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Contribution to the micromorphological study of red Mediterranean soils of Spain

J. BENAYAS and A. GUERRA

C.S.I.C., Institute of Soil Science and Plant Biology, Madrid, Spain

INTRODUCTION

The red Mediterranean soils have been the object of numerous research work in the course of the past ten years, their age, climatical conditions of formation, classification and evolution being subjects on which there does not exist any unanimous opinion amongst authors. Their presence in areas of Mediterranean climate brings them into relation to these climatical conditions although most authors agree to assigning them the character of paleosoils. The edaphic process which originated them is that of rubification which, however, is not attached to the minerological composition of the original material nor does it constitute a specific new formation of clay minerals. Red soils are to be found on original materials of such a different chemical and mineralogical composition as that of gneiss and limestone, their morphology and physical-chemical properties oscillating between very ample limits. Their presence is not dependent upon any topographical surface nor on well defined drainage conditions.

There do, however, exist some morphological properties of the red soils which are common to all of them. The intensely red-coloured B horizon is of a textural type with highly developed clay-skins among structural units covering them in all directions. Nevertheless, the textural character is little noticeable at those soils in which the original material has a marked siliceous skeleton, although even at them certain clay coatings can be seen in the quartz grains. The structure is always highly developed, prismatic or blocky, in the former case blocks are formed when prisms are broken up.

Although it is a question why in soils formed on materials of a very varied composition the B horizon is always decalcified. Carbonates, if there were any, have been washed out completely and should they be observed this is due to a secondary enrichment. The pH oscillates between rather ample limits from 5 up to about 8 in some cases, but it is always closely related to the content in original material bases. Rubification requires a complete wash-out of carbonates, but not of the exchangeable

calcium. There are red acid, neutral or slightly alcaline soils, the rubification and argillization process of the B horizon being perfectly compatible with a $Ca^{\cdot\cdot}$ saturation of the exchangeable complex. In many cases, particularly in red soils of a prismatic structure, the exchangeable magnesium reaches values comparable to those of calcium. Complete profiles are rarely to be found, as a rule the humus horizon does not exist as it is only noticeable in forest zones and bushes. Instead, there is a more or less anthropic browned horizon.

Mineralogical composition of the clay is also variable; red soils rich in bases show a clay where illite, montmorillonite and, to a much lesser degree, also kaolinite are predominant. Among the derivates of acid materials, with a pH between 5 and 6, the kaolinite is the predominant mineral, and in all of them, free iron oxides are abundant, the ratio between free iron and total iron being 60-80%.

The great number of papers submitted to the International Conference on Mediterranean soils (held in Madrid in 1966) underlined the interest in their origin and classification for Pedology.

Their distribution throughout Spain is rather extended (Map of Spanish Soils scale 1:1,000,000) [23]; they exist in all areas although, on the whole, the surface occupied by them cannot be compared with others and we think they extended over a much larger zone during the medium Quaternary.

We therefore attempted to initiate the study of red soils so as to find out their genetic relation to the main factors of formation. This is a part of an extensive research work already completed in some points, we can here only limit ourselves to stress some of the most interesting morphological and micromorphological aspects.

TECHNIQUES EMPLOYED

For the preparation of the soil thin sections we have been using the Cronolite 1108 according to conventional techniques.

For the micromorphometric structure analysis, we used the TP 200 (Leitz, Wetzlar) projector with a reproduction scale of 20:1 as well as the total photometer according to Kubiëna *et al.* method [8, 20-22].

The values obtained from the number of structure and mineral photograms are divided as follows: solid substance without minerals, mineral part and pore space. Based on these data we obtained the average percentage and standard deviation by applying the proper formula for the statistic treatment of percentages, $s = \pm\sqrt{\frac{1}{n}\left(\frac{a}{n}\right)\left(1-\frac{a}{n}\right)}$ in which n = number of photograms (in our case 30) and a = the total sum of data studied in each case.

MATERIAL STUDIED

We have chosen eight profiles (Fig. 1) among very different materials taken from areas with a certain climatical variety and of a very different topographical nature.

PRCFILE 1

Location: Poyales (Sierra de Gredos). Height: 600 m. Rainfall: 1,640 mm. Average annual temperature: 15.6°C. Very rough topography. Parent material: Fresh granite of two micas (Acid plutonic rocks, geological map of Spain, scale 1:1,000,000) [11]. Vegetation: Reforestation with *Pinus Pinaster*.

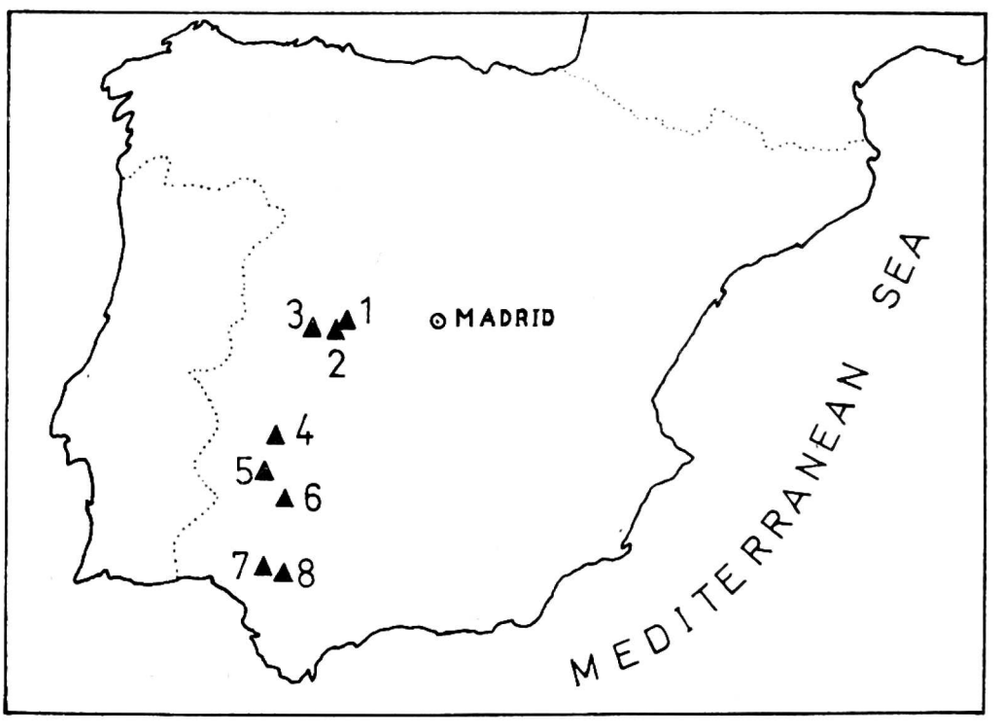


Fig. 1. Location of soil profiles.

Soil horizons

0-5 cm: A_0, dark yellowish brown (10 YR 4/4), sandy, crumby structure, little consistence, rich in organic matter, good drainage.

5-25 cm: A_1, brown (7.5 YR 4/4), sandy, little developed blocky structure, little consistence, aereated, poor in organic matter, good drainage.

25-65 cm: B, red (2.5 YR 4/8), sandy-silt, little developed blocky structure, medium consistence, very poor in organic matter, good drainage.

65-80 cm: B/C, variegated colour, sandy coarse with some silt, little developed blocky structure, medium consistence, good drainage.

〉 80 cm: C_1, highly altered granite.

Micromorphology

0-5 cm: The plasma is rather scarce, shows an intense brown-coloured granulation without any recognizable separations. The humus is mull-like moder. Abundant more or less decomposed plant remains. There is a formation of aggregates of a rather complicated shape, proper of braunerde. Skeleton grains, predominantly allochtonous: Fragments of

igneous rocks: abundant fresh, brown-coloured biotite, with intense pleochroism; muscovite; feldspars without any alteration and chlorite.

5-25 cm: Identical features to the previous sample. Besides fungi hyphae and droppings of small animals are to be found.

25-65 cm: The material has a porphyroskelic fabric [4], the plasma shows an intense reddish granulation without any recognizable separations. Very scarce plant remains. No formation of aggregates, the rate of pore space is reduced, cracks being predominant over cavities [3]. Skeleton grains, autochtonous part such as quartz, micas and microcline, and allochtonous part such as brown biotite (Plate I, 1). Slightly chemical weathering.

65-80 cm: Highly altered original material. Presence of a reddish brown-coloured ferri-argillan cutan which does not show any remarkable birefringence. There are some plant remains.

> 80 cm: Altered parent material (Plate I, 3). Very abundant ferri-argillan cutan of a bright red-colour with strong continuous orientation. We applied the micromorphometric analysis to the 25-65 cm. material, under the same conditions as the remaining profiles. The values obtained were: solid substance % 56.93 (±9.04); mineral part % 25.60 (±7.97). These data are erroneous. The abundance of brown-coloured biotites and feldspars of a rather variable size is the main reason for obtaining a lower value in the mineral part by increasing the solid substance.

PROFILE 2

Location: Arenas de San Pedro — Arroyo Pelayos (Sierra de Gredos). Height: 500 m. Rainfall: 1,550 mm. Average annual temperature: 15.8°C. Very rough topography. Parent material: Altered micaceous slates (Metamorphic rocks, geological map of Spain, scale 1:1,000,000). Vegetation: woodland of *Pinus Pinaster* and *Pteris aquilina*.

Soil horizons

0-25 cm: A, dark brown (10 YR 3/3 moist), silty-sand, crumby, weak consistence, great biological activity, good drainage.

25-35 cm: A/B, yellowish red (5 YR 4/6 moist), sandy-silt, crumby, little consistence, good drainage.

35-110 cm: B, red (2.5 YR 4/8 moist), textural, sandy-clay, subangular blocky little developed structure, medium consistence, good drainage.

> 110 cm: B/C, variegated colour, sandy-clay, the slate properties of the original material being noticeable.

Micromorphology

0-35 cm: The samples studied showed identical characteristics to those of the 25 cm profile 1. In this case, fragments are of fresh micaceous slate.

35-110 cm: There are big isolated parent material fragments which surpass 8×4 mm. They contain unaltered quartz and muscovite, biotite with deep mechanical and slightly chemical weathering. Presence of allochtonous fragments of the original material. Aggregates show an insepic porphyroskelic fabric. The skeleton grains mainly consist of quartz and mica. There are some scarce allochtonous biotites. Plant remains are found.

〉 110 cm: Identical characteristics to the foregoing sample. Main differences are a slight browning of the plasma, a greater quantity of plant remains and the absence of allochtonous minerals.

The parent material is a micaceous slate containing, besides quartz and micas, metamorphic minerals (andalucite). No mechanical alteration can be appreciated but, nevertheless, the material suffered a pseudogleyzation. No biotites can be identified.

PROFILE 3

Location: By Navaconcejo, Jerte river (Sierra de Gredos). Height: 450 m. Rainfall: 1,360 mm. Average annual temperature: 14.3°C. Rough topography. Parent material: Quartzdolerite (Acid plutonic rocks, geological map of Spain, scale 1:1,000,000). Vegetation: Reforestation with *Pinus Pinaster.*

Soil horizons

0-25 cm: Ap, yellowish-red (5 YR 5/6), silty-sand, rather crumby and subangular blocky structure, little consistence, medium drainage.

25-120 cm: B_1, dark red (10 R 3/6), silty-clay, rather prismatic structure transformed into blocks, good consistence, textural horizon with neat clay-skins, medium drainage.

〉 120 cm: B_2, dark red (10 R 3/6) silty-clay, very massive blocks, fewer clay-skins than B_1, black stains of manganese oxide, medium drainage.

Micromorphology

0-25 cm: Anthropic horizon with abundant plant remains, as a rule little decomposed. There are skeleton grains of autochtonous and allochtonous origin. There is a mixture of two contextures, fragments of the material immediately below, reddish with a slight browning, but with plasma separations and brown aggregates where the plasma separations are not visible.

25-120 cm: Material with mo-vosepic porphyroskelic fabric. The magnetite of the parent material is still unaltered. There are some fragments of skeleton crystals deriving from the alteration of pyroxens of the original material. (Plate I, 2 and 4). Feldspars are altered. No allochtonous skeleton grains are noticeable. Ferri-argillan cutan with orientation is frequently to be found.

〉 120 cm: Of the same characteristics as the foregoing material. With the electron microscope[1] the following main components are identified: abundant halloysite, scarce kaolinite, chrysotile and iron in the shape of turite.

The parent material is a quartz-dolerite, the plagioclases being accompanied by a range of pyroxenes; contains magnetite.

PROFILE 4

Location: Villanueva de la Serena (Badajoz). Height 330 m. Rainfall 569 mm. Average annual temperature 17.5°C. Undulated topography. Parent material: Slate (Cambrian). Soils on which *Olea europea* var. *sativa, Triticum, Cicer arietinum...* are grown.

[1] Study done by Dr. J. Alonso.

Soil horizons

0-25 cm: Ap, yellowish red (5YR 4/6), silty-sand, little developed blocky structure, medium consistence, no carbonates, poor in organic matter, good drainage.

25-55 cm: B textural, dark red (2.5 YR 3/6), clayey, prismatic structure transformed into blocks, good consistence, without any carbonates, medium drainage.

〉 55 cm: C, slightly altered slate, with calcium carbonate nodules in contact with the upper horizon.

Micromorphology

0-25 cm: Antropic horizon, the material is mixed, extreme differences being represented by reddish aggregates with masepic porphyroskelic fabric and brown aggregates with skelsepic intertextic fabric.

Autochtonous skeleton grains constituted by fragments of parent material are to be found in a reduced ratio in relation to the allochtonous skeleton ones formed by fragments of quartzite, quartz, feldspars and microcrystalline calcite nodules. Angular allochtonous quartz crystals are predominant, normally 0.62 mm length in comparison with 0.06 mm of the quartz deriving from the original material. There are some plant remains.

25-55 cm: Reddish material with skel-masepic porphyroskelic fabric. Skeleton grains with parent material fragments are predominant over allochtonous grains: quartzite fragments, quartz and feldspars. Absence of calcite. It contains scarce vegetal remains. Cracks predominant over cavities.

〉 55 cm: Very fine grained slate containing quartz, micas and leucoxene. In thin section some ironspots can be seen, caused by the alteration of the rock material such as for instance original ilmenite, and illuviation ferri-argillan cutan with continuous birefringence localized in fissures and on edges. There is some microcrystalline calcite, in a rather reduced proportion also to be found in fissures; colourless crystals are distributed in such a way that they form a zig zag; calcite also proceedes from illuviation.

The ferri-argillan cutan is introduced into the fissures and succeeds in separating fragments of the slate (Plate I, 5a). A close relationship between calcite crystals and the above-mentioned cutan is noticeable on the rock edges. Microcrystalline calcite and the red clay can frequently be found together (Plate I, 5b), an intermediate stage on the way to the dissolution of carbonates. Therefore, we always find a ferri-argillan cutan close together with the original material.

The micromorphometric analysis of the 25-55 cm material shows the following values: solid substance % 76.20 (±7.77); mineral part % 7.90 (±4.92); pore space % 15.90 (±6.68). These soils are classified as rotlehm [10].

PROFILE 5

Location: Campillo de Llerena (Badajoz). Height: 560 m. Rainfall: 450 mm. Average annual temperature: 14.8°C. Topography: very undulated. Parent material: Slate (Silurian). Soils on which *Triticum, Hordeum vulgare, Avena sativa* are grown.

Soil horizons

0-30 cm: Ap, light yellowish brown (10 YR 6/4), stony-silt with quartzite gravel, a good consistence, allochtonous horizon medium drainage.

30-60 cm: B_1, red (10 R 4/6), clayey, angular very developed blocky structure, medium consistence, with very much developed clay-skins, medium drainage.

65-85 cm: B_2, dark red (10 R 3/6), textural as the previous one, clayey, medium developed blocky structure, medium drainage.

〉 85 cm: B/C, variegated colour ranging from dark red (10 R 3/6) to light brownish gray (2.5 Y 6/2), sandy-clay, the slate is rather alterated, medium drainage.

Micromorphology

0-30 cm: Anthropic horizon, the plasma being scarce and the intertextic fabric predominant. The colour is brownish and no separations are to be found. Pore spaces are abundant, sometimes with ferriargillan cutan showing a continuous orientation. Scarce plant remains. Autochtonous skeleton grains are constituted by quartz crystals and big fragments of the parent material, rounded and alterated. The allochtonous skeleton consists of fragments of the fresh original material.

30-60 cm: The material has skel-masepic porphyroskelic fabric. More or less reddish zones are predominant alternating with yellow-coloured plasma. There are iron concretions. The influence of the surface is noticeable in very small zones. Autochtonous skeleton grains are formed by parent material fragments and quartz crystals. Cracks are predominant over cavities.

60-85 cm: Offers identical characteristics to the immediately higher material.

〉 85 cm: Slate much alterated by the effects of pseudogleyzation. When this is very intense a colour ranging from yellowish white to dark red almost opaque is noticeable. The material has omnisepic fabric.

Hor. C_1. The slate contains abundant altered opaque crystals deriving from magnetite. There are fissures with illuviation ferri-argillan cutan showing a continuous birefringence. No calcite can be found. The original material is a slate with scare altered opaques deriving from magnetite. On the edges there is illuviation ferri-argillan cutan with continuous birefringence, in contact with the rock. Microcrystalline calcite also be found in small quantities.

The micromorphometric analysis made with the 30-60 cm material shows the following values: solid substance % 81.66 (±7.06); mineral part % 3.67 (±3.43); pore space % 14.70 (±6.46).

PROFILE 6

Location: Azuaga (Badajoz). Height: 600 m. Rainfall: 480 mm. Average annual temperature: 15°C. Topography: flat. Parent material: Arkose (Tertiary). Soils on which *Triticum, Hordeum vulgare, Vicia faba...* are grown.

Soil horizons

0-20 cm: Ap, yellowish-red (5 YR 4/8), silty-sand, well developed subangular blocky structure, poor in organic matter, medium drainage.

20-60 cm: B, yellowish red (5 YR 5/6), textural, sandy-clay, very much developed subangular to prismatic blocky structure, strong consistence, without calcium carbonate, medium drainage.

〉 60 cm: C_1ca horizon, with calcium carbonate accumulation in the mechanically alterated arkose, good drainage.

200 cm: C, arkose. Contains calcium carbonate.

Micromorphology

0-20 cm: Anthropic horizon with predominant skelsepic intertextic fabric, the colour of the plasma being brown. Skeleton grains consist of slate and sandstone fragments, quartz and feldspars. There is microcrystalline calcite in nodules. The material contains 3.42% $CaCO_3$. There are plant remains.

20-60 cm: Ma-skelsepic porphyroskelic fabric, the plasma being of red coloured. Predominantly allochtonous skeleton grains: quartz crystals, slate, and quartzite fragments. Plagioclases are to be found. Absence of calcite. Scarce plant remains.

〉 60 cm: The original material is predominantly rich in microcrystalline calcite (contains 12.24% $CaCO_3$). On the edges of the rock fragments there is illuviation ferri-argillan cutan. Frequent plant remains. Aggregates with abundant red-coloured plasma and good birefringence and others with scare brown-coloured plasma and little birefringence are noticeable.

200 cm: The arkose contains quartz crystals, scarce feldspars, quartzite and rounded slate fragments. Presence of illuviation ferriargillan cutan with continuous birefringence. The calcium carbonate appears as a small vein (it contains $<$ 1% $CaCO_3$).

The micromorphometric analysis made with the 20-60 cm material shows the following: solid substance % 76.83 (±7.70); mineral part % 12.10 (±5.95); pore space % 11.06 (±5.73).

On Fig. 2 the distribution of the different components can be seen. The heavy fraction (sp. gr. 〉 2.9) of detritic minerals between 0.2-0.5 mm, contains the following percentages of epidota associated with zoisite: hor. Ap — 81%; hor. Bt — 80%; hor. C_1ca — 82%; hor. C — 80% [2].

PROFILE 7

Location: Sanlúcar la Mayor (Sevilla). Height: 120 m. Rainfall: 500 mm. Average annual temperature: 19.6°C. Topography: slightly undulated. Parent material: Sandy marl (Miocene). Soils on which, *Vitis vinifera, Olea europea* var. *sativa* and *Citrum aurantium*... are grown. Natural vegetation of *Olea europea* L. and *Ceratonia siliqua* L. [9].

[2] Study done by Dr. J. Pérez Mateos.

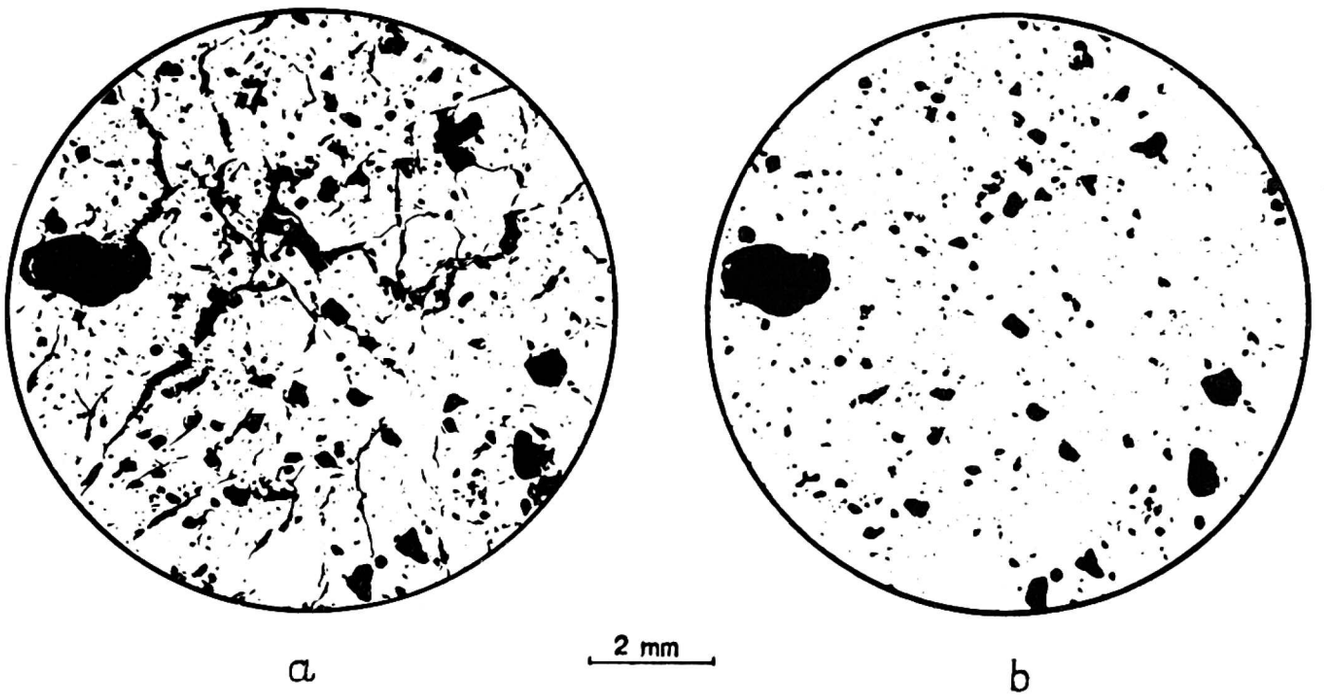


Fig. 2. Bt horizon of profile 6. *a* — structure photogram; mineral grains and pore space are shown in black, *b* — mineral photogram; mineral grains are shown in black.

Soil horizons

0-60 cm: Allochtonous, brown-reddish coloured, sandy, no structure development, with calcium carbonate.

60-80 cm: B, red (2.5 YR 4/7), textural, silty, very much developed prismatic structure, good consistence, decarbonated, good drainage.

80-90 cm: B/C, red (2.5 YR 5/6), sandy-silt, subangular blocks, medium consistence, with carbonates, good drainage.

〉 90 cm: C, sandy marl, very little consistence, good drainage.

Micromorphology

60-80 cm: Skel-masepic porphyroskelic fabric. The plasma is red-coloured. Skeleton grains are constituted by abundant quartz and feldspar crystals of the same size and shape as the original material. Cracks predominant over cavities.

80-90 cm: Scarce plasma separations. Slate and sandstone fragments are found, there is also microcrystalline calcite nodules.

〉 90 cm: Sandy marl. Contains 66.5% $CaCO_3$.

PROFILE 8

Location: Alcalá de Guadaira (Sevilla). Height: 60 m. Rainfall: 500 mm. Average annual temperature: 19.6°C. Topography: rolling. Parent material: Calcareous sandstone (Miocene) [12]. Vegetation: Reforestation with *Eucalyptus*. Natural vegetation of *Olea europea* L. and *Ceratonia siliqua* L.

Soil horizons

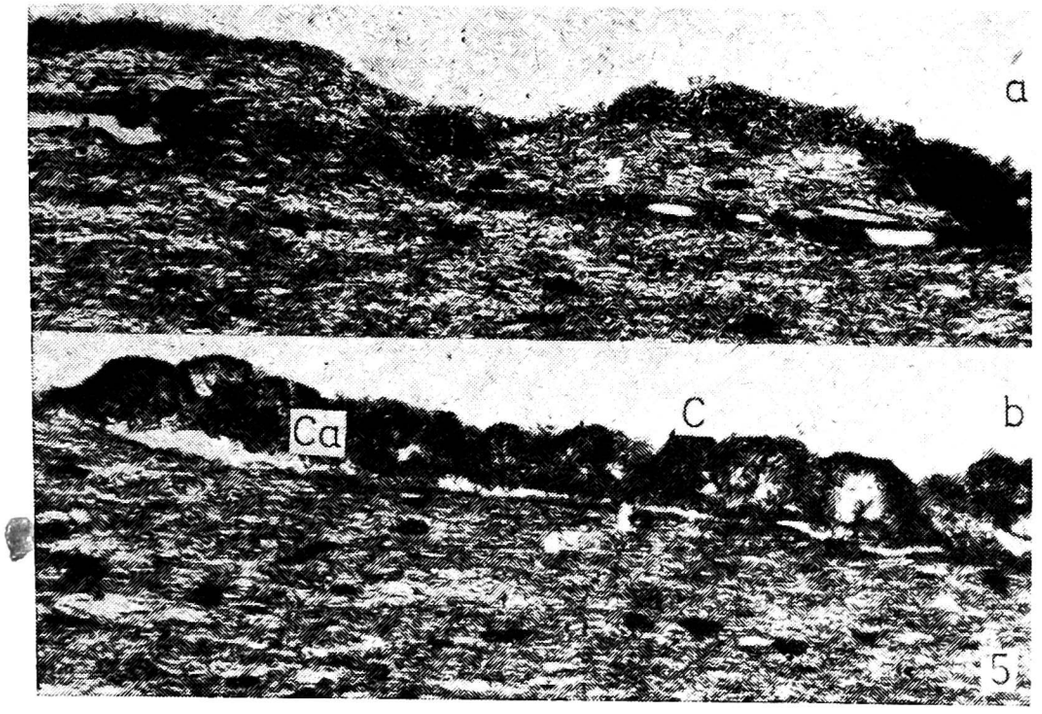
0-50 cm: B_1, red (10 R 4/6), coarse sandy, little developed blocky structure, little consistence, decalcified, very good drainage.


C
Mag 2
F
P


4


1
Bw
B


3
B
C



1. Thin section of B horizon, profile 1. Biotite (B); altered biotite (Bw). ×50. 2. Thin section of B_2 horizon, profile 3. Skeleton crystals of pyroxene (P); magnetite (Mag); altered feldspar (F); ferri-argillan with strong continuous orientation (c). ×50. 3. Thin section of C_1 horizon, profile 1. Exfoliated, weakly weathered biotite (B); ferri-argillan with strong continuous orientation (c). ×50. 4. The same as No. 2 under crossed nicols. 5. Thin section of C horizon, profile 4: *a* — the ferri-argillan cutan succeeds in separating rock fragments, *b* — microcrystalline calcite (Ca); ferri-argillan cutan (C). ×143. 6. Thin section of C horizon, profile 8. Quartz (Q), glauconite (G) and fragments of fossils (Fos). ×50.

50-85 cm: B_2, red (10 R 4/6), coarse sandy, better structured than the foregoing one, little consistence, decalcified, good drainage.

〉 85 cm: C. Calcareous sandstone.

Micromorphology

0-50 cm: Insepic porphyroskelic fabric, red brownish-coloured plasma. The skeleton grains are autochtonous, formed by quartz crystals of the original material.

50-85 cm: Skel-masepic porphyroskelic fabric, the plasma being reddish-coloured. The skeleton grains are autochtonous. The quartz is accompanied by glauconite and both have the same shape and size as the original material. Scarce vegetal remains. Cavities are predominant over cracks.

〉 85 cm: Calcareous sandstone of *Alcor*, containing rounded quartz grains, glauconite and fossiles, mainly of the *Pelecypoda* Class (Plate I, 6).

The micromorphometric analysis made with the 50-85 cm. material shows: solid substance % 43.46 (±9.05); mineral part % 32.30 (±8.54); pore space % 24.23 (±7.82). These soils have been classified as leached red soils on calcareous sandstone [26].

DISCUSSION OF RESULTS AND CONCLUSIONS

We have seen that the morphology and micromorphology of red Mediterranean soils in Spain is rather varied and complex. In Table we show the most significant properties of B horizons in these soils and their classification.

The profiles examined in the Sierra de Gredos (Nos. 1, 2 and 3) show some common characteristics. They are located on a place with a rough topography, the 25 cm top material being allochtonous.

The B horizon of profiles 1 and 2 belongs to rotlehm sediments placed over the B/C horizon of a fossil rotlehm whilst the profile 3 corresponds to a relict rotlehm [15].

The existence of truncated rotlehm profiles in the Sierra de Gredos fossilized by the actual climax formation, has been widely commented upon [1, 2, 16-18]. Nevertheless, there does not exist any unanimous opinion as to their age although all authors coincide in that they are paleosoils.

The rotlehm micromorphology [14] does not conform to the characteristics studied at the beforesaid profiles. We think it might be suitable to avoid the denomination of rotlehm although, at present, we cannot give any other classification. The B horizon of the red soils studied in Gredos is characterized by a low degree of saturation, sandy-loam to silty-clay texture, an acid pH, a little bright plasma, a scarce or null birefringence and porphyroskelic fabric. The chemical weathering process is slight.

The B horizon of profile 5 has an acid pH and likewise a low degree of saturation identical to that of the group of soils from the Sierra de

Table. Some characteristics of B horizons and soil classification

Profile	Colour	Clay (%)	pH	$\frac{S}{T}$ 100	Micromorphometric structure analysis				Classification
					Solid substance	mineral grains	pore space	fabric [4]	
1	red (2.5 YR 4/8)	18.40	5.0	6.0				plasma separations no recognizable porphyroskelic	Rotlehm sediment [15] Rhodudult [27] Groupe fersiallitique sans reserve calcique, Sous-groupe hydromorphe [5]
2	red (2.5 YR 5/6)	30.85	6.1	40.7				insepic porphyroskelic	Rotlehm sediment [15] Rhodudult [27] Groupe fersiallitique sans réserve calcique, Sous-groupe hydromorphe [5]
3	dark red (10 R 3/6)	42.93	5.2	31.0				mo-vosepic porphyroskelic	Relict rotlehm [15] Rhodudult [27] Groupe fersiallitique sans réserve calcique, Sous-groupe hydromorphe [5]
4	dark red (2.5 YR 3/6)	60.05	7.1	85.7	76.20(±7.77)%	7.90(±4.92)%	15.90(±6.68)%	skel-masepic porphyroskelic	Rotlehm [19] Rodhoxeralfs [27] Groupe fersiallitique à réserve calcique, Sous-groupe modal avec horizon Cca [5]
5	red (10 R 4/6)	74.87	4.9	40.7	81.66(±7.06)%	3.67(±3.43)%	14.70(±6.46)%	skel-masepic porphyroskelic	Pseudogley braunlehm [19] Rhodudult [27] Groupe fersiallitique sans reserve calcique, Sous-groupe hydromorphe [5]
6	yellowish red (5 YR 5/6)	45.80	7.6	85.0	76.83(±7.70)%	12.10(±5.95)%	11.06(±5.73)%	ma-skelsepic porphyroskelic	Rotlehm [19] Rodhoxeralfs [27] Groupe fersiallitique à réserve calcique, Sous-groupe modal avec horizon Cca [5]
7	red (2.5 YR 4/7)	52.51	7.4	89.4				skel-masepic porphyroskelic	Terra rossa [14] Rodhoxeralfs [27] Groupe fersiallitique à réserve calcique, Sous-groupe modal avec horizon Cca [5]
8	red (10 R 4/6)	26.00	7.2	72.0	43.46(±9.05)%	32.30(±8.54)%	24.23(±7.82)%	skel-masepic porphyroskelic	Earthy terra rossa [14] Rhodoxeralf [27] Groupe fersiallitique à réserve calcique, Sous-groupe modal avec horizon Cca [5]

Gredos. Nevertheless, the birefringence between crossed nicols is quite different.

The B horizon of profiles 4, 6 and 7 is characterized by a high degree of saturation, clayey texture, neutral to slightly alkaline pH, peptized plasma [13], good birefringence, masepic or skelsepic porphyroskelic fabric. The chemical weathering process is slight, this observation agrees with that made by other authors [7]. Cracks predominate over cavities.

Although the micromorphology of the surface part (profiles 4 and 6) is little significant — as they are cultivated soils — it is browned and contains small quantities of calcium carbonate; it corresponds to browned rotlehm [19].

Finally, the B horizon of profile 8 has an identical pH value, degree of saturation and fabric to the last above-mentioned profiles. Nevertheless the nature of the original material is mainly reflected in a high percentage of the mineral part in the micromorphometric analysis.

The examination of the original material and the skeleton grains throughout the profile has been partly made to find out whether the red soils are allochtonous or autochtonous.

We consider the profiles studied as autochtonous although we admit that except profiles 3, 5, 7 and 8, the B horizon of the remaining profiles has a more or less intense allochtonous contribution. As to profiles 1 and 2, in view of the topography, we think that the rotlehm sediment has a very near origin, coming from the top of the mountain so that in this sense it appears to be possible to include it into the autochtonous soils.

In profile 6 the micromorphology of the material > 60 cm permits to suppose that the B horizon is perhaps a rotlehm sediment. Nevertheless, we feel inclined to think that the soil is autochtonous based on the fact that the profile has been taken from a very reduced area, with tertiary outcroppings, and that in the B horizon we found the original material, quite apart from the great homogeneity shown by the heavy fraction of the detritic minerals in the profile.

To study the alteration of the original material during the rubification process, we have chosen granite, slate and quartzdolerite from the area of Gredos. The quartz contains ferri-argillan cutan mainly caused by illuviation in its fissures, with continuous birefringence. The biotite is found partly colourless, the pleochroism becomes very weak or even disappears, partly darkened with iron oxydes [24], or partly transformed into chlorite. Its mechanical weathering is very marked.

In the feldspars, alterations vary between plagioclases and microclines. The surface occupied by the former appears as reddish area which among crossed nicols does not show any optical continuity. Pyroxenes, extending from pigeonite to subcalcium augite, are reduced to a surface with irregular outline formed by several cleavage fragments from the original crystal with ferric hydroxides [6].

In the Badajoz slate (profile 4) the illuviation ferri-argillans break up the material. The presence of microcrystalline calcite on the edges is outstanding in a process united to the existence of the beforesaid cutan.

The original material of the red soils is sometimes affected by a pseudogleyzation (profiles 2 and 5).

In calcareous rocks the calcium carbonate is dissolved. The glauconite is not affected.

SUMMARY

Eight representative soil profiles are selected in order to study the micromorphology of Spanish Mediterranean red soils. These soils offer a red coloured B_t horizon as a common character, the colour varies from dark red to yellowish red showing mainly 2.5 YR hues.

The parent materials are silicate or calcareous rocks. The age of the soils is different. They are paleosoils which have undergone intense rubefication.

In the Spanish red soils generally the B horizon has rotlehm fabric according to Kubiëna or skel-masepic porphyroskelic fabric according to Brewer. In the upper part of the profile we generally have earthy rotlehm fabric.

Special attention is paid to micromorphometrical investigations and to the investigation of skeleton grains.

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