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/ The ANDISOLS of Central and South America /

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THE ANDISOLS OF CENTRAL AND SOUTH AMERICA

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INTRODUCTION

To help in understanding the andisols, we have divided them into the following groups based on simplified climo topo sequences :

1) Tropical regions of altitude with a relatively constant temperature - Ecuador - Columbia,
2) Temperate regions with an alternating temperature regime,
3) Hot, tropical regions - Caribbean.

TROPICAL AREAS OF ALTITUDE WITH RELATIVELY CONSTANT TEMPERATURE DURING THE YEAR ISOTHERMIC - ISOMESIC - ISOFRIGID -

I - SOILS FORMED FROM VOLCANIC ASH WITH PRESENCE OF SILT AND FINE SAND

The rainfall and humidity increase progressively :

1-1 - Mollisols and intergrades with andisols in wetter area (udic moisture regime - isothermic) -

For about one to two meters, the soil is black (10 YR 2/1) and often blacker below the plow layer. It's a sandy silt to loamy, sandy silt.

The bulk density is near one. The base saturation is more than 50 percent, often 80 percent.

The organic matter content is high, about 4 to 6 percent in the top soil and two at one meter depth. In many cases there are several buried soils and distribution of organic matter in the whole profile is not always uniform. Humic acid is more abundant than fulvic acid, especially in the deep layers.

One can observe several variations :

-FIRST :

About 50 cm to 1 meter depth, one can clearly observe shiny coatings with a little feeling of clay in depth.

The clay may come both from :
a) translocation of clay from the upper layer and
b) more intensive weathering of the older and deeper ash deposits.
Probably this second phenomena is the most important.
The halloysitic clay is evident in the less than two microns fractions.
Dr. Smith thinks that there is an argillic horizon so that this soil might be an Argiudoll or an Argic Tropudoll.

-SECOND :

The soil is very uniform, without coatings, not shiny nor with any feeling of clay. The base saturation varies from 60 percent to 90 percent, depending on the wetness of zone. The soil does react to FNa Fieldes' Test, or slowly.

In the less than two micron fractions one can clearly observe halloysitic clay by X-Ray diffraction as the 10 A° basal spacing is very distinct.

The soil might be a Tropudoll.

In soil Taxonomy 1975, it is an Eutrandept.

-THIRD :

The field appearance of the soil is exactly the same, but the less than two micron fraction does not show evidence of crystalline clay. X-Ray diffraction shows a strong peak at 4,45 Å which could be an indication of crystalline clays, but we do not observe any clear peak at 7 Å or 14 Å

Some of the X-Rays do not appear clearly. Infrared spectrometry and electron microscopy do not give much complementary information.

Professor Yoshinaga of Ehime University in Japan thinks after examination of our results that there are irregular interstratifications of crystalline clays : halloysite, metahalloysite and montmorillonite.

Dr Smith thinks we have to classify all these soils as mollisols in spite of the difficulty of identifying clay mineral constituents. But in Soil Taxanomy 1975, this is an Eutrandept.

Remark : Properties of mollisol/andisol intergrades :

Some of the second and third soils described above without clay coating have all the properties of halloysitic soils.

Other soils have weak andic properties of allophanic soils like a higher water content, a slightly higher water content at the same pF values on soil kept moist than on air-dried soil : a change in total cation exchange capacity with a change in pH of saturating solution, and occasionally a little reaction to Fieldes'sodium fluoride test for allophane.

In the field, it is impossible to detect any differences between these soils for mapping purposes.

Many times in other countries we have observed this high water content (80 % at pF 2.5 or 3) in halloysitic soil and in soil which contains minerals of better organization than allophanic substances. In very young halloysitic clay, the 10 Å X-Ray peak is strong but infrared spectrometry diagrams do not present clear evidence of halloysitic clay. Electron microscopy shows concentric rounded particles or nothing really clear.

1-2 - Andisols "haplotropand and hydrotropand" in wet area (Udic moisture regime - Isothermic temperature regime) -

The soil is wet throughout the year.

One can observe the formation of allophanic soils deeply black : 2/3 meters deepth chroma 2 or 3.

All the properties of allophanic soils are present and they can be classified as haplotropand or hydrotropand.

- High water retention and irreversible desiccation of air-dried soil, less of 100 water per 100 gr of dried soil : haplotropand ; more 100 % hydrotropand,
- Variations of total cation exchange capacity with the pH of saturating solutions,
- Strong and rapid reaction with sodium fluoride test, pH NaF > 9.5
- Percentage of base saturation near 50 percent or lower, sometimes very low.

Sometimes we can observe an intergrade which has properties of allophanic soils with little more than 50 percent base saturation. These soils are not extensive, just narrow transitional bands. The total exchangeable bases decrease in the wetter areas if some properties of allophane appear in the soils.

In Soil Taxonomy, most of these soils are dystrandept or hydrandept, few only eutrandept.

1-3 - Andisols - "Hydrotropand, haplotropand" in wet and cold areas (udic moisture regime - Isomesic temperature regime) -

The higher the altitude, the more cloudiness permanent humidity and low evapotranspiration.

At very high altitudes, when the soil temperature is lower than 13°C at 50 cm depth (isomesic) soils are very dark : chroma is 0 to 1.

Organic matter content approaches 10 to 25 percent with slighly more parts of humic than fulvic acid.

In permanent very humid areas with constant cloudiness on fine silty sandy ash, we can observe very strongly hydrated allophanic soils. The water content can reach 200 to 300 percent of dry soil : the bulk density is about 0.25 to 0.35.

There is not any cultivation when the soil temperature is lower than 10 ° C Isofrigid.

II- SOILS FORMED FROM COARSE VOLCANIC ASH WITHOUT EVIDENCE OF SILT

The slope of young volcanoes with deep ash or pumice deposits are often very regular. Climo-toposequences are particulary evident.

The content of clay minerals or allophanic substances is so small that it is sometimes very difficult to identify them, they generally do not have much influence on the soil properties.

Presence of halloysite, montmorillonite, or allophane is only an index of the climatic environnement and the moisture regime of the soil. The organic matter content and the size distribution of the ash are much more important than the nature of the clay minerals for the soil properties,

If the organic content of the top 20 cm layer is less than 1 percent, these soils are classified as Psamments.

If the organic matter is more than 1 percent in the top layer, we classify a large part of these soils as vitritropand. Any distinction between halloysitic soils or allophanic soils is difficult because the content of the less than two microns fractions is very low.

III- SOILS FORMED PARTIALLY FROM VERY FINE VOLCANIC ASH IN WET AND COLD AREAS

The regions distant from the volcanoes only receive very fine ash.

On the upper part of moderate slopes, cloudiness and low evapotranspiration help to keep the soil damp, which allows the vegetation to hold the fine ash, whereas on the dryer sides of the slopes, this ash is swept away by the wind.

Black soils are formed of varying thickness. They are very rich in organic material 15-30 % of carbon. The very fine ash weathers quickly, and because of this, the primary minerals can rarely be identified.

These soils have all the properties of andisols : high water retention (200-300 %), instantaneous reaction to the Fieldes test, great variation in the exchange capacity in function of the pH, etc...

Thus, these soils can be called organo-hydrotropand.

Do any allophanic substances remain ? Only miniscule quantities of mineral substances can be extracted: or andisols are mineral soils by definition.

The allophanic substances existed, but then mostly disappeared, which explains why it is so difficult to extract mineral substances. The aluminium would have remained bound to the organic material.

Perhaps this is one of the organic aluminium phases that Wada would like to have included in the andisols because the "exchange complex is dominated by active hydroxyaluminium".

TEMPERATE AREAS WITH VARIATIONS OF THE TEMPERATURE DURING THE YEAR - THERMIC-MESIC.

— FIRST SEQUENCE : Vitrudand - hydrudand - gibbsitic-hydrudand - Intergrade Halloysite - Hapludalf.

This sequence (cross-section) from the Osorno volcano to the Pacific perfectly illustrates the change from very young allophanic soils on the slopes of the volcano ; to the very hydrated allophanic soils without gibbsite, to older allophanic soils with gibbsite ; and finally to the intergrade allophane/halloysite soils which contain crystalline halloysitic clay (or metahalloysite) also with some gibbsite.
Further to the west, there are heavy clayey red soils which are much older.

1-1 - Young allophanic soils on the slopes of the volcano -

These young sandy soils already have the characteristics of allophanic soils. Moisture retention reaches 75 percent at pF 3 on soil kept moist and falls rapidly when measured on previously air-dried soil. This soil gives a strong reaction with the Fieldes Test.
The evolution towards allophanic soils with high water content is thus already very clear, event though not much allophanic substance has been formed yet.

1-2 - The very hydrated allophanic soils without gibbsite - h drudant - On the edge of the cultivated plain -

The top layer, 30 cm thick is dark chroma 2 with 15 percent organic matter.
To two meters depth, the organic content is about 6 percent, but the soil color is lighter (chroma 4) except for some buried organic horizons.
In the whole profile, the soil crumbles easily. It is soft, loamy, soapy.
The water retention of the soil kept moist is considerable, 160 percent water per 100g. of dried soil.
If the water retention at different pF values is determined on previously air-dried soil the water content is lower (30 to 40 percent). The decline is relatively more important in the always wet deep horizon than in the top layer wich is sometimes temporarily drier in the field.
The base saturation percentage is very low but the pH in water and KCl are about the same a little bit higher than 6.
The electron microscope reveals a lot of fiber and shapeless materials.

1-3 - The very hydrated allophane with gibbsite -

They are probably formed from an older ash deposit than in the last profile at least in the deep horizon.
The morphological appearance of the soil and most of the physico-chemical characteristics are very close to those in the preceding profile without gibbsite.
Except for the cultivated top layer, which has undergone slight desiccation , all the horizons are very hydrated with 150 or 200 percent water content.
The bulk density is constant about 0.4. The water content at several pF on previously air-dried soil samples is much lower (30 to 40 percent) than the water content at the same pF on soil samples always kept moist.
The exchangeable base content and the base saturation are very low.
However, the pH in water is about 5.5 and higher in potassium chloride.
Gibbsite increase from the top to the bottom. At a depth of about 4 meters in the older deposit the percentage of gibbsite reaches its maximum and white elongated or rounded concretions of several millimeters of pure gibbsite are clearly visible.

1-4 - Intergrades between allophanic and halloysitic soil near the coastal range -

The top layer already has a clearly blocky structure and does not crumble finely as allophanic soils do. The sodium fluoride reacts very slowly and little.
The soil gives a noticeable feeling of clay when you touch it.
The water content at various pF's is considerably lower than in all the preceding allophanic soils we have described.
The pH in water is definitely higher than the pH in KCl.
There is halloysitic clay and other crystalline clay in noticeable quantity with some gibbsite ultisols.

— SECOND SEQUENCE : Young soil - hydrudand - hapludand - Halloysitic soils -

This cross-section also shows clearly, from the East, near the volcano Antillanca, to the West, where rainfall decreases, the succession :

- from very young allophanic soil on the slopes of the volcano, where rainfall is very high : 3 or 4 meters per year,
- to very hydrated allophanic soils, hydrudand .
- to the Trumaos soil, a less hydrated allophanic soil with a very friable particular field texture : rainfall is lesser about 1.3 meters a year and decrease to the west,
- to the halloysitic soils : rainfalls about 1 meter or less.

We did not find allophanic soils with gibbsite.

2-1 - Young allophanic soils on the slopes of the volcano -

Young allophanic soils have several layers of unweathered coarse pumice or scoriea.

2-2 - Hydrudand in the beginning of the cultivated plains -

The soil is black in the first 40 to 50 cm with about 20 percent organic matter. Deeper, the soil is lighter still with 10 percent organic matter at I meter depth. Fulvic acids are very abundant.

One can observe all the properties of very hydrated allophanic soils :

- water content of samples that have been kept moist, is high, more than 150 % at pF 2,5, with strong irreversible desiccation. There is a little desiccation of the upper horizons, and bulk density is a little higher (0,6) than in depth (0,35),
- the pH in KCl is higher than the pH in water, except in the top layer.

The electron microscope shows many fibers which are very similar to those observed on "so-called imogolite", in Japanese soils. Sometimes fibers are joined and juxtaposed. Electron diffraction clearly shows the typical rays of imogolite mineral at 1.4 - 2.1 an 2.7 A°.

According to Dr. Yoshinaga, we find here all the characteristics of so-called imogolite, a fiber mineral (Some of this data was obtained by him on our clay samples).

There is a mixture of imogolite with other allophanic substances.

2-3 - Hapludand Trumao osorno in the broad cultivated plains -

There is less rainfall, a little more than one meter.

The soil is dark brown to about 20 cm deep, chroma 2-3 (organic matter = I5 percent C/N = 10) then pale yellow, chroma 6-8, with 6 percent organic matter at I meter depth. The main characteristic is the very friable structure of the B horizon. The soil seems composed of very fine round aggregates. The bulk density is about 0.5 to 0.6.

The water content is still high with depth but no more than I00 percent.

In the top horizon, water content is lower and the water at different pF values is the same on soil kept moist as on air-dried soil.

The pH in water is a little higher than the pH in KCl.

The AF/AH ratio is near one in the top layer but increases in the depth.

2-4 - Halloysitic soils near the Western Coastal Cordillera - Ultisols -

Further to the west, rainfall is lower, less than I meter per year. It is also an older deposit.

The soil is loamy clay with an evident feeling of clay.

The water content is low comparated to the allophanic soils, and we obtain the same result at different pF values on soil kept moist as on air-dried soil.

The bulk density approaches I.

The sodium fluoride test gives a weak and slow reaction.

X-Ray diffraction shows a mixture of halloysite and metahalloysite clays with a little goethite.

Electron microscopy shows rounded concentric spherical particles with some swollen tubes of halloysite.

TROPICAL WARM LOWLAND AREAS WITH ISOTEMPERATURE REGIME

I-I - Rusty brown halloysitic soils (typic halloysitic tropudalf) -

Rainfall is about I800 to 2000 mm and the dry season is pronounced. There is a lack of water for a few months at certain times of the year. The upper horizons partially dry out to varying depths.

These conditions favor the synthesis of crystalline clay. One can observe halloysite formation.

There are several types of halloysitic clay.

In this sandy clay soil, clay coatings are especially distinct. I know of no other soils tnat nave such evident shiny coatings.

I0 Å halloysite which is often associated with metahalloysite especially in the top layer.

One cannot simply refer to halloysite, but to different forms of halloysite which correspond to soils with very different properties.

I-2 - Allophanic soil "haplotropand" with temporary desiccation of the upper layers -

In higher altitudes, there is little deficit of water throughout the year. The soils remain constantly moist or dry out only on the surface few cm. Soil moisture rarely falls below pF 4.2.

The A horizon is crumbly and dark colored to a depth of I0 to I5 cm but the thickness is often less in plowed and eroded areas.

The B or BC horizon might be 50 cm to I or 2 meters thick, sometimes with interbedding (or with) harder layers. The soil color is lighter (I0YR 5/8) yellow beige. Air-dried soil is much lighter than moist soil, being nearly white in color. After prolonged air-drying, the soil turns a dark rusty brown. There are no coatings.

These soils can absord a considerable amount of water and still remain quite crumbly. In the surface soil, moisture can reach 50 to 70 percent on air-dry soil basis. Soil moisture is much higher at a depth of around I m reaching 90 to I00 percent. Once the soil has been left to air dry for several weeks it can no longer absorb as much water, even if it is left in contact with water for months.

These soils have good permeability. In over I000 samples, we have found field moisture content very year near pF 2.5 as measured on soil kept moist.

I-3 - Allophanic soil more hydrated always wet "hydrotropand" -

Rainfall and cloudiness increase and evapotranspiration is reduced with altitude. One can observe (1) an increase in the soil moisture, (2) an increase in organic matter content, (3) a reduction of exchangeable base content and (4) the soapy feeling of the soil becomes more and more pronounced.

The humic horizon is darker and richer in organic material but only about 15 cm thick. Deeper soils il yellow.

Irreversible dehydration of air-dried soil is high. The results obtained at pF3 and 4.2 on previously air-dried soil are much lower than those on soil kept moist. All the horizons are moist throughout the year.

We noted that the water content of the soil never fell below pF 4.2. There is always some rain.

Our laboratory analysis revealed that irreversible dehydration would only occur when the soil moisture value is less than that at pF 4.2.

1-4 - Strongly hydrated allophanic soils (hydrotropand) without gibbsite -

Rainfall is higher with frequent cloudiness. The soils in higher altitudes have a very high water content. The organic matter content is high, 10 to 15 percent or more, in the upper 20 cm. The organic horizon is thin over the conve slopes and thick in the concave slopes. In the latter one occasionnally finds soils which have become peaty.

The soils contain more than 150 or 200 percent water throughout the profile.. They are very spongy and greasy and easily identified in the field. Desaturation is virtually complete, with less than 1 me /100 g of exchangeable bases. In the very cloudy regions, one o ften sees rusty colored and light graying mottles around the roots. This phenomenon of irun reduction only occurs in such extremely wet soils. Sometimes, appears placic horizon.

OTHER SEQUENCE :

1-5 - Older soils - Allophanic soils with gibbsite -

These soils are derived from older ash deposits. This gives an especially clear cartographical distinction which is useful for observing the behavior of phosphorous.

The soils closely resemble those in the preceding topo-climosequence.

There is a large, sometimes very large amount of gibbsite throughout the profile. It is especially abundant in the very wet mountain regions. It sometimes appears at some depth in the form of small pure white gibbsite concretions.

COMPARAISON OF ANDISOLS WITH DIFFERENT TEMPERATURE REGIME

a) Isothermic - Isomesic - Isofrigid -(Tropical altitude)

b) Isohyperthermic -(Warm tropical lowland)

c) Thermic - Mesic -(Central Chile)

We observe many noticeable differences :

— FIRST :

In the low altitude tropical warm areas and temperate areas with alternating season, the dark humic horizon is 15 to 20 cm thick. The deeper soil is yellow, chroma 4 to 8.

In the middle altitude, from 1500 to 2000 meters, the dark upper horizon is deeper, 50 to 60 cm.

In high altitude, about 2000 to 3500 meters, the whole profile is black to a depth of 1 or 2 meters.

Chroma $\geq$ 2 if the soil temperature is warmer than 13 °C, and 0 or 1 if soil temperature is colder than 13 °C.

— SECOND :

In tropical areas with constant temperature and in temperate areas with alternating temperature regime andisols contain a lot of fulvic acid and little humic acid. It's the same in the wet temperate middle latitude of Chile (pyrophosphate extract).

In the tropical middle altitude, andisols often contain more humic acid than fulvic acid.

In the higher altitudes in cold areas, the proportion of humic acid is high compared to fulvic if the permanent soil humidity is due more to a very low evapotranspiration and constant cloudiness rather than heavy rainfail .

On the other hand, if the rainfall is high, we observe a higher proportion of fulvic acid, but yet humic acid is dominant.

— THIRD :

In the tropical areas, with constant temperature and in temperate areas with an alternating temperature regime, the soil pH in water and in potassium chloride is very similar. Sometimes, the soil pH in potassium chloride is higher than pH in water.

In the higher altitude, soil pH in water is much higher than pH in potassium chloride. Possibly this is the influence of the nature of organic matter.

INTERGRADES BETWEEN ALLOPHANIC AND HALLOYSITIC SOILS

The change in the field from halloysitic soil to allophanic soil is mainly due to rainfall variations.

Tropical warm areas - Isohyperthermic -

This intergrades soil is a uniform dark brown through 60 to 80 cm, so it seems like a deep organic rich soil.

In the allophane soils found in slightly higher altitudes, on the other hand, the dark organic horizon is not very thick, 15 to 20 cm. At greater depth the horizon is light yellow. This light yellow horizon usually contains more organic matter than the allophane-halloysite intergrades in horizons at the same depth.

The dark color of the organic material does not come out in the allophane because of the M.O-allophane bonding.

In contrast, in the allophane-halloysite intergrades, all the profile is dark-colored, which can be useful for soil cartography.

This less-than-two-micron clay gives the best X-ray diagram of halloysite that I have ever seen. The 10 Å peak is extremely clear and much stronger than the 4.45 Å peak. In contrast, the infrared diagram is rather poor. This young halloysite appears as round particles under the electron microscope.

In contrast, the X-ray diagrams of the older, more evolved halloysite soils are less characteristic (The 4.45 Å peak is often stronger than the 10 Å peak), but the infrared diagrams are much better defined. The tubular halloysite at first appears swollen and then shrinks to a well formed tube.

Tropical altitude areas - Isothermic - Isomesic -

The profiles of the mollisols and the allophanic soils look alike, except when the coatings appears. Soil is deeply black.

In the less than two micron fraction :

- either, there is not a well-identified clay. The 4.45 Å X-ray peak is strong, but the other X-Ray peaks at 7 Å , 10 Å , 14 Å are very weak. There is an irregular interstrafied.
- or the clay consists of well formed X-ray diagrama, halloysite with 10 Å peak very distinct and stronger than the 4.45 Å peak.

SPECIAL PARTICULAR WATER RETENTION PROPERTIES OF ALLOPHANE AND ALLOPHANE IMOGOLITE SOIL

Some of allophane-imogolite soils are very hydrated, between 150 or 200 percent of water content, per 100 g of dried soil.Bulk density is about 0.3.

Some important differences in water retention can be observed between these imogolite soils and typical allophanic soils.

(1) The water content at pF 4.2 on samples kept moist is lower in imogolite soils than on allophanic soils with an equivalent water content at the field capacity. There is a great difference between the water content at pF3 (orpF 2,5) and pF 4,2 mesured on soil kept moist. Thus there is a great deal of avaible water.

These soils behave somewhat like a sponge which can reabsorb a large quantity of water after having lost some.

(2) For the samples studied, which contain imogolite, the water content at pF 3 (or pF 2,5), after air-drying still remains high, even after oven-heat desiccation. It is lower though than for samples which were kept wet, but much higher than with strongly hydrated allophanic soils of equivalent humidity at the field capacity.

So when compared to allophanic soil, the imogolite soils can lose a higher quantity of water. After air-drying, the imogolite layers can reabsorb a higher water quantity than allophanic soils do.

WATER CONTENT AT pF 3 AFTER DRYING THE SOIL TO DIFFERENT LEVELS OF HUMIDITY						
Soil was dried to this water content p.100 of dried soil before the pF 3 measurement.	Allophane-Imogolite Soil			Allophanic soils		
	E 319	E 384c	E 346 c	E 370c	E 266c	S 59 d
	Samples from Chile			Chile	Ecuador	Antilles
Without desiccation	178	164	154	184	280	252
200				158	270	214
150		158			261	203
125	139	154	142			
100	147	149	142	155	236	190
75	115	139	138	134		
50		133	133		187	
air dry	80	82	95	35	44	37
dry 105°		62	66	28	28	26
pF 4.2 on always wet soils,without desiccation.	80	106	72	141	206	

CLASSIFICATION

Before Dr. Guy Smith's trip to the French West Indies and Ecuador, we had classification difficulties with the andisols, and particularly separating andisols from mollisols, dystrandepts from hydrandepts.

The new proposition for the andisols (G. Smith : Soil Bureau NZ April, 1978) has solved almost all the problems.

We suggest adding a gibbsitic subgroup to the haplotropand, hydrotropand, hapludand, hydrudand. Gibbsite in itself on the quantity present, has no particular importance. Silica has had to be eliminated in order, for gibbsite to appear. Gibbsite is, therefore, an indication of allophanic substances with a low silica/alumina ratio. Some of the properties are different from more siliceous allophane : high phosphorous fixation, possibility of alumina toxicity, etc...

Our results show that a part of allophanic soils of warm tropical countries have a phosphate fixation estimated by the New Zeland method, less than 90 %. To come to a conclusion further studies would be necessary.

Some soils which present all the characteristics of isomesic, isothermic hydrotropand are very rich in organic matter with more than 15 % carbon content. A subgroup of rich organic matter hydrotropand could perhaps be created.

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QUESTION - REPONSE
QUESTION - REPLY

1 - Question Professeur TAVERNIER : Belgique

You have mentionned that in Isomesic or warmer Isotemperature regimes of Central and South América, that the limit between the andisols with low chroma (0 or 1) with those with higher chroma (≥ 2) occurs at a temperature limit of about I3° C. My question is if in the areas with a xeric moisture regime, in Chili you find this transition at the same temperature limit. The reason for this question is that in mediterannee area of Europe, we find this limit at about I0° C.

1 - Réponse :

Je n'ai pas étudié les andisols du Chili en Xeric moisture regime.

1 - Reply,

I have not studied the andisols in Chili with a xeric moisture regime.

2 - Question RUKAKAAN - Rwanda

Le conférencier a dit que les andisols à gibbsite peuvent être classés différemment des autres andisols. Par ailleurs, il a précisé que les Andisols à gibbsite favorisent parfois certaines toxicités pour les plantes. Etant donné que la gibbsite n'a aucune toxicité contre les plantes, il faut donc en conclure que les andisols à gibbsite contiennent une quantité appréciable d'alumine échangeable ou extractible.

Peut-on se servir de formes échangeables ou extractibles d'alumine comme critère de diagnostic.

2 - Réponse :

La gibbsite est l'indice de substances allophaniques avec de bas rapport SiO^2/Al^2O^3.

Certaines propriétés sont analogues mais d'autres différentes de celles des sols à allophane plus siliceux.

Dans les sols très désaturés en bases, des toxicités aluminiques, liées à des déficiences en phosphore peuvent être observées.

Pour corriger les déficiences en P et obtenir le même niveau de P assimilable (Truog-Olsen...) il a fallu apporter beaucoup plus de phosphates dans les sols à allophane gibbsite que dans les allophanes plus siliceux sans gibbsite.

2 - Question RUKAKAAN - idem in english

The lecturer said that the gibbsitic andisols, can be classified differently from the other andisols. On the other hand, he said that the gibbsitic andisols sometimes encourage certain toxicities in plants. As gibbsite is not toxic for plants, the conclusion would be that the gibbsite andisols contain a large quantity of extractable or exchangeable alumina.

Can the extractable or exchangeable form of alumina be used as a criteria for identification diagnostic ?

2 - Reply :

Gibbsite indicates allophanic substances with a low SiO^2/Al^2O^3 ratio. Some of the properties are the same, but others are different from more siliceous allophane soils.

Alumina toxicity, related to the deficiency in phosphorous, can be found in soils which have low base saturation.

In order to correct the P deficiencies, and obtain the same level of assimilable P (Truog-Olsen...) much more phosphate has to be added to the gibbsitic allophane soils than to the more siliceous allophane soils that have no gibbsite.

3 - Question ESWARAN - USA

How much gibbsite would you use for it to the diagnostic in andisols ?

3 - Reply :

The quantity of gibbsite is not important. It varies greatly in the profile, and depending on the size of the particles : scattered fine gibbsite, or in concretions in some horizons.

The presence of gibbsite shows that the silica was eliminated in large enough quantity to enable gibbsite to form in the soil. Gibbsite itself does not act on the properties of the soil.

4 - Question HERBILLON - Belgique

We have recently obtained results concerning the surface charge properties of allophanic clays (not soils). They completely support the conclusions made by the author concerning the importance of gibbsite in andisols from a soil management point of view. For details see Gonzalez BATISTA et al. Clays and clay minerals 1981 (in press).

5 - Question COMERMA - Venezuela

You have stressed the difference between deep dark andisols in tropical highlands with yellow subsoil andisols in hot tropics and temperate areas in latin America. Doesn't this contradict the Tropands proposition ?

5 - Reply :

Indeed, the aspect of the profile of the andisols from hot tropical regions is closed to the andisols from temperate regions with alternating seasons (mesic), than to soils from the altitudes in the tropics.

The choice of Tropands, goes beyond the limits of andisols, since there are tropudalf, tropudult, tropudoll, etc..., which designate soils than can be cultivated all year long, in opposition to the soils from regions : with a cold winter (mesic) ; a dry season lasting several months (ustic) ; on where the temperature is too low throughout the year to allow farming (soil temperature less than 10° C - isofrigid). Is this criteria more important than the aspect of the profile ?

All the andisols in an isothermic or isomesic regime that I know of, are deeply black with chroma between 0 and 1, for the buried horizons, the argilic horizons, and the overall profile, when the soil temperature is less than 13° C. The term "melanic" is only usefull if soils with yellow horizons exist in these thermic regimes

6 - Question VALENS NDORYAHO - Rwanda

Les sols sous le vent étant plus secs que les sols au vent (plus humides) ont des propriétés pédogénétiques différentes. Cette différence se remarque telle au niveau de la fertilité.

6 - Réponse :

La nature et les propriétés des andisols varient beaucoup avec le régime climatique. Mais il y a aussi beaucoup de variations pour le choix des cultures et des espèces qui conviennent le mieux à chaque endroit. Ce ne sont pas les mêmes maladies, les mêmes parasites qui apparaissent ou avec des intensités différentes.

La fertilité des sols dépend donc aussi de la nature des cultures et des exigences de celles-ci : besoins en engrais et mode d'application, besoins en eau, résistance aux déficiences ou toxicités, etc... qui diffèrent suivant les endroits.

Les liens étroits qui existent entre les sols et le climat permettent donc une zonification des différentes cultures en montrant quels sont les avantages ou les inconvénients en chaque endroit.

6 - Question VALENS NDORYAHO - idem in english

As the leeward soils are dry, and the windward soils wet, the pedogenetic properties are different. Can this difference be noticed for what concerns fertility ?

6 - Reply :

The nature and properties of the andisols vary considerably with the climatic regime.

But there is also great variation in the choice of crops and the species which is best for a particular place. The diseases and parasites vary, as well as the severity of each, depending on the place.

The fertility of the soils, therefore, also depends on the kind of crops, their need for fertilizer and the type of application, their need for water supply, their resistance to deficiencies or toxicities, etc... all of which differ depending on the place.

Due to the close relation ship between soils and climate, crops can thus be zoned by showing what the advantages and disadvantages are for each particular place.

7 - Question HERBILLON - Belgique

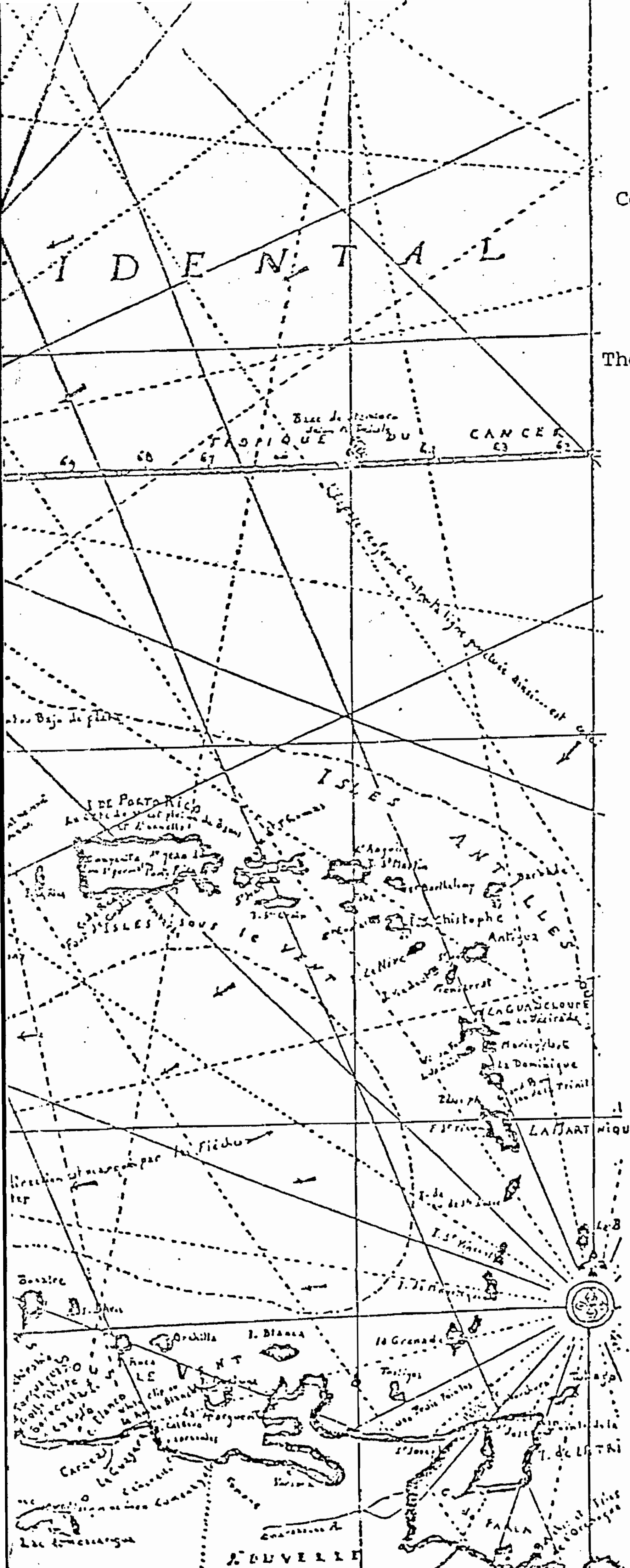
Do the Tropand (the soils rich in Al humus compounds) show the same morphological features as those characteristic for what has been called in Rwanda "l'horizon socle".

7 - Reply :

We have often found hard, discontinuous blocks, similar to the socle horizon, in the deep yellow horizons of well-hydrated allophane soils.

Their origin is not clear : they may be a hard, weathered ash horizon which has not completely weathered : or in situ formation due to the increase in "allophanic cohesion".

Hydrated allophane soils often have an "allophanic cohesion", of the blocks which is not found in the mollisols which developed on the same materials. Even though this cohesion is very clear, it is usually very weak, except for a few cases where the blocks have hardened enough to be cut with a knife.



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ANDISOLS

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CENTRE DES ANTILLES

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