GENETIC STUDY OF SOME SOILS DEVELOPED ON TRIASSIC MATERIALS

by

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INTRODUCTION.-

A study of the materials of the Trias adds to the complexity of its geological materials the difficulty of presenting a chromatic range and a granulometry that will coincide in large extent to the colours and textures that can be obtained, as a result of pedological processes.

On the other hand, many of the geological materials of this age have some physical properties that bridle the action of the factors of soil formation, with a result that in many cases, the soils are very little developed.

In fact, these anticipated difficulties, have been what have influenced us to initiate this work. We pretend to penetrate on the knowledge of these soils, so that we have studied them as completely as we have been able.

As a previous study we have done a Cartographic study of the elected zone (Mesa, A. 1.975) the drillings made have allowed to select in profiles representatives of the soils of the area, from which we have chosen 3 profiles as more representatives.

FACTORS OF SOIL FORMATION.-

The soil location so as the lithology and the climate are shown at the folloing maps and graphs.

Vegetation: The climax vegetation occurs as a consequence of the degradation of the cak grove. It veongs to the Quercetea-ilicis Class (Rivas Martinez, 1.974). It is a transition among the communities of the Quercion rotundifolias alliance, Rhamno-Cocciferetum association and the Oleo-Ceratorium alliance, Chamaeropo-Rhamnetum lycioidis association. Throughout all the zone of climax vegetation, the species Quercus ilex ssp rotundifolia and Quercus coccifera appear. The former, in the form of evergreen oaks except in more protected zones and in some places already cultivated, where they are real oaks. On the flatter places appears the plametto (Chamaerops humile), characteristic of the second association.

RESULTS

The obtained results are shown at tables I-6.

PROCESSES OF SOIL FORMATION .-

We start off with the study of soil 2, a typic Xerorthent, as it is the one of the smallest evolution and in which, due to its topographic position, it could have contributed some of its materials to the other soils without receiving anything from them.

The facts and data of interest which have been observed in this soil have been:

a) The material corresponging to horizon C of this soil is located in pockets within a landscape of marls in which it is situated an AC soil similar to the one under, study.

b) Texture strongly different between Ap and C horizons of this profile with a 16 % more clay in C horizon.

c) Characters strongly edaphic of C horizon, with very abundant argillans from diffusion and sesquioxidic-nodules.

d) However, as it can be seen in the description , C is a horizon unaffected by any biological activity.

e) Ap and C horizons contain frequent ophite and dolomite fragments in different degrees of weathering.

f) Very high content of grains of a volcanic origin in the coarse sand fraction of this soil (60 % lithorelicts 18 % glass, 15 % quartz of volcanic origin).

g) Decarbonated soil, in spite of being surrounded by marls . No decarbonated grains can be seen in the coarse sand fraction.

h) The lithorelicts and volcanic glass present very rounded shapes, as a consequence of a transport.

i) However, there are also little rounded quartz (bipyramids) without any trace of transport.

j) Hematite grains of two different origins are present:

Hematites-Dolomite (volcanic)abundant.
Hematite pseudomorphic from pyrite (proceeding from limes or marlstones) very scarce.

k) There are no amorphous materials at the clay fraction as it could be expected from the evolution "in situ" of volcanic material.

l) No significant changes in the crystalchemical parameters of the clays are apparent.

We have not considered the formation of an argillic horizon because we have the evidence that at present time do not exist a illuviation process : the cutans of diffuse bandaries are characteristic of a stage of degradation rather than of a constructive process. This degradation, however, is not a consequence of the pedoturba tion produced by biological activities, because as we have see , this activity is reduced to a minimum in this horizon.

On the other hand, we find pebbles very well preserved throughout the profile.

Consequently, the only plausible explanation we find is as follows:

A material from the Trias evolued in favourable climatic conditions, with alternances of humidity and dryness and vegetation (possibly forest) leading towards a soil with a very deep argillic horizon. This soil belonged to a different landscape from the present one in this zone , as, posteriorly, successive gullies began destroying the soil and modifying extensively the landscape to become as it is at present , in which the ditchs take up a good percentage of the total of the area, remaining only small redoubts in which remnants of material from the primitive soil are preserved.

A proof of this theory is the preservation, at present time, or mounds of similar height, very close to one another, but separated by small water-way which mark the present remnants of the former surface.

The material from the trias contributeed the grains of bipyramidal quartz, not rounded, and the martite grains while successive gullies brought in the volcanic materials, with signs of erosion by transport.

These gullies mixed the material from the primitive soil with volcanic sand and pebbles of the surroundings, scattering them among all the material, which explains the varied weathering of the stones, independently from profile situation.

This mixture took place in a fluid muddy state and many signs of a former edaphyzation have been left preserved which would have been destroyed if the clay would have been dragged in suspension. If this were the case, some signs of a posterior sedimentation would be apparent, what it is not then.

On being situated the sand grains of volcanic origin and the pebbles immersed into a closed medium, as it is the case of clay soil, without going through any posterior adeaphyzation, they have practically preserved themselves in the same state as that in which they were deposited what would explain why no gels can be found in these clays. Still in need of an explanation is the presence of hematites procedings from the marls (martite) without any calcareous nodules which, logically, should be present.

The only possible explanation is to consider that, this contribution was done in the primitive soils, during the time of its evolution causing the accompanying carbonates to be washed away from the profile.

In consequence, the present soil have had as parent rock this mixture of materials, and starting off from them is evoluing slowly, as the nature of the material (highly impermeable), the climate (Xeric), the vegetation and the topography (25 % slopes), bridle and even counteract the action of the factors of formation and the evolution of the pedological processes.

On this material a horizon becomes differentiated, in whose formation two processes have ocurred : Removal of the original material by the action of the fauna and the plants hat, moreover, have added organic matter. The other one is the sideway dragging of fine materials, clay size, downhill through the surface, causing the textural discontinuity of these two horizons.

The evolution of the present soil, starting off from this material, is also verified by the homogeneity of the crystalchemical parameters of the clay minerals. If the C horizon material were caused by an edaphyzation "in situ" you should appreciate a different degree of crystalli nity depending on the depthness of the profile.

On the other hand the exchange cations capacity at this profile is due, mainly to the chlorite. As the exchan ge cations capacity is larger than the usuel one, the chlo rites must be very labile; more in Al horizon than in C. This weakness is supported by the transformation biotite to chlorite found at the coarse sand fraction, which is more developed in Al horizon than in C horizon.

PROFILE 6

As in the former soil in the first place we are going to relacionate all the fact and data of interest.

a) A 15 % textural change in the clay content is ob served between Apw and IIB2 horizons.

b) There is a structure strongly developed in IIB2 horizon.

c) The weathering of the rock fragments is modera te in Apl and Ap2, strong in IIB2 and not noticeable in IIC1 and IIC2.

d) There is a discontinuity in the Carbonate contents between horizons IIB2 and IIC.

e) Pedorrelicts can be observed in Ap1 and Ap2 ho rizons.

f) The agglomerates of matrix are abundant.

g) The quartz content in the profile decrease with depth.

h) The quartz of volcanic origin is only of 9 % from the total and this percentage decreases with depth .

i) The volcanic materials appear aged.

j) The hematites type martite is very abundant at the heavy fraction of coarse sand so the goethite.

k) The heavy minerals differ from those existing in soil 2.

The profiles 2 and 6 are situated at 375 m from one to another. Consequently, the erosive pedogenetic pro- cesses, must be the same in both soils.

After the intensive erosive stage, the underlying marl outcropped. The degree of evolution of the soils , over developed will depend only on the local conditions of each pedon.

After the erosive stage quoted two main processes have taken place, from which we have evidence by the mor phological characters preserved.

During the first stage over the marl of horizon IIC1 and IIC2 a soil with a well developed cambic horizon had taken place. This soil had this develop due to the topo - graphic position with gentle slopes and a vegetation of forest which protected the soil from erosion. The proogs of this cambic horizon are the presence of glaebulas, the removal of $CaCO_3$ and the strongly developed structure at the IIB2 horizon.

During the second stage after deforestation, due to unknown causes, an erosion and /or a contribution with mixture of materials took place. Possibly, the low con- tent of organic matter in horizons Ap1 and Ap2 is due to an erosion that took out the organic horizon and poste - riorly, by plowing the most typical part of the cambic ho rizon was destroyed mixing it with the original material, which explain the textural discontinuity between the Ap2 and IIB2 horizons so as the pedorelicts present at Ap1 and Ap2 horizons.

The larger aged of volcanic materials in this profi le is a consequence of pedological processes quoted formerly. In the clay mineralogy, it is observed that the size of the illite from the upper horizons (Ap1 and Ap2) is larger than those from the underlying horizons, this may be due to the aloctonous character of these superficial horizons.

PROFILE 13

The fact and data more intesting in this soil are as follows :

a) Fragments of secondary carbonate are present at Ap and B2t horizons, larger amounts in the first one.

b) The textural change between Ap and B2t horizons is smaller than it could be expected.

c) The quartz presents rounded shapes but some grains are subangulars or even angulars.

d) 18 % of the quartz is from volcanic origin.

e) There is an 11 % of sand with volcanic origin and of hematite-dolomite grains, while the (martite) represents also a 11 %.

The mineralogy of the coarse sand fraction present a contamination by aloctonons materials from volcanic origin (in larger proportion than in soil 6, but much smaller than in soil 2) distributed homogeneously at the profile.

Few conclusions can be pointed out of this distributions, since there are evidences of a disturbation in this soil, as it is the presence on the surface of secondary carbonates, and the few differences existent between the granulometry of Ap and B2t horizons nevertheless a clay and sesquioxidic illuviation is evident (as verified by micromorphological study) to consider horizon B2t as argillic.

This disturbation probably has been caused by plowing bringing up to the surface fragments of the underlying petrocalcic horizon, although erosion possibly took place previously as it has happened in nearly all the soils of the area.

The contamination we spoke about formerly must have happened throughout the period of formation of this soil, with materials proceeding from the erosion of the triasic levels which contain these minerals, because two stages of formation do not appear to be possible here as it happened at the soil 6.

Furthermore, the minerals do not appear so aged, as in soil 6, nor are characteristic of the original materials of the soil .

The size of the illite, is small as it is in consonance with a degraded illite. The uniformity in size of the illite throughout the whole profile may be due to the fact that in the illuviation process, the clay illuviated is the smallest.

On the other hand, the disturbation, formerly mentioned, mut have contributed to the uniformity in size.

SOILS DEVELOPED ON TRIASSIC MATERIALS

TABLE I

Profile	Parent material	Relief	Slope (%)	Vegetation	Drainage	Soil Type
2	Triassic clay	Rolling	25	Al: Asparrago-Rhamnion Oleoidis Or: Pistacio-Rhamnetalia Alaterni Cl: Quercetea Ilicis	Moderately well drained	Fine clayey, mixed, thermic, tipic Xerortent.
6	Triassic marls	Rolling	4	Or: Lygeo- Stipetalia Cl: Thero-Brachypodietea Degradation from Quercetea Ilicis	Imperfectly drained	Fine clayey, illitic, thermic, Aquic Xerocrept.
13	Triassic marls	Rolling	4		Moderately well drained	Fine clayey, illitic, thermic, Petrocalcic Rhodoxeralf.

TABLE II

MACROMORPHOLOGICAL DESCRIPTION OF SOIL PROFILE

Prof.	Horiz.	Depth.	Colour	Tex.	Structure	Pores	React.	Roots	Bound
	O1	1	-	-	-	-	-	-	-
2	A1	15	5YR 4,5/3	scl	m1sbk & cr	ab-larg-med	-	fr-larg-v. fin	c. s.
	C	> 125	5YR 4/4	cl	c1sbk	sc-fin	-	R-v. fin-fin.	-
	Ap1	15	7,5YR5,5/4	cl	m2cr	ab-fin-med	es	sc-v. fin	a s
	Ap2	10	7,5YR 5/4	cl	c2sbk	ab-v. fin	es	sc-v. fin	a s
6	IIB2	25	6,25YR 5/4	c	c3sbk	sc-fin-med	es	sc-v. fin. larg	c s
	IIC1	30	6,25YR 6/4	c	c2sbk	fr-v. fin	es	R-fin	d
	IIC2	?	7,5YR 6/4	sic	m1sbk	-	es	R-fin	-
	Ap	25	3,75Y 3/6	cl	f3cr	ab-v. fin-med	ev	-	a s
13	B2t	30	2,5YR 3/6	sic	m3sbk	sc-fin	e	-	a i
	Ccam	?	2,5YR 4/6	-	pl	-	ev	-	-

ab = abundant
fr = frequent
sc = scarce
R = rare

larg = large size
med = medium size
fin = fine size
v. fin = very fine size

a = abrupt
c = clear
d = diffuse
s = smooth
i = irregular

TABLE III

Prof.	Horiz.	FABRIC		CUTANS			
		Related distribution	Plasmic	Number	Surface affected	Nature	Origin
2	A1	Intertextic	Silasepic	Scarce	Embedded grain, vughs	Argill.-ferriargill. Silans	Diffusion
	C	Porphyroskelic	Skelsepic/vomosepic.	very abundant.	Embedded grain, vughs	Argillans	Diffusion
6	Ap1	Porphyroskelic	Insepic	Rare	Embedded grain	Argillans-Ferriargillans	Diffusion
	Ap2	Porphyroskelic	Insepic	Rare	Embedded grain	Ferriargillans	Diffusion
	IIB2	Porphyroskelic	Argillasepic	few	Embedded grain	Ferriargillans	Diffusion
	IIC1	Porphyroskelic	Argillasepic	-	-	-	-
	IIC2	Porphyroskelic	Argillasepic	-	-	-	-
13	B2t upper	Porphyroskelic	vo-ma-skel-mosepic.	abundant	Embedded grain, skewplanes, vughs.	Ferriargillans	Illuviation
	B2t middle	Porphyroskelic	skel-mosepic/skelclinobimasepic.	abundant	Embedded grain	Ferriargill-Argillans. Calcans-Chalcedans	Illuviation
	B2t lower	Porphyroskelic	masepic unistrial	abundant	vughs	Ferriargillans & argillans	Illuviation

TABLE III (Continuation)

Prof.	Horiz.	GLAEBULES Types	Nature	Number	VOIDS Type	Number
2	A1	Nodules	Sesquioxidic	Rare	Macrovoids: orthovughs, mammillated metavughs, and small channels.	30 %
	C	Nodules	Sesquioxidic	Rare	Macrovoids: meta and orthovughs Mesovoids : metavughs	15-20 %
6	Ap1	Nodules Concretions	Silty-clay & Sesquioxidic. Sesquiox. & Clayey	Frequent Few	Ortho and metavughs, skewplanes	20 %
	Ap2	Nodules	Sesquiox. & Clayey	Few	Intrapedal orthovughs	15-20 %
	IIB2	Nodules Nodules Concretions	$CO_3^=$ Sesquioxidic Sesquioxidic	very abundant frequent few	Macro and mesovughs , skewplanes	7 %
	IIC1	Nodules Concretions	Sesquioxidic Sesquioxidic	abundant few	Ortho and meta vughs, channels, skewplanes and craze planes.	3- 5 %
	IIC2	Nodules Concretions Septarias	Sesquioxidic Sesquioxidic $CO_3^=$	abundant frequent few	Intrapedal orthovughs, interconnected channels	7-10 %
13	B2t upper	Nodules Nodules Concretions	Sesquioxidic $CO_3^=$ Sesquiox. & clayey	frequent few few	Macro and mesovoids : meta and orthovughs, planar voids and channels	40 %
	B2t middle	Nodules Nodules	Sesquioxidic $CO_3^=$	few few	Macro and mesovoids : meta and orthovughs, planar voids and channels.	40 %
	B2t lower	Nodules	Sesquioxidic	few	Macro and mesovoids : meta and orthovughs, Craze planes, channels.	40 %

TABLE IV

ANALITICAL DATA

Profile	Horiz.	Particle size distribution (mm)						
		V.c.s 2-1	C.s. 1-0,5	M.s. 0,5-0,25	F.s. 0,25-10	V.f.s 0,10-0,05	Silt 0,05-0,002	Clay 0,002
2	A1	10,7	11,2	8,3	18,7	10,1	19,2	22,1
	C	12,6	11,2	5,7	10,0	5,9	17,1	38,5
	Ap1	5,6	5,4	4,2	9,7	8,1	32,5	34,7
	Ap2	5,2	5,6	4,3	10,3	8,8	31,2	34,6
6	IIB2	6,6	4,1	2,6	5,1	4,4	27,9	49,0
	IIC1	4,5	3,8	1,8	3,2	3,6	37,3	45,6
	IIC2	4,3	3,1	1,9	2,2	2,5	41,8	44,5
13	Ap	3,6	3,6	3,5	11,7	11,5	26,4	37,6
	B2t	0,8	2,1	2,1	5,8	5,4	40,2	43,5

TABLE IV (Continuation)

ANALITICAL DATA

Profile	Horiz.	$CaCO_3$ equiv. % Clay	Soil	pH (H_2O)	O.M. %	E.C. meq/100g	C.E.C. meq/100 g	Base sat. %	E.C.
2	A1	0,0	0,0	7,1	2,7	16,2	17,4	93	1,2
	C	0,0	0,0	7,3	1,1	17,4	20,6	84	0,6
6	Ap1	3,9	11,8	7,9	2,1	50,9	15,8	100	0,7
	Ap2	0,0	10,3	7,9	1,8	53,9	17,0	100	0,8
	IIB2	5,1	10,8	7,9	1,8	51,1	19,8	100	0,6
	IIC1	4,1	32,2	8,0	0,9	56,5	16,2	100	0,6
	IIC2	2,4	33,4	8,0	0,5	45,9	17,0	100	0,6
13	Ap	0,0	9,4	8,0	1,1	43,0	20,6	100	0,6
	B2t	1,0	1,2	7,8	0,5	36,7	26,5	100	0,5

TABLE V

CLAY MINERALOGICAL COMPOSITION OF SOILS AND CRYSTAL CHEMICAL PARAMETERS

Profile	Horizc.	I.	K	Ch	Mo.	Illite Al	Illite Fe	Illite G.P.	Illite T.A (Å)	Chlorite Al	Chlorite Fe	Chlorite Mg	Chlorite T.A (Å)
2	A1	31	-	69	-	3,05	0,95	0,2	444	1,20	1,20	3,60	444
	C	41	-	59	-	3,0	1,0	0,13	242	1,07	0,55	4,38	444
6	Ap1	66	T	34	-	3,15	0,85	0,13	242				
	Ap2	62	-	38	-	2,90	1,10	0,05	313	1,20	0,50	4,30	761
	IIB2	73	-	27	-	2,45	1,55	0,20	127	1,20	0,75	4,05	2665
	IIC1	66	-	34	-	2,95	1,05	0,32	166	1,20	0,50	4,30	761
	IIC2	67	-	33	-	2,65	1,35	0,20	127	1,20	0,01	4,79	592
13	Ap	83	-	17	-	1,85	2,15	0,20	102	1,20	3,0	1,80	242
	B2t	90	-	10	-	2,85	1,15	0,17	102	1,20	2,10	2,70	444

I = Illite; K = Kaolinite ; Ch = Chlorite ; Mo. = Montmorillonite ; - = absent ; T = Traces.

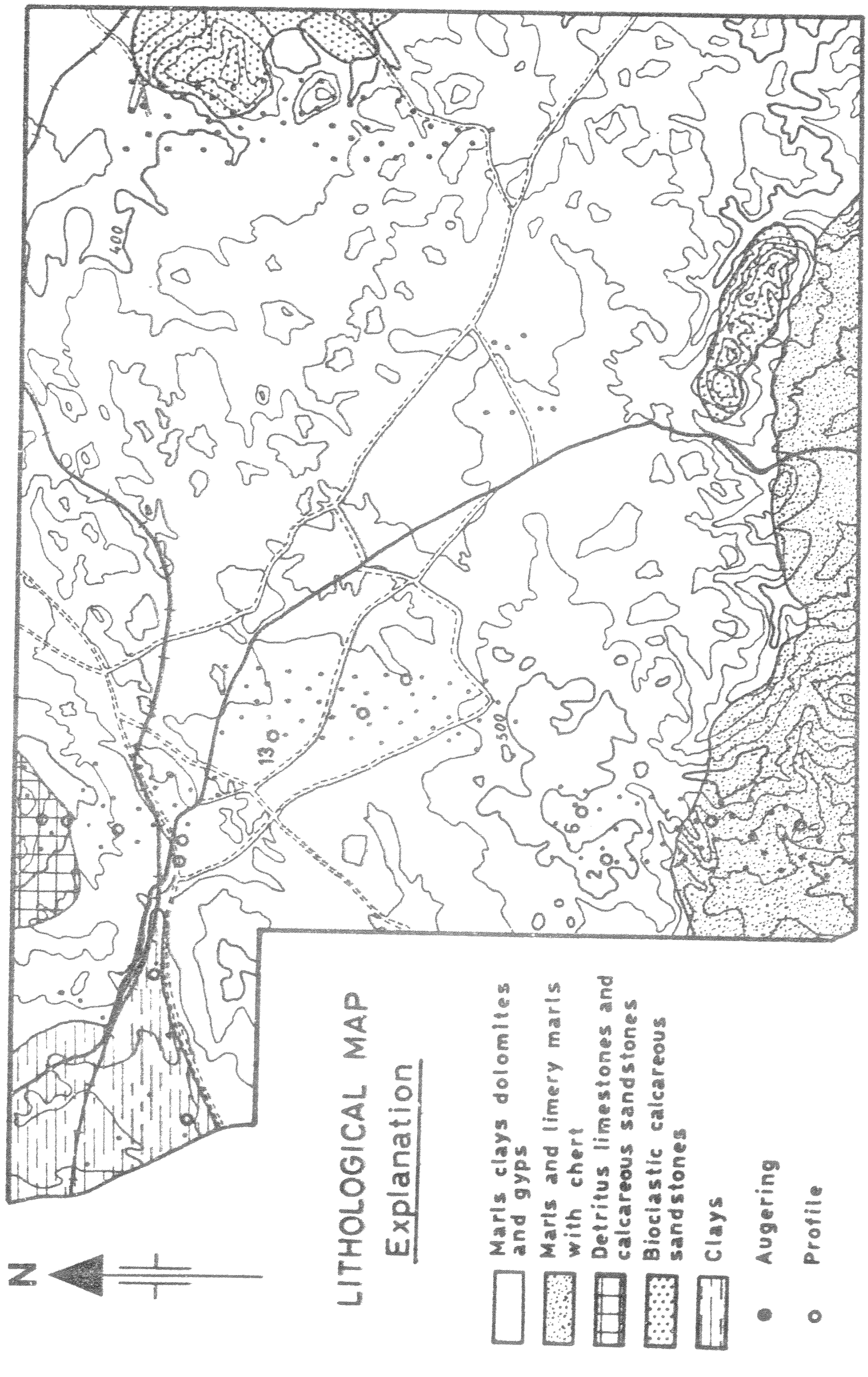
TABLE VI

COARSE SAND MINERALOGICAL COMPOSITION OF SOILS

Profile	Horiz.	Q	Mi	$CO_3^{=}$	Z	A & P	Fe. min.	G	Ch
2	A1	56	≤1	3	20	≤1	2	19	≤1
	C	53	≤1	2	28	≤1	2	14	≤1
6	Ap1	87	4	4	2	≤1	3	≤1	≤1
	Ap2	79	7	9	1	≤1	4	≤1	≤1
	IIB2	68	5	24	1	≤1	2	-	-
	IIC1	35	4	58	1	≤1	2	-	-
	IIC2	26	2	70	≤1	≤1	2	-	-
13	Ap	82	1	12	2	≤1	3	≤1	-
	B2t	90	≤1	4	3	≤1	3	≤1	-

Q = quartz ; Mi = mica $CO_3^{=}$ = carbonates; Z = zoisite; Fe. min = Iron minerals; G= glass

A & P = amphiboles and pyroxenes.


400
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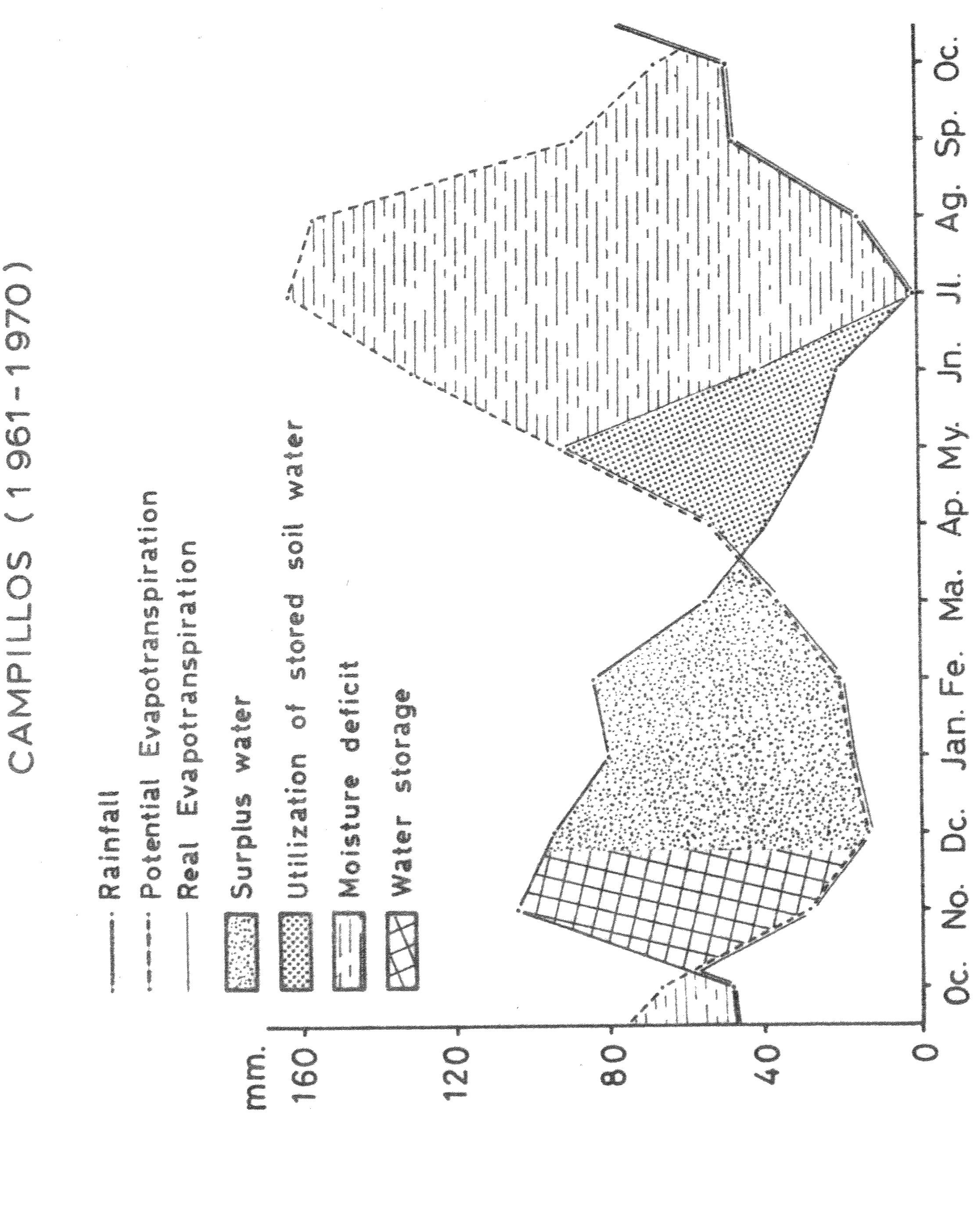
LITHOLOGICAL MAP
Explanation
Marls clays dolomites and gyps
Marls and limery marls with chert
Detritus limestones and calcareous sandstones
Bioclastic calcareous sandstones
Clays
Augering
Profile
N


CAMPILLOS (1961-1970)
Rainfall
Potential Evapotranspiration
Real Evapotranspiration
Surplus water
Utilization of stored soil water
Moisture deficit
Water storage
mm.
160
120
80
40
0
Oc.
No.
Dc.
Jan.
Fe.
Ma.
Ap.
My.
Jn.
Jl.
Ag.
Sp.
Oc.

Legend of figures

Fig. 1.- Volcanic glass grain 64 x oblique nicols.

Fig. 2.- Volcanic quartz grains with embayments 64 x oblique nicols.

Fig. 3.- Volcanic glass aging to quartz + chlorite 32 x oblique nicols.

Fig. 4.- Volcanic glass aging to chalcedony 64 x oblique nicols

Fig. 5.- Chlorite formed from volcanic glass 128 x crossed nicols.

SUMMARY

It has been studied the soils developed on triassic materials at the area of Campillos (Málaga).

From the field descriptions, micromorphological and mineralogical studies and analitical data, we have pointed out the possible genesis of the soil of this area.

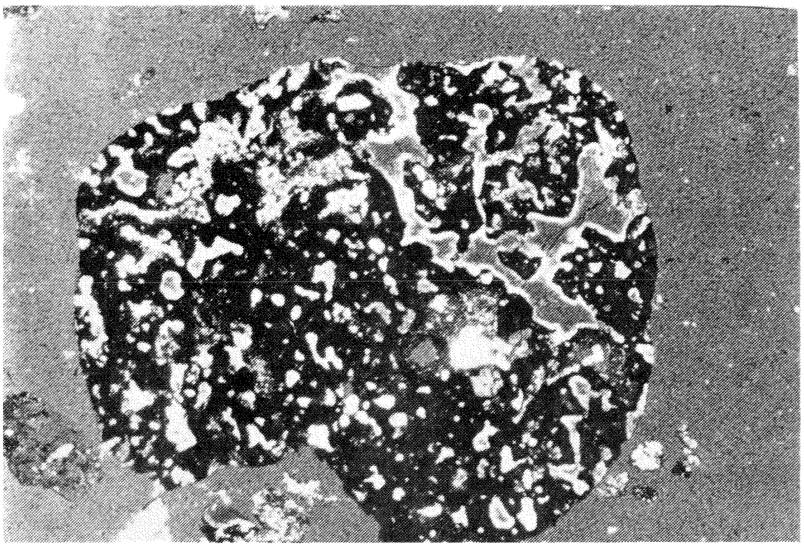


Fig. 1

Fig. 4

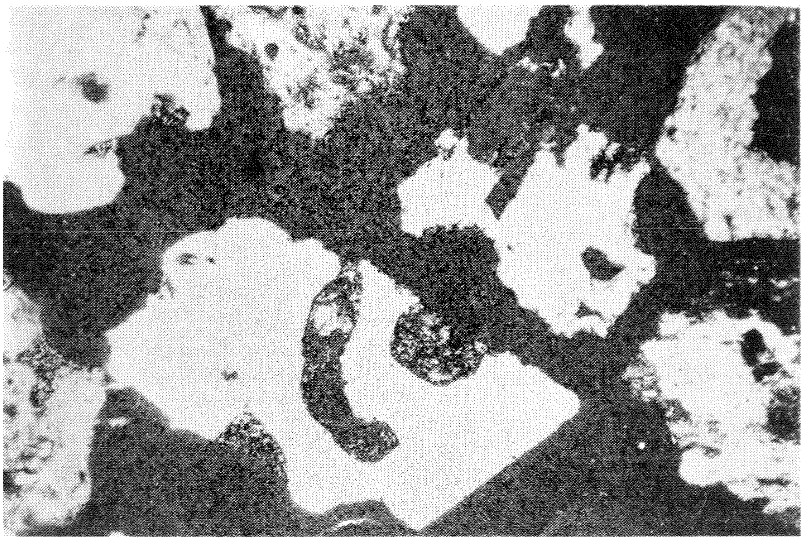


Fig. 2

Fig. 5

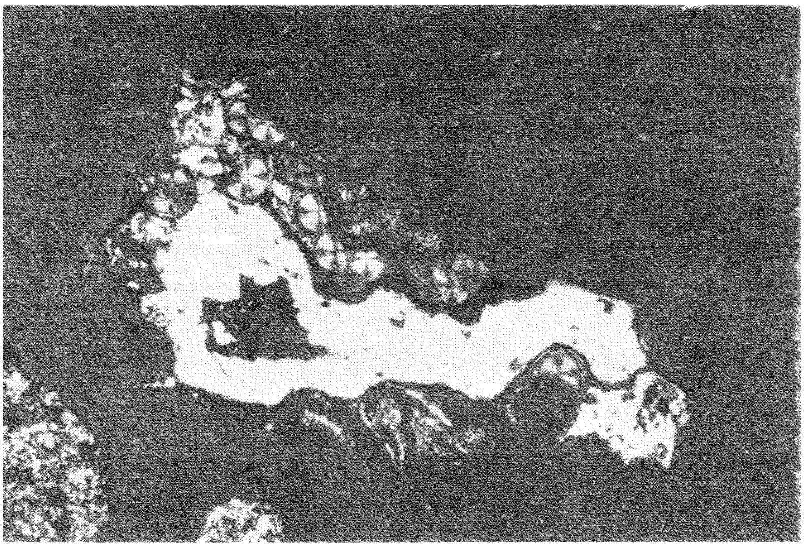


Fig. 3

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