through presenting a study relative to the soil monolith collection, to result in either a soil monolith paper or other pertinent documentation.

Guest research in 1981 included the following topics:

Comparison of Podzols (Spodosols) in temperate regions
(Dr. D.L. Mokma, Michigan State University, U.S.A.)
Period; 15 September 1980 - 1 September 1981.
Funding: combined Michigan State University - Agricultural University, Wageningen-International Agricultural Centre, Wageningen.

The main results of this research, of which the purpose was already amply described in Annual Report 1980, are available in manuscript form and will probably be published by ISM as a soil correlation monograph entitled "Podzols and Podzolization in Temperate Regions" with Dr. P. Buurman, Department of Soil Science and Geology, Agricultural University Wageningen, as co-author. Some aspects of the methodology developed have resulted in three different articles to be submitted to scientific journals.

Experience from Kenya learnt that these problems can partly be solved by relying on mathematical relations that can be established between different analytical data. If such relations are valid it will be possible to reduce the number of repetitions of the measurements, and the number of samples required for analysis, without loss of information, as the relations will allow reliable estimates. It is the purpose of this research programme to check the validity of the presumed relations with soil data available from Kenya and other tropical regions. The research is being carried out in close cooperation with the ISM staff and with Prof. Dr. J. Bennema, Department of Soil Science and Geology, Agricultural University in Wageningen.

Preparation of two Soil Monolith Papers on representative soils from Jamaica
(Messrs. J.J. Scholten and W. Andriesse, coming from Jamaica)
Period: 1 September - 31 December 1981
Funding: study leave, DGIS

Both experts were associated with a Netherlands bilateral project assisting the Ministry of Agriculture in the establishment and operation of a 'Rural Physical Planning Unit' in the Western Region of Jamaica. Three soils were selected as objects for scientific studies to be carried out at ISM. These soils are provisionally classified as follows:

JA 1 Humic Acrisol (Orthoxic Palehumult, clayey, mixed, isohyperthermic).
JA 2 Eutric Nitosol (Ultic Tropudalf, very fine, mixed, isohyperthermic).
JA 3 Orthic Ferralsol (Haplic Acrorthox, clayey, gibbsitic, isohyperthermic).

The profiles JA 1 and 3 have been retained as subject for Soil Monolith Papers 5 and 6 respectively. Drafts have been prepared, but their finalization still awaits the availability of complete laboratory data and thin sections. Pot experiments are being conducted by Mr. H. Raadschilders at the Department of Soils and Fertilizers, Agricultural University Wageningen.

In addition to the Soil Monolith Papers two articles are being prepared on the genesis of the three soils, and on quantitative land evaluation procedures for detailed rural planning in the Western Jamaican region, to be submitted for publication in a scientific journal.

Elaboration of soil data from Kenya
(Dr. W. Siderius, Kenya Soil Survey)
Period: 1 December 1980 - 11 April 1981
Funding: study leave, Dutch Directorate General for International Cooperation (DGIS)

The programme has already been given in Annual Report 1980. Actual work concentrated on volcanic ash soils and its agricultural use on which a paper was presented at the International Conference on Soils with Variable Charge in New Zealand.

A start was made in preparing Soil Monolith Paper 4 on a Humic Nitosol (EAK 16) of which all data from analyses were made available later in the year.

After expiration of his sabbatical leave, Dr. Siderius became liaising officer for the cooperation project with Colombia (see section 4.3).

Study on land evaluation for irrigation/drainage projects, with special reference to Planosols
(Mr. A. Hoekstra, irrigation planner, coming from Costa Rica)
Period: 25 April - 31 August 1981
Funding: study leave, DGIS

The programme included a desk research on the methodology and terminology of land evaluation procedures for application in development projects in the field of irrigation and drainage. Special attention has been paid to problem soils (gypsiferous soils, Vertisols, Solonetz/Solonchaks, Planosols) and a review has been made of the occurrence, properties and agricultural use possibilities of the Planosols.

Assessment of recent developments in soil chemistry and in soil physics and their relevance for tropical countries, in particular for Kenya
(Mr. D. Legger, Kenya Soil Survey)
Period: 1 May - 1 September 1981
Funding: study leave, DGIS

Soil research in the tropics often suffers from:
- lack of sufficiently reliable laboratory data
- insufficient laboratory capacity
- insufficient number of kinds of analyses

Documenting the soil monolith collection with land evaluation criteria
(Mr. G.J. Staring, coming from Botswana)
Period: from 1 October - 31 December 1981, three days per week
Funding: nil

This work was originally scheduled as part of Dr. W. Siderius' programme (see Annual Report 1980). The study of soil characteristics and properties becomes of practical value only through an appraisal of its usefulness for agriculture, forestry and other kinds of land use. Such an appraisal should be based on physical and socio-economic aspects. However, as the latter is too site and time specific, it cannot be taken into account. For similar reasons also the climatic aspects cannot be evaluated properly. Knowing these limitations it is still felt useful to present for each soil monolith in the exhibition hall a general appraisal based on the soil properties only, as to differentiate the agricultural use possibilities of the exhibited soils for field crops under rainfed conditions.

Elaboration of data of the LABEX programme
(Mrs. C.H.M. Duijkers-van der Linden)
Period: 1 November - 31 December 1981, part time
Funding: nil
Programme: to assist ISM staff with elaboration of data of the LABEX programme

Future guest research

A number of applications to do guest research at ISM were received. For the near future the following research is expected to be carried out in the guest research scheme:
- study of a Japanese paddy soil (Aquorizem), and comparative studys on similar soils from Southeast Asia (Dr. M. Okazaki, Tokyo University of Agriculture and Technology, Japan)
- Study of a Japanese Andosol, and comparative studies on similar soils from other regions (Dr. C. Mizota, Fac. of Agriculture, Kyushu University, Fukuoka, Japan).

5.2 Training

International Course on the Establishment and Use of Soil Reference Collections

The course has been held from 6 April to 8 May 1981 and was attended by Mrs. A. Correa who is in charge of the Colombian collection to be established at the Instituto Geografico 'Augustin Codazzi' in Bogotá and Mr. P. Manzanares, who was preparing his posting as soil scientist in Mozambique. The training included the taking and impregnating of soil profiles and the display and storage of monoliths, as well as aspects of the management of a soil museum.

Henceforth, this course will be held annually under the auspices of Unesco. For the next few years courses with a duration of five weeks are scheduled to take place in April-May. Each course can be attended by five trainees.

A detailed programme and information about fellowships is available on request.

Training in the preparation of soil monoliths.

6 TRAVEL AND MISSION REPORTS

(81/1)Visit to Unesco's Regional Office for Southeast Asia, Jakarta, Indonesia

December 1981. *Participant: W.G. Sombroek*

Scientific backstopping of Mr. H. van Reuler, Unesco-associate expert ecological sciences (soil science). Contacts with institutions involved in soil research in Indonesia.

(81/2) International Conference on Soils with Variable Charge, New Zealand, February 1981. *Participants: L.P. van Reeuwijk, W. Siderius, W.G. Sombroek.*

Presentation of papers on 'A rapid method to determine a CEC delta value' (van Reeuwijk) and on 'The distribution, range in characteristics and classification of Andosols in East Africa' (Siderius). Discussions of the LABEX sample exchange programme with a number of participants. Exchange of information on soil analytical methods and on ongoing international programmes especially the Benchmark Soils Project. Discussions with specialists on chemistry and mineralogy of variable charge compounds. Meetings of ICOMAND, ICOMLAC and ICOMOX. Participation in field excursions.

(81/3) Second Expert Group Meeting on World Soils Policy. Rome, Italy, February 1981, organized by UNEP with cooperation of FAO. *Participant: W.G. Sombroek.*

Review of international activities in soil related fields of several organizations, with a renewed plea to harmonize these programmes and establish a clearing house for exchange of information. Discussions on a working paper "Elements of a World Soils Policy" and formulation of a Plan of action for its execution.

(81/4) International Conference on Aridic Soils, Israel, March-April 1981, organized by the ISSS Commissions V and VI in cooperation with the Israel Soil Science Society. *Participant: J.H.V. van Baren.*

Discussions on the properties, genesis and management of soils in dry regions, with special attention for the problems of soil degradation and desertification. Establishment of contacts with national soil scientists for the possible collection of soil profiles for ISM in conjunction with building up national collections.

(81/5) Working visit to Nairobi, Kenya for discussions with UNEP, Unesco Regional Office for Africa and Kenya Soil Survey (KSS), May 1981. *Participant: W.G. Sombroek.*

Discussions with UNEP staff on World Soils Policy, on the prospects of programme support for ISM, on the Global Environment Monitoring System (GEMS), and bilateral cooperation projects in Kenya.

Review of the work of Mr. A. van Kekem Unesco-associate expert for the MAB areas in the African region in general and the Intregrated Project in Arid Lands (IPAL) study area in North Kenya in particular.

Discussions with KSS staff on classification of Andosols (for ICOMAND), on finalizing the exploratory soil map of Kenya and on Lamu-north research project proposal.

(81/6) Fourth International Soil Classification Workshop, Rwanda, June 1981, organized by the Institut des Sciences Agronomiques de Rwanda (ISAR) with the cooperation of the Soil Management Support Services (SMSS) of US-SCS/USAID, the University of Puerto Rico and the University of Ghent. *Participant: W.G. Sombroek.*

Presentation of two papers viz. "The Oxisols of Kenya" by F.N. Muchena and W.G. Sombroek, and the "Progress report on the ISM/KIT Laboratory Methods and Data Exchange Programme (LABEX)" by L.P van Reeuwijk and W.G. Sombroek. Discussions on classification of some specific tropical soils (Oxisols, LAC soils and Andosols). Recommendations to the effect that the LABEX programme be continued and expanded and ISM to undertake comparative studies on soil classification. Contacts with African soil specialists. Selection of two Rwandan soils for the ISM collection.

(81/7) Second consultative meeting on the preparation of an International Reference Base for soil classification (IRB), Sofia, Bulgaria, June 1981, organized by UNEP, FAO, Unesco and ISSS. *Participant: W.G. Sombroek.*

Agreement on principles of the proposed IRB: four categories, with nomenclature based on the FAO/Unesco terminology. Elaboration of IRB will be funded by UNEP, executed by FAO with support along LABEX lines by ISM. A steering committee is to be formed consisting of UNEP/FAO/Unesco/ISSS representatives and a scientific advisory panel consisting of selected members of ISSS Commission V.

(81/X) Consultancy mission to Colombia, June-August 1981. *Participant: W. Siderius* (see section 4.3).

(81/8) Sixth International Working Meeting on Soil Micromorphology, London U.K. August 1981, organized by the ISSS Subcommission on Soil Micromorphology, in cooperation with the British Society of Soil Science and the Soil Survey of England and Wales. *Participants: D. Creutzberg and W.G. Sombroek.*

Discussion of new scientific and technical developments in micromorphology, including the new ISSS system for the description of thin sections which will be adopted by ISM. ISM to receive reference material for micromorphological laboratories. Post-meeting excursion to England and Wales (Creutzberg) and selection of eleven excursion profiles for the ISM monolith collection.

(81/11) Soil profile collection trip to England and Wales, September 1981. *Participant: D. Creutzberg* (see section 3.1).

(81/9) Visit to Unesco Headquarters, Paris, France, September 1981. *Participant: W.G. Sombroek.*

Discussions on ISM contribution to MAB exhibit, on status and function of ISM in view of the coming international evaluation commission, on Unesco fellowships for the 'International Course on the Establishment and Use of Soil Reference Collections' and on the ISM/MAB cooperation programme in the field of soil science.

(81/12) Colloquium on the Handling of Soil Data, Paris, France, September 1981 organized by the ISSS Working Group DP (Data Processing) with cooperation of the Institut National Agronomique (INA). *Participant: C.A. van Diepen.*

Acquaintance with computer applications in soil science. Establishment of contacts with French organizations working overseas for collection of documention.

(81/13) MAB Conference and Exhibit at Unesco, Paris, September 1981, organized by Unesco-MAB and ICSU. *Participants: W.C.W.A. Bomer, C.A. van Diepen, W.G. Sombroek*

Contribution of ISM to MAB Exhibit with a special stand on ISM and on applications of soil science (Bomer). Explanation of ISM stand along with attendance to Conference (Van Diepen). Allocution on ISM-MAB work and on role of soil science in the study of ecosystems (Sombroek).

(81/14) Sixth Expert Consultation on Soil Correlation and Land Evaluation in West and Central Africa, Lomé, Togo, December 1981, convened by FAO. *Participant: R.F. van de Weg (staff member of the University of Amsterdam acting as ISM representative).*

Establishing contacts with West African soil survey institutions. Discussions on establishing national soil reference collections and on scope of ISM. Participation to conference and excursion.

(81/15) Soil profile collection trip to Kenya, November 1981. *Participant: J.H.V. van Baren* (see section 3.1)

7 INTERINSTITUTIONAL RELATIONS

7.1 International relations and activities

FAO

Close contacts were maintained during the year on a number of matters, viz. the envisaged programme of updating the FAO/Unesco Soil Map of the World and its applications. Copies were obtained of FAO's 1:5 million maps on the Agroclimatological Zonification of Latin America, Africa, South and Southeast Asia. Together with the soil resources information, this climatic zonification is indispensable for a sensible land evaluation and assessment of production potential of the land, on a worlds wide basis.

Support was rendered to the current FAO/UNFPA-programme of establishment of natural resources based population carrying capacities, on country basis.

Unesco

The cooperation with Unesco's Division of Ecological Sciences continued to be very close, through the joint programme for soil studies in the MAB biosphere reserves and research sites in Latin America, Africa and Southeast Asia (see section 4.1).

Agreement was reached on the format of an annual training course at ISM on the establishment and use of soil reference collections, for which Unesco is prepared to grant fellowships (see sections 2.1 and 5.2)

UNEP

Contacts with UNEP developed very positively. Cooperation was rendered to its efforts to arrive at a "World Soils Policy" with a Plan-of -Action and the development of an "International Reference Base for Soil Classification (IRB)". The latter programme, in which also FAO, Unesco and ISSS cooperate, took shape during a second international meeting in Sofia, June 1981.

At this meeting it was agreed that FAO is to coordinate the efforts of the various international working groups to be established and that ISM is to investigate on the suitability of various laboratory methods for the determination of diagnostic features while ISSS Commission V will act as the scientific forum. The ISM involvement will take the form of an expansion of its current LABEX programme (see section 3.2). Funds were specifically earmarked for this purpose in the programme proposals submitted to UNEP by the Sofia group. Details on the World Soils Policy and IRB programmes are recorded in ISSS Bulletin no. 59 (1981/1).

The request for a substantial programme support to ISM for four years was admitted for consideration by the Fund of UNEP in December 1981.

ISSS

ISM continued to house the Secretariat-general of this single international organization of professionals in all branches of soil science. Particularly close contacts were maintained with the Officers of its standing scientific Commission V (Soil genesis, classification and cartography) notably at the shaping of the programme for an International Reference Base for soil classification (IRB) and the development of methodologies of land evaluation for various uses (forestry, range management, soil conservation). ISM is also contributing to the collection of reference material on the nomenclature of hydromorphic soils (Working Group NO) as occurring in the various national and regional systems of soil classification that are currently in use.

European Commission

Contacts were maintained with the Land Use and Rural Resources Programme (DG 6-F4) of the European Commission and project suggestions were submitted to its Programme for Research and Science for Development (DG 12-B3).

International Committees on Soil Classification

Staff of ISM are members of all of the US,- sponsored Committees on improvement of the US Soil Taxonomy system of classification (ICOMLAC, ICOMOX, etc., see ISSS Bulletins 57 and 59 for details). In the framework of these Committees the Director participated in an international workshop on the classification of soils with low activity clays and soils derived from volcanic materials, held in Rwanda, hosted by the Institut des Sciences Agronomiques de Rwanda (ISAR).

Contacts are maintained with several French-speaking groups working on improved soil classification such as the Working Group "Projet de classification des Sols" of ORSTOM and the Working Group on the "Caractérisation et la classification des organisations, des horizons et des sols calcaires" of CPCS. Also modern approaches of soil classification of USSR, Brazil, Japan etc. are being kept in touch. Mr. R.F. Van de Weg of Amsterdam University participated on behalf of ISM, in the 6th FAO-sponsored regional meeting on Soil Correlation and Land Evaluation in West and Central Africa in Lomé, Togo, December 1981.

These contacts should help ISM to assist in the international correlation of soil classifications in general, and the development of an International Reference Base in particular.

Others

The proposed International Board of Soil Resources Management (IBSRM) to deal with soil constraints in the tropics and subtropics, is still on the planning board (cf Annual Report 1980).

Contacts with the Benchmark Soils Project (BSP) of USAID/Universities of Hawaii and Puerto Rico and its likely successor the International Network of Benchmark Sites for Agrotechnology Transfer (INBSAT) continued.

An appeal for cooperation by the IFIAS-"Save Our Soils" project resulted in a formal request to the Dutch Directorate for Development Cooperation (DGIS) for a two-year support through ISM, to determine the degree of biophysical constraints to the successful application of known technologies for the control of soil degradation, and soil erosion in particular, in thirteen countries of the tropics and subtropics.

The Director continued to serve in the international advisory panel of the Soil Management Support Services (SMSS) of USAID/USDA Soil Conservation Service.

Effective contacts were established with the Geological Institute of the University of Ghent, especially in the field of soil micromorphological training of students in its international M. Sc. course in soil science.

7.2 National relations and activities

The following contacts were maintained as before:

- International Institute for Aerial Survey and Earth Sciences (ITC) in Enschede, and its Department of Soil Science in particular (lecturing, ad-hoc training).
- Royal Tropical Institute (KIT) in Amsterdam, Department of Agricultural Research in general and its Division of Soil Science and Agrochemistry in particular (the joint ISM-KIT Laboratory Exchange programme LABEX).
- Agricultural University (LH) in Wageningen, in particular its Department of Soil Science and Geology (soil monolith collection and characterization), its Department of Soils and Fertilizers (fertility testing of selected soils) and its MSc. Course in Soil Science and Water Management (instruction).
- The Dutch Soil Survey Institute (STIBOKA) in Wageningen (micromorphology; determination of physical properties of soils; cartography; project preparation; job mediation).
- The Netherlands Foundation for the Advancement of Tropical Research (WOTRO) in The Hague (soil and vegetation studies in national parks of Kenya and Malawi).
- The Soil Departments of the University of Utrecht (international soil classifications, soil monolith collection) and of Amsterdam (map collection, publications, representation).
- The National Agricultural Centre (IAC) in Wageningen and its Project Advisory Committee (fellowships; visitors accommodation; technical assistance projects; job mediation).
- The Royal Netherlands Academy of Sciences (KNAW) in Amsterdam (soil science exchange programme with China).
- The Directorates of Agricultural Research (DLO) and Agricultural Assistance Developing Countries (AHO) of the Dutch Ministry of Agriculture.

8 PUBLICATIONS

8.1 Soil Monolith Papers

In 1981 the first number in the series Soil Monolith Papers (SMP) has been issued on a Thionic Fluvisol from the Central Plain region in Thailand. The paper has been elaborated mainly by O.C. Spaargaren with specialist contributions of D. Creutzberg, L.P. Van Reeuwijk, and C.A. Van Diepen. Valuable comments on earlier drafts have been received from N. Van Breemen and R.F. Van de Weg. Final editing has been done by C.A. Van Diepen. The paper will serve as a model for subsequent papers in the series of which five others are in preparation by either ISM staff or guest researchers at ISM as senior authors:

SMP 2, Orthic Ferralsol from Zambia (Z 2), by J.H.V. Van Baren
SMP 3, Placic Podzol from Ireland (IRL 9), by D. Creutzberg
SMP 4, Humic Nitosols from Kenya (EAK 16), by W. Siderius
SMP 5, Humic Acrisol from Jamaica (JA 1), by J.J. Scholten and W. Andriesse.
SMP 6, Acri-Orthic Ferralsol from Jamaica (JA 3), by W. Andriesse and J.J. Scholten.

Each paper deals with a soil monolith that can be considered as a representative example of a soil unit according to the legend of the FAO-Unesco Soil Map of the World. A Soil Monolith Paper presents information on the soil unit in general and on the soil monolith proper, including the soil and its environment, with aspects of soil genesis, soil classification and land evaluation. Its is intended to achieve a good balance between the site- specific information on the one hand and generalizations to regional and global level on the other.

8.2 Technical Papers

- Preparations were made for the publication of a Spanish language version of ISM Technical Paper 1 "Procedures for the Collection and Preservation of Soil Profiles".
- Technical Paper 2 has appeared, entitled "The Photography of Soils and Associated Landscapes". The paper has been prepared by J.M. Ragg of the Soil Survey of England and Wales with D. Creutzberg.

8.3 Other papers

- A paper entitled "Podzols and Podzolization in Temperate Regions" has been prepared by D.L. Mokma, guest researcher at ISM, and P. Buurman of the Agricultural University in Wageningen. If financing permits, the paper will be published in 1982 as an ISM Monograph.

- A second slightly amended edition was printed of ISM's "Field Extract of Soil Taxonomy".
- Negotiations are underway for an English-language field extract of ORSTOM's "Projet de classification des sols" and of EMBRAPA-SNLCS's "Sistema Brasileiro de Classifiçacao de Solos" and for an updated field extract of the FAO-Unesco "Legend to the Soil Map of the World".

8.4 Annual Report 1980

An annual report over the year 1980 has been issued, giving details on the institutional developments, activities of the sections, projects, guest research and training, travel and mission reports, interinstitutional relations, publications, and personnel. It includes two articles, viz. "Some considerations on quality and readibility of soil maps and their legends" by W.G. Sombroek and R.F. van de Weg, and "Desertification: Extent, Causes, and Control" by J.H.V. van Baren. Reprints of the articles can be obtained on request.

9 PERSONNEL

9.1 ISM Board of Management

Members of the Board of Management were on December 31, 1981:

- Prof. Dr. Ir. G.H. Bolt, Chairman Netherlands Advisory Council.
- Prof. Dr. L. van der Plas, Agricultural University Wageningen.
- Ir. J.B. Ritzema van Ikema, International Institute for Aerial Survey and Earth Sciences (ITC), Enschede.
- Ir. R. P.H.P. van der Schans, Division for Agricultural Research, Ministry of Agriculture and Fisheries, Wageningen (Chairman)
- Prof. Dr. Ir. T. Wormer (personal member).

9.2 International Advisory Panel

The International Advisory Panel (IAP) met in 1967, 1972 and 1979. The members of the IAP in 1979 were:

- Prof. Dr. G. Aubert, ORSTOM, Bondy, France.
- Dr. F. di Castri, Unesco, Paris, France.
- Dr. R. Dudal, FAO, Rome, Italy.
- Dr. S. Holzhey, USDA-SCS, Washington, USA.
- Dr. R. Herrera, IVIC, Caracas, Venezuela.
- Prof. Dr. V.A. Kovda, Moscow State University, Moscow USSR.
- Dr. R.S., Murthy, National Bureau of Soil Survey and Land Use Planning, Nagpur, India.
- Dr. A.M. Osman, ACSAD, Damascus, Syria.
- Dr. S. Pereira Barreto, ORSTOM, Dakar, Senegal.
- Dr. L.D. Swindale, ICRISAT, Hyderabad, India.

9.3 Netherlands Advisory Council

Members of the NAC on December 31, 1981 were:

- Ir. J.G. van Alphen, International Institute for Land Reclamation and Improvement (ILRI), Wageningen.
- Prof. Dr. Ir. J. Bennema, Department of Soil Science and Geology, Agricultural University Wageningen.
- Prof. Dr. Ir. G.H. Bolt, Department of Soils and Fertilizers, Agricultural University Wageningen (Chairman).
- Dr. Ir. J.C. Dijkerman, M.Sc. Course Soil Science and Water Management, Agricultural University Wageningen.
- Prof. Dr. Ir. A. van Diest, Royal Netherlands Society of Agriculture, Wageningen.
- Dr. Ir. Th. J. Ferrari, Institute for Soil Fertility, Haren.

- Prof. Dr. Ir. D. Goosen, International Institute for Aerial Survey and Earth Sciences (ITC), Enschede.
- Ir. B. van Heuveln, State University Groningen.
- Dr. F. Kadijk, Laboratory for Soil and Crop Testing, Oosterbeek
- Prof. Dr. Ir. F.R. Moormann, State University Utrecht.
- Ir. A. Muller, Royal Tropical Institute, Amsterdam.
- Ir J.C. Pape, Soil Science Society of the Netherlands, Wageningen.
- Dr. Ir. J. Schelling, Soil Survey Institute (Stiboka), Wageningen.
- Drs. J.F. Th. Schoute, Free University, Amsterdam.
- Prof. Dr. Ir. A.P.A. Vink, Laboratory for Physical Geography and Soil Science, University of Amsterdam.
- Ir. W. van Vuure, Division for Agricultural Research, Ministry of Agriculture and Fisheries, Wageningen.
- Dr. Ir. G.P. Wind, Institute for Land and Water Management Research (ICW), Wageningen.

9.4 ISM Staff

9.4.1 Present Staff

On December 31, 1981 the ISM staff members were:

Dr. Ir. W.G. Sombroek		: Director; soil classification and correlation
Drs. J.H.V. van Baren		: Curator of the soils collection; documentation
Dr. Ir. L.P. van Reeuwijk MSc		: Soil chemistry, mineralogy and physics
Drs. D. Creutzberg		: Soil micromorphology; educational affairs
Ir. C.A. van Diepen		: Publications; agricultural applications
Ing. R.O. Bleyert		: Soil micromorphology; map documentation
Mr. A.J.M. van Oostrum		: Chief laboratory analyst, chemical
Mr. J.R.M. Huting		: Laboratory analyst, clay mineralogical and physical
Mr. R.A. Smaal (seconded by ITC)		: Laboratory analyst, physical
Mr. J.G. ten Bokkel (seconded by Labour Bureau)		: Laboratory analyst, special assignment
Mr. W. Bomer Sr.		: Technician monolith preparation; technical services
Mr. W.C.W.A. Bomer Jr.		: Technician, photography and drawing
Mr. J.D. Schreiber		: Technician, thin-section preparation
Mr. J. Brussen		: Internal administration*
Mrs. P.C. van Leeuwen Mrs. A.C. Reyerse	sharing	: Clerical services
Mrs. J.C. Jonker-Verbiesen Mrs. J. Nijhuis-Möller	sharing	: Maintenance services

* External administration by Managing Director, ITC, Enschede

9.4.2 Mutations in Staff

One staff member left in 1981:
Dr. O.C. Spaargaren, who joined ISM in 1978 as the Educational officer. He has been very active in the development of the educational programme and has also elaborated upon the concept of the Soil Monolith Papers. He was also responsible for the preparation of the Annual Report 1979. During one-third of his time he was the right-hand of the Secretary-General of the International Society of Soil Science.

Dr. Spaargaren left for an American consulting company and will be responsible for carrying out soil survey and land use planning projects in developing countries.

Joined in 1981:
Ir. C.A. van Diepen. who replaces Dr. Spaargaren as Educational officer. Mr. Van Diepen was formerly associated with FAO, working in Thailand and Benin, mainly as land evaluation and soil conservation officer. Mr. van Diepen has a fixed-term appointment of two years, during which he will also deal with the publication of ISM reports and papers and assist the Secretary-General of I.S.S.S.

On a temporary basis, ISM employed following persons during 1981:
- *Mrs. Y.G.L. Karpes-Liem*, typist, 6 months and thereafter on a task basis.
- *Mrs. M. de Groot-Sot*, chemical analyst, 6 months.
- *Miss E.C.M. Schouten*, library assistant and typist, 4 months.
- *Mr. J.C. ten Bokkel*, chemical analyst, 4 months.

Their employments have been made possible by subsidies of the Ministry of Social Affairs.

9.5 Guest researchers and trainees

The following scientists have received hospitality at ISM for research or for training purposes:
- *Mr. W. Andriesse*, coming from Jamaica
- *Mrs. A. Correa*, Colombia
- *Mrs. C.H.M. Duijkers-van der Linden*, the Netherlands
- *Mr. A. Hoekstra*, coming from Costa Rica
- *Mr. D. Legger*, coming from Kenya
- *Mr. P. Manzanares*, going to Mozambique
- *Dr. D.L. Mokma*, USA
- *Mr. J.J. Scholten*, coming from Jamaica
- *Dr. W. Siderius*, coming from Kenya
- *Mr. G.J. Staring*, coming from Botswana

APPENDIX A - Visitors in 1981

Groups of professional visitors

National

Agricultural University (LH), Wageningen	14 groups	298 persons
Delft University of Technology (TH), Delft		12 persons
Free University (VU), Amsterdam		8 persons
International Institute for Aerial Survey and Earth Scienes (ITC), Enschede		16 persons
National Agricultural School (RHLS), Deventer	2 groups	40 persons
School of Agriculture (HLS), Den Bosch		15 persons
School of Agriculture and Horticulture (HLTS), Kerk Avezaath		18 persons
State University Groningen (RUG), Groningen		34 persons
Teacher College for Biology (Witte Lelie), Amsterdam	2 groups	34 persons
Teacher College for Geography (MO Aardr.k.), Utrecht		25 persons
University of Amsterdam (UvA), Amsterdam	2 groups	29 persons

International

Agricultural University (LH), Wageningen, MSc course Soil Science	26 persons
Belgian Soil Sciene Society	54 persons
Fachhochschule Osnabrück, GFR	20 persons
Group of students from Berlin, GFR	8 persons
Group of students from Bonn, GFR	40 persons
International Agricultural Centre (IAC), Wageningen, Fertilizer Course	19 persons
International Institute for Aerial Survey and Earth Sciences (ITC), Enschede, Netherlands	18 persons
International Institute for Hydraulic and Environmental Engineering (IHE), Delft, Netherlands	25 persons
International Institute for Land Reclamation and Improvement (ILRI), Wageningen, Drainage Course	30 persons
International Symposium 'Peat lands below sea level', Wageningen, Netherlands	67 persons
Land and Water excursion from Romania	25 persons
National School of Tropical Agriculture (RHLS), Deventer, Netherlands	9 persons
Portsmouth Polytechnic, Dept. of Geography, UK	20 persons
School of Environmental Sciences, Un. of East Anglia, Norwich, UK	40 persons
University of Osnabrück, GFR	18 persons

Group of non-professional visitors

National

Agricultural University (LH), Wageningen, personnel:		40 persons
Free School, Zeist		22 persons
HAVO, Gorinchem		15 persons
Heldring College, Zetten,	2 groups	22 persons
Wageningens Lyceum, Wageningen	2 groups	50 persons
National Council for Agricultural Research (NRLO)		30 persons
Royal Netherlands Society for Natural History (KNNV)		46 persons
School for analysts (STOVA), Wageningen	2 groups	49 persons

International

Farmers from Denmark, invited by Shell	35 persons
University of Nitra, Czechoslovakia	17 persons
Television crew, Japan	4 persons

VISITORS FROM ABROAD IN 1981

official representatives of international organizations

T. Ajibola Taylor (ISNAR)
C.J. Bentley (ISSS)
F. Di Castri (Unesco)
R. Dudal (FAO)
F. Fournier (Unesco)
A.S.R. Juo (IITA)
A. Mina (ISNAR)
C. Ter Kuyle (IITA)
M. Zehni (ISNAR)

visitors by country

Argentina
Meca, M.I.
Nakama, V
Pazos, H.
Rosell, R.A.
Rosell, U.M.

Australia
Chartres, C.
Smiles, R.
Talsma, T.
Torlael, D.

Austria
Kastanek, F.

Bangladesh
Athwal, D.S.
Islam, A.T.S.Z.
Scholten, J.H.M.
Taher, A.

Belgium
Baert, G.
Buggenhout, J.
Buggerhout, P.
Callebaut, F.
De Cock, T.
De Coninck, F.
Delecour, F.
De Pauw, E.
D'Hoore, J.
Dufey, J.
Gabriëls, D.
Gabriëls, R.
Hanotiaux, G.
Hofman, G.
Hulot, A.
Kiekens, L.
Lacroix, D.
Langohr, R.J.

Louis, A.
Lozet, J.

Belgium (cont'd)
Marcoen J.M.
Mathieu, C
Moreale, A.
Nisot, J.
Sanders, J.
Saussus, A
Stradiot, P.
Sys, C.
Van Cleemput, O.
Van der Beken, A.
Van der Eijk, W.
Van Ranst, E
Van Ruymbeke, M.
Verdegem, L.
Verheye, W.
Verloo, M.

Benin
Van Diepen, C.A.

Bolivia
Padilla, A.

Botswana
Remmelzwaal, A.
Staring, G.J.

Brazil
De Aranjo Lessa, P.
De Hoogh, R.J.
Macedo, S.
Valadares, J.M.A.S.
Van der Cruys, F.

Burma
U Hti Aung

Cameroon
Efite, D.

Canada
Bentley C.J.
Bentley, Mrs.
Campbell, J.A.
Copp. G.
Finstad, M.
O'Callaghan, M.
Roy, C.A.

China
Qu Cuihui
Wang, S

Colombia
Correa, A.
Daza, O.H.
Triana, M.P.

Costa Rica
Cordes, M.
Hoekstra, A.

Cyprus
Grivas, G.

Czechoslovakia
Antalova, A.
Baker, D.
Dabec, V.
Dudas, J.
Dzatko, M.
Ehrenhold, P.
Hvasko, S.
Machaiova, D.
Majlaq, D.
Molnas, T.
Odrianek, J.
Ojziakav, S.
Raska, Dr.
Remsik, E.
Rovdecon, J.
Stizmen, V.
Ubrezi, G.
Zilla, A.

Denmark
Larsen, J.P.
Mortensen, J.R.

Egypt
Abdelkerim, A.
Ali, F.A.M.
Arnous, A.
El-Sayed, H.
Gamal, A.N.K.S.
Gouda, M.
Hamed, K.S.
Helmy, M.K.M.
Makled, F.M.A.
Mohamed, S.A.B.
Olhman, M.
Omar, A.E.
Salem, B.A.
Sharrif, M.

Ethiopia
Bekele, T.
Menelik, G.

Fiji
Khan, J.

Finland
Dergunov, A.
Heikurainen, L.
Puustjärvi, V.

France
Floquet, A.
Fresse, C.
Fresse, J.C.
Laban, P.
Ruellan, A.
Van Oort, N.
Vouters, P.

Gambia
Demba, K.F.
Jatta, S.F.K.

Germany, Fed. Rep.
Alther, H.
Bahlmann, C.
Bailly, F.
Bartels, R.
Bien, P.
Birnbach, M
Böhringer, R.
Burghardt, W.
Dumbeck, G.
Eggelsman, R.
Esser, D.
Gerke, H.J.
Graser, C.
Grimme, H.
Gudmundsson, T.
Kobel-Voss, A.
Kronen, M.
Kuntze, H.
Lumparski, F.
Norbert, U.
Pape, R.
Rödel, R.
Schuh, M.
Schuh, Mrs.
Schwerdtfeger, G.
Schwerdtfeger, H.
Sieveling, J.
Stahr, K.
Streif, H.
Tributh, H.
Von Bielow, S.
Wiechmann

Ghana
Asamoah, C.
Boaleng, E.
Danso, J.K.
Kuatsinu, E.K.
Nanful, G.A.
Osae, N.O.

Greece
Agossandrou, A.
Zathopoulos, F.

Honduras
Van Ginneken, P.C.

Hungary
Cranyis, B.
Varallyaj, G.
Varallyaj, Mrs.

India
Dhrangaelharia, D.
Singh, I.S.
Yaduwanshi, R.P.S.

Indonesia
Astiana
Bachtiar
Darul, S.W.P.
Dja'Far Shiddig
Goenarson, D.
Iswandi, A.
Kronen, M.
Lopulisa, C.
Munting, A.
Nastiti, S.M.
Raimadoya
Siregar, B.
Sjahirial, L.
Soekirman, S.
Sudarsano, I.K.
Sudarsono
Sunjoto, A.
Suprianto, N.
Syakban, H.
Undang, K.
Van Barneveld, B.
Van Beek
Watoelangkow, S.L.
Widyaningsih, J.

Iran
Farshad

Iraq
Abdul, G.A.S.
Abdul, K.A.S.R.
Hassan, F.A.
Jassim, J.F.
Nawzat, L.J.
Ranja, S.S.

Ireland
Giggins, G.
Hammond, R.F.
Healy, J.
Mc Nally, G.
O'Brien, D
Ryan, T.C.

Israel
Dalberg, S.
Dweiry, I.
Schalinger, K.M.
Wolansky, J.

Italy
Boccizi, P.
Favi, E.
Janetti, N.
Mahler, P.J.
Rossi, R.

Jamaica
Andriesse, W.
Burton, Th. T.
Scholten, J.J.
Wilks, R.
Zyson, C.

Japan
Araki, S.
Fukushi, R.
Kageyama, M.
Kurihara, M.
Tabuchi, T.
Takashima, T.
Tsuchida, H.
Yamana, K.

Director of ISM interviewed by Japanese T.V. crew.

Jordan
Bakr, H.A.H.
Shaheen, H.Q.
Waked, M.K.

Kenya
Altenburg,
Braun, H.M.W.
Buch, M.
Groot, J.
Kinyangui, H.
Legger, D.
Legis, R.P.L.
Mbuguah, :J:M:
Osoro, C.M.
Shitakha, F.
Van der Pouw, B.

Korea
Kil, Y.S.
Kim, J.J.
Koo, K.Y.
Lee, Y.I.
Yu, K.Y.

Lesotho
Berding, F.R.

Liberia
Korvah P.N.

Lybia
Zehni, M.

Malaysia
Abdul Rahman, H.
Abu Bakar, I.B.
Foo Kon Chen
Ping Tat Chin
Teng, C.S.
Wong Chaw Bin
Zainuri, M.

Malawi
Msuku, I.R.
Varela, K.G.

Mozambique
Manzanares, P.
Van Engelen, J.
Van Mourik, W.

Nepal
Pradhan, T.M.

New Zealand
Wilde, R.H.

Nigeria
Abdullah, Y.A.
Adedeji, F
Khaleil, A
Okenyi, S.
Ter Kuyle, C.

Norway
Valen-Sendstad, O

Pakistan
Nisar, A.
Sham-Ul-Haque

Peru
Moncada Mori, P.
Mora W.J.F.
Munive, E.
Soldarzaga, S.

Philippines
Aganon, A.G.
Bautista, L.N.
Bihis, Z.V.
Clemente, R.S.
Cura, O.R. Jr.
Directo, A.V.
Dumo, A.B.
Irinco, R.E.
Ramat, I.B.
Ranosa, J.R.

Poland
Ilnicki, P.
Marcinek, J.
Okruszko, H.
Szorygielski, S.

Portugal
Arenido, J.
Campos, J.E.R.V.
Coulinho, J.
Leal, G.M.
Nunes Perdigao, V
Perdigao, A.
Pereira, L.A.
Texeira, A.

Romania
Carstea, S.
Costea, V.
Dumitriu, R.
Liviu, B.
Miraea, A.
Munteanu, I
Titu, C.V.
Ursacescu, G.
Vatau, A.D.
Yovila, V.

Samoa
Salesa, A.S.

Sao Tomé
Areyás, M.F.
Espirito Santo, S.A. do

Senegal
Hilwig, F.
Van Sleen, L.

Sierra Leone
Conteh, M.A.R.
Dyfan, T.
Schalks, B

South Africa
Hildyard, P.
Le Roux, J.
Louw, H.A.

Sri Lanka
Abeysingha, M.P.B.
Broersma, J.
Mahipala, M.W.
Srikanthan, S.

Sudan
Arvad, J.
Ateeg Awad
El Naim, M.A.
El Tiraifi, D.
Gadir, A.A.
Girgis, G.M.
Hassan, I.M.
Van Oort, C.

Surinam
Prade, H.O.

Sweden
Linner, H.
Olsson, M.
Swantesson, J.O.H.
Tideman, A.
Troedsson, T.

Switzerland
Blum, H.
Buchter, B.
Jener, N.

Syria
Khoury, A.

Tanzania
Dumea, H.A.
Lesuis, M.
Lupeja, P.M.
Mgogo, S.
Moshi, L.A.
Mowo, J.G.

Thailand
Kongngoen, R.
Kosaiyakanont, T.
Sittibusaya, Ch.
Yamchoti, S.

Tunesia
Kallala, A.

Turkey
Acun, O.
Aktas, S.
Atilla, K.
Kaytan, G.
Sengül, F.

Uganda
Magunda, M.
Ogwal, M.

United Kingdom
Allen, N.
Burton, A.
Canti, M.
Carfield, H.
Carter, D.
Chakruarly, N.
Chiterd, A.
Clarke, A.
Cunningham, M.
Deacon, B.
Deamon, J.
Dent, D.
Donse, S.
Duangchai, N.
Dye, J.
Edwards, P.
Evans, J.
Evans, M.
Findlay, D.C.
Findlay, J.
Foster, R.
Goodwin, J.L.
Grant, R.
Greenwood, S.
Guller, R.P.
Hall, D.G.M.
Harvey, W.
Haywood, S.
Heathwaite, L.
Hobbs, M.
Howell, K.
Hudson, N.
James, L.
Jones, H.
Karas, J.
Kenyr, A.
Lawson, K.
Liaq, K.
Maloney, S.
Mellas, G.
Miles, N.
Moody, D.

United Kingdom (cont'd)
Newland, M.H.
Perke, L.
Pitt, J.O.
Ravensdale, J.R.
Rees, H.
Reeve, M.J.
Richards, M.
Roberts, D
Robertson, R.A.
Scott, D.S.
Spelding, A.
Spurway, E.
Talbot, M.R.
Vandersteen, K.
Vincent, S.G.
Wallis, J.S.
Walter, D.
Ward, C.
Webster, R.
Wellings, S.R.
White, S.
Willis, C.
Woods, G.
Zorbilade, F.

Upper Volta
Jordans, R.
Molenaar, L.
Van Staveren, J. Ph.

Uruguay
Angueira, C.
Prieto, D.R.
Terzaghi, C.I.A.

U.S.A.
Byrnes, F.C.
Finkl, C.W.
Kimble, J.
Lutan, W.
Patrick, W.H.Jr.
Peake, C.
Peake, G.W.III
Potosky, G.M.
Stephens, Mrs.
Street, C.
Street, J.
Vlek. P.
Wilding, L.P.

USSR
Davydik, I.L.
Filippo, H.A.
Korchunov, S.S.
Novik, A.
Parnasova, E.
Pavozkow, IJ.
Sokalow, B.N.

Vietnam
Thai Phien
Vu Cao Thai

Yemen, Arab Rep.
Hadi, A.K.
Kohri, A.Y.H.

Yemen, P.D.R. of
Gadiv, A.A.

Yugoslavia
Rodojka, O.

Zaire
Asan, M.

Zambia
Commissaris, A.
Tiang, W.T.
Veldkamp, W.J.

Appendix B-Laboratories participating in the 'Laboratory Methods and Data Exchange Programme for Soil Characterization (LABEX):

AUSTRALIA
CSIRO, Division of Soils, Davies Laboratory
Pte Bag, Townsville, QLD 4810, Australia
Liaison officer: Dr. G.P. Gillman

BELGIUM
Lab. v. Fysische Aardrijkskunde en Bodemstudie.
Geologisch Instituut
Krijgslaan 271, B-9000 Gent, Belgium
Liaison officer: Prof: Dr. C. Sys

BRAZIL
SNLS-EMBRAPA
Rua Jardim Botânico, 1024 - Gávea
22460 Rio de Janeiro, RJ Brazil
Liaison officer: Dr. A.F. de Castro

CAMEROON
Inst. of Agric. & Forestry Research
Centre for Perennial Crops, Ekona
PMB 25, Buea, Cameroun
Liaison officer: Dr. S.N. Lyonga, Chief of Centre

COLOMBIA
Instituto Geografico "Augustin Codazzi"
Laboratorio de Suelos
Carrera 30, no. 48-51
Bogota, Colombia
Liaison officer: Dr. C. Luna Zambrano

FRANCE
Services Scientifiques Centraux
O.R.S.T.O.M.
70-74, Route d'Aulnay
93140 Bondy, France
Liaison officer: Dr. P. Pelloux

GERMANY (FRG)
Ordinariat für Bodenkunde
Universität Hamburg
Von Melle Park 10
2000 Hamburg 13, BRD
Liaison officer: Dr. G. Miehlich

INDIA
Nat. Bur. of Soil Survey & Land Use Planning
Seminary Hills, Nagpur-440 006, India
Liaison officer: Dr. R.S. Murthy

INDONESIA

Centre for Soil Research
Jalan Juanda 98
Bogor, Indonesia

Liaison officer: Dr. D. Muljadi, Director

JAPAN

Tropical Agricultural Research Centre
Min. of Agric. Forestry & Fisheries
Yatabe, Tsukaba, Ibaraki, 300-21 Japan

Liaison officer: Dr. Yutaka Arita

KENYA

Kenya Soil Survey
P.O. Box 14733, Nairobi, Kenya

Liaison officer: Mr. F.N. Muchena

MALAYSIA

Analytical Services, Dept. of Agric., H.Q.
Jalan Swettenham
Kuala Lumpur, Malaysia

Liaison officer: Mr. Lim Han Kuo

MOZAMBIQUE

INIA, Dept. de Pédologia
Caixa Postal 3658, Maputo, Mozambique

Liaison officer: Mr. C.D. Konstapel

NETHERLANDS

International Soil Museum
P.O. Box 353,
6700 AJ Wageningen, Netherlands

Programme Secretary: Dr. L.P. van Reeuwijk

Royal Tropical Institute
Mauritskade 63, Amsterdam, Netherlands

Liaison officer: Dr. F. van der Pol

NEW ZEALAND

Soil Bureau, DSIR
Private Bag, Lower Hutt, New Zealand

Liaison officer: Mr. L.C. Blakemore

NIGERIA

I.I.T.A.
PMB 5320, Ibadan, nigeria

Liaison officer: Dr. A.S.R. Juo

SYRIA

The Arabic Center for the Studies of
Arid Zones and Dry Lands (ACSAD)
P.O. Box 2440, Damascus, Syria

Liaison officer: Mr. J.-O. Job

UNITED KINGDOM

Tropical Soil Analysis Unit, LRCD
Min. of Agric., Fisheries & Food
Coley Park, Reading RGI 6DT, England

Liaison officer: Mr. R. Baker

U.S.A.

Soil Conservation Service
Room 393, Federal Building
100 Centennial Mall N.
Box 52503
Lincoln, NE 68508, U.S.A.

Liaison officer: Dr. J.M. Kimble

Dept. of Agronomy & Soil Science
College of Tropical Agriculture
3190, Maile Way
Honolulu, Hawaii 96822, U.S.A.

Liaison officer: Dr. J.A. Silva

VENEZUELA

CENIAP, MAC
Seccion Suelos
Maracay 200, Venezuela

Liaison officer: Dr. A.V. Chirinos

LIST OF ISM PUBLICATIONS

Technical Paper 1: Procedures for the collection and preservation of soil profiles (J.H.V. van Baren and W. Bomer). 23 pp. ISBN 90-6672-004-2

Technical Paper 2: The photography of soils and associated landscapes (J.M. Ragg and D. Creutzberg) 12 pp. ISBN 90-6672-005-0

Technical Paper 3: A new suction apparatus for mounting clay specimens on small-size porous plates for X-ray diffraction (L.P. van Reeuwijk) 4 pp. ISBN 90-6672-006-9

Field Extract 1: Field Extract of Soil Taxonomy. The 1975 system of soil classification of the U.S.D.A./S.C.S. 95 pp. ISBN 90-6672-003-4

Soil Monolith Paper Series: ISSN 0167-8701

Soil Monolith Paper 1: Thionic Fluvisol (Sulfic Tropaquept). Central Plain region, Thailand (O.C. Spaargaren. D. Creutzberg, L.P. van Reeuwijk, and C.A. van Diepen) 48 pp. ISBN 90-6672-007-7

ISM Monograph: Podzols and Podzolization in Temperate Regions (D.L. Mokma and P. Buurman) (in preparation).

AIMS OF ISM

- to serve as a documentation centre on soils of the world - through its collection of soil monoliths and reports and maps on land resources with emphasis on the developing countries
- to improve methods of soil analysis - through research and international correlation with emphasis on soil characterization and classification
- to transfer specialized information - by lecturing and by publishing on the collected materials and on research data, and by advising on the establishment of national or regional benchmark soil collections
- to stimulate and contribute to new developments in soil genesis and classification, soil mapping and land evaluation - through active participation in international scientific working groups

ISBN: 90-6672-008-5