Evaluation of Soil Taxonomy and FAO-Unesco in relation to nine climo-sequence soils, Argentine

PETER FREDERIKSEN

Frederiksen, Peter: Evaluation of soil taxonomy and FAO-Unesco in relation to nine climo-sequence soils, Argentine. Geografisk Tidsskrift 81: 11-15. Copenhagen, October, 1981.

The ability of Soil Taxonomy and FAO-Unesco to segment nine soils of a climo-sequence from a genetical point of view was evaluated. The nine soils were classified as A1A2BtC, ABC, A(B)C and AC soils. The determination of moisture regimes was problematic, although waterbalance diagrams could be constructed. From a genetical point of view like soils were classified differently at suborder and subgroup level of Soil Taxonomy, and neither of the two taxonomies were able to distinguish between a well and weakly developed cambic B horizon.

Peter Frederiksen, M. Sc. research fellow, Geographical Institute, University of Copenhagen, Haraldsgade 68, DK-2100, Copenhagen O, Denmark.

According to Cline (1949) the purpose of any classification is to organize our knowledge such that the properties of objects may be remembered and their relationships may be understood most easily for a specific objetive. As a class is a group of individuals bound from within, not circumscribed from without, the soil population may neither be a continuum or dispersed (clustering must occur) if it is to be classified according to a hierarchial structure. Any field pedologist can easily verify that soils are a continuum, and soils can therefore - in sensu strictu - not be classified according to such a structure.

Furthermore any delimitation or definition of boundary conditions is arbitrary as all »systems« are open and a mental abstraction of the rational mind, which does not correspond to reality. Therefore any attempt to reach a final classification, no matter how many approximations it passes through, will be infertile. Some systems are, however, more practical, more useful than others, and elucidate by their arbitrary structure and construction more essential relationships in relation to a specific objective than other systems, and are therefore better approximations.

The first classification systems used state factors of soil formation as a basis for classification without much reference to soil morphology, chemistry and physics. Later interpretations of soil genesis were based on soil morphology, but as soil genesis is the integration of a large number of processes that have varied in intensity due to the changing aspect of state factors of soil formation in time and space, doubt was apparent as to whether it was possible to deduce soil genesis on the basis of soil morphology. Soil Taxonomy (1975) and FAO-Unesco (1974) are based on measurable morphological, chemical and physical properties, and the variation (or lack of variation) of these may permit to understand relationships between soils and the factors responsible for their character.

These taxonomies impose their hierarchial structure on a soil continuum, and it is the purpose of this study to see how they segment a continuum of nine climo-sequence soils, and furthermore to comment on problems related to the classification of these soils.

THE SOILS

The nine soils are from NW-Argentina, developed in loess under a subtropical climate with pronounced differences between precipitation on a seasonal and yearly basis, and between the different profiles. *The soils will be numbered from 1 to 9, p1 being the most humid* and with increasing dryness with higher number, *p9 being the driest. P1-3 are A1A2BtC*-soils, *p4-6 ABC*-soils, *p7-8 A(B)C*-soils and *p9 and AC*-soil (for further details on genesis, morphology and chemistry, see: Frederiksen (1982, this issue)). The fieldwork was carried out during The Danish Scientific Expedition to Patagonia and Tierra del Fuego, 1978-79.

The following descriptions and measurements have been carried out: soil morphology (FAO), texture, humus, $CaCO_3$ pH ($CaCl_2$) nitrogen (topsoil) for all profiles; for p1,2,4,6,8 and 9 CEC, Ca, Mg, K, Na and base saturation, and for p1,3,4,6 and 8 water retention (pF-curves and volumetric weight). Furthermore the water balance was calculated for all profiles.

CLASSIFICATION ACCORDING TO SOIL TAXONOMY

Soil Taxonomy requires many measurements, even in order to classify the soil at the order level. Not all measurements necessary are done, and a number of estimations are therefore needed:

HORIZON LEVEL

Epipedons

The A1-horizons of p1-8 fulfill the humus, structure, colour and thickness requirements of the mollic epipedon, but as no measurements have been carried out on P_2O_5-content, length of the cumulative moist period, the n-value and for p3,5 and 7 base saturation, it is in sensu strictu not possible to classify these soils, as type of epipedon is unknown. It is therefore supposed:

1) that the P_2O_5-content is less than 250 ppm, as the soils are only fertilized with nitrogen, and there are no traces of bones or shells.

2) that the n-value is less than 0,7, as none of the soils are constantly moistened to field capacity.

3) that the base saturation of p3,5 and 7 is higher than 50 %, as it is not less than 78 % in the A1 horizons of p1,2,4,6 and 8.

4) furthermore a mollic epipedon must be moist for at least 3 months (cumulative) in 7 out of 10 years, when the soil temperature is 5°C or higher. Studies of Zuccardi et al (1971) from an Argiudoll in the same area showed, that the topsoil was the moistest part of the profile in the summer period (the rainy season) and the driest part in the winter period (the dry season). Furthermore Zuccardi y Fadda (1971) showed, that the average soil temperature was a bit higher than the average atmosperic temperature (18-19°C). These results can probably be extrapolated to p1-9, and the problem is therefore to determine the length of the moist period. As the maximal potential evapotranspiration in the area reaches 7 mm/day (Minetti y Fogliata, 1975), it is found - by dividing the annual precipitation in mm with 7 mm/day - that it takes more than 3 months to evaporate the annual precipitaion in p1-7 provided no throughflushing to the groundwater takes place. As the field capacity of the profiles is higher than the maximum amount of stored water (Frederiksen, 1982 - this issue) this will seldom happen, except when the precipitation is of a very high intensity. In the arid zone, where the insecurity related to the amount of throughflushing water has more to say in determining whether the epipedon is mollic or not, no watercourses of importance were observed. Studies of topographical maps show, however, the existence of depressions (saltflats) also observed on LANDSAT (false colour composite), thus indicating a certain effluence of water. Some part of the precipitation is therefore most probably throughflushed.

p8 will with a potential evapotranspiration of 7 mm/day only have moisture in the profile for 89 days, but as the evaporation easily falls down to 4 mm/day, it is probable that the epipedon will be moist for more than 3 months. p9 is probably moist for less than 3 months as the annual precipitation divided by 7mm/day gives 75 days, and as the soil has a much coarser texture (sandy loam) than the others (loam), a rapid throughflushing is much more probable.

Considering the above-mentioned, p1-8 thus have a mollic epipedon and p9 an ochric epipedon.

Subsurface diagnostic horizons

No micromorphological or fine clay investigations have been carried out, but Frederiksen (1982-this issue) considered on the basis of texture, humus and porosity, that clay illuviation had taken place in p1-3 to such a degree that their respective B-horizons classified as argillic.

As no Bh or Bir were observed morphologically, analysis of free Fe and Al have not been carried out, and it is supposed that no spodic horizon is present in any of the pedons.

Order level

p1-8 have no organic soil material, no plinthite, no oxic or spodic horizon, have less than 30 % clay in the upper 50 cm and/or no gilgai, slickensides and wedgeshaped structures, does not have an ochric or anthropic epipedon, and have a base saturation of more than 50 % and are therefore neither Histosols, Spodosols, Oxisols, Vertisols, Aridisols or Ultisols. p1-8 have a mollic epipedon and are thus Mollisols or Inceptisols depending on a) the content of volcanic glasses and b) the volumetric weight:

a) according to Zuccardi y Fadda (1972) the parent material of soils of the area consists of 40-60 % volcanic glasses in the upper part decreasing rapidly to 10-20 % with depth.

b) in p1,3,4,6 and 8 the volumetric weight nowhere falls below 1,13 g/cm^3 and this can supposedly be extrapolated to p2,5,7 and 9.

p1-8 are therefore Mollisols.

It was not decided in the field whether p9 had structure in more then half its volume, and it cannot be decided whether the horizon below the A is a cambic B or a C horizon. As recalled, structure was found in less than half the volume, and on the basis of the waterbalance the profile will have a deficit in alle 12 months (the moisture regime will therefore be aridic). Furthermore the Na-saturation is less than 15 % in all horizons, and p9 is therefore an Entisol.

Suborder level

At this level determination of moisture and temperature regimes is crucial without which classification cannot proceed.

The mean annual atmospheric temperature lies between 18-19°C, the soil temperature a bit higher (Zuccardi y Fadda, 1971) and none of the profiles thus have a frigid, cryic or pergelic temperature regime. Rain falls in summer and no profiles have signs of reducing conditions, consequently none of them have a xeric or aquic moisture regime. All profiles have less than 40 % $CaCO_3$, and p1-8 are therefore Ustolls or Udolls, p9 an Orthent as organic C content is just less than 0.2 at 1.25 m below the surface - that is, very close at being a Fluvent.

By calculating the length of the replenishment, utilization and deficit periods of the water balance (Frederiksen, 1982 - this issue) an estimation of the moisture regimes can be given, but as the water retention capacity and precipitation type (high or low intensity) is not considered, and as no statistics are available for a period of 10 years, the further classification is problematic, It is really of importance to know what happens to the precipitation of different intensities in soils - how much is retained, and how much is lost to the groundwater. This is further complicated by differences in root intensity, depending on plant and soil type, time of the year, etc. As it was not even possible to estimate these parameters in the nine soils, classification continues on the basis of the water balance diagrams, according to which p1 have a udic (Udoll), p2-3 a ustic (Ustoll), p4-8 an aridic (Ustoll) and p9 an aridic (Orthent) moisture regime.

Great group level

This level provides no problems for p1-9, p1 has an argillic horizon redder than 10YR, a chroma less than 4 and is thus an Argiudoll. p2 and p3 have no duripan, petrocalcic or calcic horizon, but both have an argillic horizon and are thus Argiustolls. p4-8 have no duripan, petrocalcic or argillic horizon, and as less than 50 % of the mollic epipedon under A_p is filled with wormholes they are Haplustolls. p9 have a torric moisture regime (equivalent to aridic, just at lower level of classification), and is a Torriorthent.

Subgroup level

At this level classification must once more rely heavily on estimates.

p1 have no mottles or lithic contact, a texture finer than loamy sand, no horizon with more than 35 % clay in any horizon thicker than 50 cm, and is thus either a Typic or an Oxic Argiudoll, depending on CEC/100 g clay. For Schwarzerde on loess (german classification, can most conveniently be regarded as part of the Mollisols) Scheffer/Schachtschabel (1976) give the following approximate CEC-values

organic substance	300 meq/100 grammes
2-6 µm	15 meq/100 grammes
6-20 µm	6 meq/100 grammes

On the basis of these numbers a rough estimate of the CEC of the clay fraction can be given provided 1) that the 2-6 µm and 6-20 µm fractions are equally distributed througthout the profile giving the 2-20 µm fraction a CEC of (15+6)/2 = 10,5 meq/100 g (this figure may be changed somewhat as most german Schwarzerde contain illite and montmorillonite as the dominating clay minerals, whereas the present soils with 10-60% volcanic glasses most probably contain allophane), 2) that fractions above 20 µm have such a low CEC that they can be disregarded, 3) that the influence of Al and Fe-oxides is negligible. The formula for calculating CEC-clay would then be

[CEC(total) - ((% org.matter x 300) + (% 2-20 um x 10,5))] x 100/% clay

This gives for p1 the following (unit in CEC/100 g clay): A1: 50, A2: 30, B2t: 55, B3t: 65 and C: 90. These values are only very rough approximates, but as most of them lie well above 24 meq/100 g clay, p1 is classified as a Typic Argiudoll.

p2 and p3 have no mottles with a chroma equal to or less than 2, no brittle horizon or lithic contact, but have an eluvial horizon with a value too high to be mollic, and a chroma too high to be albic, no calcic horizon and is dry in less than 6 tenths of the year, and are thus Ustalfic Argiustolls or Torrertic Argiustolls, depending on presence or absence of cracks. Cracks were not observed during fieldwork, which took place in the rainy season, and in comparable soils of the more arid zone cracking was not observed in the same parent material and topography. Cracks are therefore supposed not to be present, hence p2-3 are classified as Ustalfic Argiustolls.

p4-8 are considered not to have a salic horizon as Ca and Mg dominates the cation-exchange complex (more than 70 %), not to have cracks (not observed) and a CEC/100 g clay higher than 24 (by the same method as under p1). Furthermore they do not have a calcic horizon and p4 is dry for less than 6 tenths of the year, and is thus a Udic Haplustoll, whereas p5-8 is dry for more than 6 tenths of the year, and are therefore Aridic Haplustolls.

p9 have no durinodes or lithic contact and less than 35 % clay, is dry all months, and never saturated with water, and is thus a Typic Torriorthent.

CLASSIFICATION ACCORDING TO FAO-UNESCO

Considering the above-mentioned classification according to Soil Taxonomy, p1-8 have a mollic epipedon, no cracks and are not formed in recent alluvial deposits, have a low salinity, no hydromorphic properties, less than 65 % volcanic glasses and no coarse texture, spodic, oxic, albic, natric, calcic or gypsic horizon, and no bleached coatings on ped surfaces, and are therefore Phaeozems. p9 has an ochric epipedon, but otherwise corresponds to the above-mentioned and is therefore a Regosol.

p1-3 have an argillic horizon and are Luvic Phaeozems, p4-8 have no argillic horizon and are Haplic Phaeozems and p9 have no permafrost or calcium between 20-50 cm, and have a base saturation of more than 50 % and is therefore a Eutric Regosol.

A COMPARISON OF THE SYSTEMS

As it appears, a great many estimations are necessary at all levels except Great Group level of Soil Taxonomy as the differentiating criteria of this level had been determined at higher level. Now to the ability of the two taxonomies to differentiate the soils of the climo-sequence. Below is given a table of the main morphological groups and their corresponding classification:

Frederiksen (1982-this issue) differentiated the soils on the basis of presence or absence of a B horizon, subdividing this into argillic and cambic horizons with further subdivisions of the latter into well and weakly developed cambic horizons. This division was thereafter related to waterbalance - not the

Table 1

p1	p2	p3	p4	p5	p6	p7	p8	p9	differentiating characteristica	classification
Soils with B-horizon								AC	presence/absence of B	Frederiksen (1982)
Argillic			Cambic B					AC	type of B	
Argillic			Well d.			Weak		AC	type of cambic	
Mollisols								Entisol	epipedon	Soil Taxonomy (1975)
Udoll	Ustolls							Orthent	moisture regime	
Argi	Argi		Haplu					Torri	argillic	
Typic	Ustalfic		Udic	Aridic				Typic	moisture period	
Phaeozems								Regosol	epipedon	FAO-Unesco (1974)
Luvic			Haplic					Eutric	argillic	

Comparison between three ways of classifying soils of a climo-sequence. For further explanation, see text.

other way round. The thickness of the A1 horizon and its moisture regime was considered as of less importance. The identification of the B were based on morphological, chemical and physical properties accoring to Soil Taxonomy.

FAO-Unesco (1974) classify into soils with a mollic epipedon (Phaeozems) and soils without a mollic epipedon (Regosol). At the next level, Phaeozems with argillic horizon are separated from Phaeozems without argillic horizon (Luvic vs. Haplic), but for the Haplic Phaeozems nothing is said about presence or absence of a cambic horizon, and the only statements about the B horizon that can be made is that p1-3 have an argillic horizon, and that p9 does not have a B horizon, which is far from satisfactory from a genetical point of view.

Soil Taxonomy (1975) follows the same path as FAO-Unesco at the order level by dividing the soils into Mollisols (p1-8) and Entisols (p9), using type of epipedon as differentiating characteristica (mollic vs. ochric), and not on the basis of presence or absence of a B horizon (Mollisols may be AC-soils). The similarity between the morphological classification and Soil Taxonomy is thus accidental. At the suborder level moisture regimes are considered more important than the type and degree of development of a B horizon, thus separating the Mollisols into soils with a udic moisture regime (Udolls) (A1A2BtC-soils), and soils with a ustic or aridic moisture regime (Ustolls) (A1A2BtC/ABC/A(B)C-soils), thus splitting the A1A2BtC-soils into two groups, leaving two of them with the cambic group. Not before the Great Group level is the presence and type of B horizon considered important (Udolls and Ustolls do not necessarily have cambic or argillic horizons). The Ustolls are separated into soils with an argillic horizon (Argiustoll) and soils with cambic horizon (Haplustoll). These Haplustolls are separated at the subgroup level on the basis of the length of the dry period, thus splitting the ABC soils into two, leaving two of them with the A(B)C-soils. The degree of development of the cambic horizon is not considered as more emphasis is put on moisture characteristica. Furthermore, the genetical relationship of the nine soils as related to the climatic gradient is not fully understood at any lower level of classification and this is kind of weird, explained by the emphasis placed on the potential of the soil in relation to agriculture etc., which in this case stands out much clearer than the genetical implications.

This is not to be understood as a criticism of Soil Taxonomy, but rather as an underlining of differences in purpose of classification. The presence or absence of a mollic epipedon and type of moisture regime is in agriculture generally more important than presence or absence of an argillic/well developed cambic/weakly developed cambic horizon.

In a system where the morphological, chemical and physical properties are given genetic implications, the cambic B horizon should, however, be divided into various (noted by Soil Taxonomy, p. 33 as a fact, but impractical for its purpose), in this case two - 1) a well developed with difference in colour and structure between B and C, and 2) a weakly developed with the same colour but difference in structure between B and C, although it is admittedly difficult to recognize this kind of structural difference by augering.

CONCLUSIONS

1) The following estimations were necessary at different levels of classification (related to what was not already analyzed)

Soil Taxonomy

Horizon: P_2O_5, cumulative moist period, n-value and base saturation for the mollic epipedon; texture, humus, porosity for the argillic horizons; Fe and A1 for the spodic horizon. *Order:* p1-8: base saturation, content of volcanic material, volumetric weight; p9: volume of structure.

Suborder: p1-8: moisture and temperature regimes; p9: Na-saturation.
Great Group: necessary estimations done at higher level.
Subgroup: p1 and 4-8: CEC of clay fraction; p2-3: cracks and length of dry period; p4-8: Salinity, cracks, COLE, length of dry period: p9: cracks, COLE, length of dry period.

FAO-Unesco
Horizon: as Soil Taxonomy
Soil Unit: cracks, salinity, content of volcanic material, volumetric weight.

2) Of the above estimates, the estimation of moisture regimes was problematic, the rest less problematic.

3) The three classifications (Frederiksen, Soil Taxonomy, FAO-Unesco) did not correspond to each other *due to differences in purpose:* a) The genetical relationships of the nine soils in relation to the climatic gradient was not fully understood at any level in Soil Taxonomy due to its relation to agriculture (mollic epipedon and moisture regimes more important than presence/absence and type of B horizon), b) FAO-Unesco gave more importance to the mollic than any B horizon, and even at lowest level of classification no attention was paid to presence or absence of the cambic horizon, and hence not to a subdivision of this horizon. In a genetical system the degree of development of the cambic horizon should be considered, in this case between a weakly developed with the same colour but different structure between B and C, and a well developed with differences in both colour and structure between B and C.

ACKNOWLEDGEMENTS
The Danish National Science Research Council is thanked for supporting laboratory analysis, the Faculty of Natural Sciences, University of Copenhagen, for giving me a scholarship, and prof., dr. phil. N. Kingo Jacobsen for appointing me member of the expedition. For further acknowledgements, see Madsen et al (1980).

DANSK RESUMÉ

Soil Taxonomy og FAO-Unesco's anvendelighed ved klassifikation af ni løss-jorde udviklet som en klimasekvens, blev evalueret, Da ikke alle målinger, nødvendige for klassifikationen, var blevet udført, var flg. skøn nødvendige:

Soil Taxonomy
Horisont-niveau: P_2O_5, kumulative længde af fugtige periode, n-værdien og basemætningsgraden for det molliske epipedon; tekstur, humus, porøsitet for den argilliske horisont; Fe og Al til at udelukke den spodiske horisont.
Order-niveau: p1-8: basemætningsgrad, indhold af vulkansk materiale, volumenvægt; p9: strukturvolumen.
Suborder-niveau: p1-8: fugtigheds og temperatur regimer; p9: Na-mætning.
Great Group-niveau: nødvendige skøn udført på højere niveau.
Subgroup-niveau: p1 og 4-8: CEC af lerfraktionen; p2-3: sprækker og længden af den tørre periode; p4-8: salinitet, sprækker, COLE, længden af tør periode; p9: sprækker, COLE, længden af tør periode.

FAO-Unesco
Horisont-niveau: som under Soil Taxonomy.
Soil Unit: sprækker, salinitet, indhold af vulkansk materiale, volumenvægt.

Af de ovenstående skøn er fastsættelsen af fugtighedsregimer problematisk, de øvrige mindre problematiske.

De to klassifikationssystemer sammenlignedes med et system, der inddeler på grundlag af type og udviklingsgrad af B-horisonten (p1-3 er A1A2BtC-jorde, p4-6 ABC-jorde, p7-8 A(B)C-jorde og p9 en AC-jord), og disse svarede ikke til hinanden på grund af forskel i formål: a) den genetiske sammenhæng mellem de ni jorde i relation til den klimatiske gradient kunne ikke forstås fuldt ud i Soil Taxonomy , selv på laveste klassifikaionsniveau på grund af dette klassifikationssystems relation til landbrug (det molliske epipedon og fugtighedsregimerne var vigtigere end tilstedeværelsen eller fraværet samt type af B horisonten), b) FAO-Unesco betragtede det molliske epipedon som vigtigere end hvilken som helst B horisont, og selv på det laveste klassifikationsniveau blev der ikke skelnet mellem om en cambisk horisont var tilstede elller fraværende, og derfor blev der heller ikke skelnet mellem den cambiske horisonts udviklingsgrad.

I et genetisk system bør der skelnes mellem den cambiske horisonts udviklingsgrad, i det her tilfælde mellem en svagt udviklet cambisk med samme farve, men forskellig struktur i B og C, og en veludviklet cambisk med både forskellig farve og struktur mellem B og C.

LITERATURE

Cline, M. G. (1949): Basic principles of soil classification. Soil Sci., Vol. 67, pp. 81-92.
FAO-Unesco (1974): Soil map of the world, 1:5.000.000, Vol I, Legend. Unesco-Paris 1974.
Frederiksen, P. (1982): Climatic influence on morphology and chemistry of nine loess-profiles. Geografisk Tidsskrift 1982.
Madsen, H. B. et al (1980): The Danish Scientific Expedition to Patagonia and Tierra del Fuego, 1978-79. Geografisk Tidsskrift, bind 80, pp. 1-28.
Minetti, J. L. y Fogliata, F. A. (1975): Balance hidrico en el area canera de Tucuman y uso del tanque de evaporacion para control de riego. Rev. Industrial y Agricola de Tucuman, Tomo 52 (2), pp. 25-60.
Scheffer/Schachtschabel (1976): Lehrb. d. Bodenkunde. Stuttgart.
US. Soil Conservation Service: Soil Taxonomy. USDA Agriculture Handbook No. 436.
Zuccardi, R. B. et al (1971): Regimen hidrico de un Argiudoll. Rev. Agr. N. O. Argent., Vol. X (2), pp. 347-365.
Zuccardi, R. B. y Fadda, G. S. (1971): Regimen termico de un Argiudoll. Rev. Agr. N. O. Argent., Vol. IX (2), pp. 367-381.
Zuccardi, R. B. y Fadda, G. S. (1972): Mapa de reconocimiento de suelos de la provincia de Tucuman. Publicacion especial No. 3, Univ. Nac. de Tucuman, Fac. Agr. Zoot.

Suborder: p1-8: moisture and temperature regimes; p9: Na-saturation.
Great Group: necessary estimations done at higher level.
Subgroup: p1 and 4-8: CEC of clay fraction; p2-3: cracks and length of dry period; p4-8: Salinity, cracks, COLE, length of dry period: p9: cracks, COLE, length of dry period.

FAO-Unesco
Horizon: as Soil Taxonomy
Soil Unit: cracks, salinity, content of volcanic material, volumetric weight.

2) Of the above estimates, the estimation of moisture regimes was problematic, the rest less problematic.

3) The three classifications (Frederiksen, Soil Taxonomy, FAO-Unesco) did not correspond to each other *due to differences in purpose:* a) The genetical relationships of the nine soils in relation to the climatic gradient was not fully understood at any level in Soil Taxonomy due to its relation to agriculture (mollic epipedon and moisture regimes more important than presence/absence and type of B horizon), b) FAO-Unesco gave more importance to the mollic than any B horizon, and even at lowest level of classification no attention was paid to presence or absence of the cambic horizon, and hence not to a subdivision of this horizon. In a genetical system the degree of development of the cambic horizon should be considered, in this case between a weakly developed with the same colour but different structure between B and C, and a well developed with differences in both colour and structure between B and C.

ACKNOWLEDGEMENTS
The Danish National Science Research Council is thanked for supporting laboratory analysis, the Faculty of Natural Sciences, University of Copenhagen, for giving me a scholarship, and prof., dr. phil. N. Kingo Jacobsen for appointing me member of the expedition. For further acknowledgements, see Madsen et al (1980).

DANSK RESUMÉ
Soil Taxonomy og FAO-Unesco's anvendelighed ved klassifikation af ni løss-jorde udviklet som en klimasekvens, blev evalueret, Da ikke alle målinger, nødvendige for klassifikationen, var blevet udført, var flg. skøn nødvendige:

Soil Taxonomy
Horisont-niveau: P_2O_5, kumulative længde af fugtige periode, n-værdien og basemætningsgraden for det molliske epipedon; tekstur, humus, porøsitet for den argilliske horisont; Fe og Al til at udelukke den spodiske horisont.
Order-niveau: p1-8: basemætningsgrad, indhold af vulkansk materiale, volumenvægt; p9: strukturvolumen.
Suborder-niveau: p1-8: fugtigheds og temperatur regimer; p9: Na-mætning.
Great Group-niveau: nødvendige skøn udført på højere niveau.
Subgroup-niveau: p1 og 4-8: CEC af lerfraktionen; p2-3: sprækker og længden af den tørre periode; p4-8: salinitet, sprækker, COLE, længden af tør periode; p9: sprækker, COLE, længden af tør periode.

FAO-Unesco
Horisont-niveau: som under Soil Taxonomy.
Soil Unit: sprækker, salinitet, indhold af vulkansk materiale, volumenvægt.

Af de ovenstående skøn er fastsættelsen af fugtighedsregimer problematisk, de øvrige mindre problematiske.

De to klassifikationssystemer sammenlignedes med et system, der inddeler på grundlag af type og udviklingsgrad af B-horisonten (p1-3 er A1A2BtC-jorde, p4-6 ABC-jorde, p7-8 A(B)C-jorde og p9 en AC-jord), og disse svarede ikke til hinanden på grund af forskel i formål: a) den genetiske sammenhæng mellem de ni jorde i relation til den klimatiske gradient kunne ikke forstås fuldt ud i Soil Taxonomy , selv på laveste klassifikaionsniveau på grund af dette klassifikationssystems relation til landbrug (det molliske epipedon og fugtighedsregimerne var vigtigere end tilstedeværelsen eller fraværet samt type af B horisonten), b) FAO-Unesco betragtede det molliske epipedon som vigtigere end hvilken som helst B horisont, og selv på det laveste klassifikationsniveau blev der ikke skelnet mellem om en cambisk horisont var tilstede elller fraværende, og derfor blev der heller ikke skelnet mellem den cambiske horisonts udviklingsgrad.

I et genetisk system bør der skelnes mellem den cambiske horisonts udviklingsgrad, i det her tilfælde mellem en svagt udviklet cambisk med samme farve, men forskellig struktur i B og C, og en veludviklet cambisk med både forskellig farve og struktur mellem B og C.

LITERATURE
Cline, M. G. (1949): Basic principles of soil classification. Soil Sci., Vol. 67, pp. 81-92.
FAO-Unesco (1974): Soil map of the world, 1:5.000.000, Vol I, Legend. Unesco-Paris 1974.
Frederiksen, P. (1982): Climatic influence on morphology and chemistry of nine loess-profiles. Geografisk Tidsskrift 1982.
Madsen, H. B. et al (1980): The Danish Scientific Expedition to Patagonia and Tierra del Fuego, 1978-79. Geografisk Tidsskrift, bind 80, pp. 1-28.
Minetti, J. L. y Fogliata, F. A. (1975): Balance hidrico en el area canera de Tucuman y uso del tanque de evaporacion para control de riego. Rev. Industrial y Agricola de Tucuman, Tomo 52 (2), pp. 25-60.
Scheffer/Schachtschabel (1976): Lehrb. d. Bodenkunde. Stuttgart.
US. Soil Conservation Service: Soil Taxonomy. USDA Agriculture Handbook No. 436.
Zuccardi, R. B. et al (1971): Regimen hidrico de un Argiudoll. Rev. Agr. N. O. Argent., Vol. X (2), pp. 347-365.
Zuccardi, R. B. y Fadda, G. S. (1971): Regimen termico de un Argiudoll. Rev. Agr. N. O. Argent., Vol. IX (2), pp. 367-381.
Zuccardi, R. B. y Fadda, G. S. (1972): Mapa de reconocimiento de suelos de la provincia de Tucuman. Publicacion especial No. 3, Univ. Nac. de Tucuman, Fac. Agr. Zoot.