MICROMORPHOMETRY OF VOIDS IN OLIVE GROVE SOILS

by

[1] Dorronsoro, C.; Ortega, E.; Sierra, C. and Delgado, M.

This paper covers a wider study performed by us on the micromorphometry of existent and developped soils under olive grove. In it we try to establish the possible relation between porosity and soil fertility. We consider it justified on the basis that the cultivation of the olive grove is the most extensive one in our region (64.000 hectares in the province of Granada alone).

From the 39 sampled soils, this report includes the measurement for 6 of the most representative ones. The measurements that have been reproduced belong to Ap horizons and correspond with levels located at depths most affected by cultivation and labour tasks.

The main characteristics of these soils are summarized in Table I. A more complete study of these as well as for the other 33 soils may be found in the works of Sierra and Delgado (1970) and Sierra (1971).

MEASURING EQUIPMENT UTILIZED

Microvideomat equipment (Carl Zeiss) was utilized. This apparatus work in principle along the same lines like other automatic image analysis systems. The optic producing sistems of the image for the Microvideomat was a photomicroscope II Pol from Carl Zeiss.

MEASUREMENT TECHNIC

The measurements of porosity were made using a positive-negative photo approach. It is a sophisticated photographic procedure resulting from the experiences of Lafe-

(1) Departamento de Edafologia, Facultad de Farmacia, GRANADA

MICROMORPHOMETRY OF VOIDS

SOIL		1	10	12	22	33	36
Gavel	Abundance	++	-	(+)	+++	++	++
	Mineralogy	Carbonates	-	Quartz	Gypsum	Carbonates (Chalcedony)	Chalcedony
Coarce Sand	%	3	46	7	(1)	28	18
	Mineralogy	Carbonates (Quartz)	Quartz	Quartz (Carbonates)	Gypsum	Carbonates (Chalcedony)	Chalcedony (Quartz)
	Fine Sand %	11	34	8	(1)	9	13
	Silt %	25	1	50	(14)	10	8
	Clay %	60	16	35	(46)	50	60
Plasma	Abundance	+++	(+)	++++	++	+++	+++
	Transparency	Weak	Weak	Mean	Mean	Nil	Weak
	Birefringence	Mean	Nil	High	Mean	Weak	Mean
	Plasmic	Argillasepic (Crystic)	Innoskelsepic	Insepic	Crystic	Argillasepic (Crystic)	Masepic Argillasepic Insepic
	Related Distribution	Porphyroskelic	Intertextic	Porphyroskelic	Porphyroskelic	Porphyroskelic	Porphyroskelic

Voids	Abundance	++++	++	++	++	++++	++++
	Types	Compound paking voids	Paking voids	Vughs Planar voids	Vughs Planar voids	Compound paking voids	Compound paking voids
Fe-Mn Nodules		+++	+	++	-	+++	++
Organic Matter	%	0,80	1,05	1,64	0,70	1,05	1,36
	C/N	8,88	10,32	9,41	8,63	10,15	8,97
	Roots	+	(+)	+++	+	++	(+)
	Structure	Crumb	Crumb	Crumb	Subangular blocky	Crumb	Subangular blocky
Parent Materials		Carbonate Conglomerate	Sandstone	Marl	Gypsum Marl	Carbonate Conglomerate	Limestone
Profile	Horizons	A_p-B2-C1Ca-C2	A_p-B21t-B22t	A_p-B2-C	A_p-AC-C	A_p-B2 C1-R	A_p-B1-B2t
	Solum depth	60	60	60	80	40	45
	Soil type	Calcic Xerochrept	Typic Palexeralf	Calcic Xerochrept	Salorthid	Eutric Xerochrept	Typic Palexeralf
	Location	Valderrubio	Loja	Moraleda de Zafayona	Ventas de Huelma	Iznalloz	Iznalloz
Olive grove age		16	100	100	40	65	45
Olive productivity Kg/Olive		25	32	10	5	37	27

Table I Some characteristic of these soil studied.

ber and Kurbanovic (1965) and Jongerius et al. (1972 b).

Our work has been done as follows : a) the photos were taken on a 1:1 scale ; b) the photographic equipment used was a Tessovar from Zeiss fitted with a 35 mm photographic camera onto which a polarizer and analyzer were added; c) the crossed nicoles negative were taken with seven superimposed exposures, turning the nicoles 15º for each one; d) in our case the positive was established through contact by using a strip of photographic film; e) the positive-negative photographic ensemble was measured by transparency.

The figuring out of the total area for the existing pores on the measuring screen is read out in a direct manner, but the distribution of the total area in its fractions, according to size, requires a lengthier procedure (Jongerius et al. , 1972 a, 1972 b).

RESULTS AND DISCUSSION

Mean values obtained in the measurements of porosity for the six soils under study are resumed in Table II. These measurements confirm that soils 10, 12 and 22, present very low percentages of porosity; the areas most abundant in them correspond to the pores with diameters ranging from 75 to 275 microns. On the other hand, soils 33, 1 and 36 reflect porosity values that are quite higher, these areas being at all times larger than the soils in the former group, on all sizes of pores considered; in these soils the most abundant areas are those corresponding to larger pore sizes (over 275 microns in size). In the case of soil 33, the larger pores (over 1500 microns) are those that have the larger areas.

Fig. 1. Is representative of the accumulative curves corresponding to the pore size distribution of these soils. Outstanding is the similarity existing between soils numbers 10, 12 and 22 on the hand, and numbers 1, 33 on the other.

PORE SIZE \ SOILS	1	10	12	22	33	36
< 30 µ ‰	2.7	3,0	2,2	1,7	3,6	1,9
30-75 µ ‰	10,4	9,1	7,7	5,6	9,0	7,5
75-150 µ ‰	22,9	15,5	14,8	9,3	19,2	17,3
150-275 µ ‰	33,2	15,4	15,9	10,5	28,1	26,7
275-525 µ ‰	55,6	16,2	17,1	13,2	52,2	44,9
525-1.000 µ ‰	45,2	6,9	10,7	7,4	57,2	43,0
1.000-1.500 µ ‰	22,8	0,7	2,6	3,4	35,2	24,1
> 1.000 µ ‰	16,8	-	1,5	8,6	56,6	23,7
Total Area	221,0	75,7	80,2	65,3	260,2	193,8
Intersecpts	2299	1654	1315	1023	2374	1876
Intersecpts /475	4,8	3,5	2,8	2,1	5,0	3,9
Absolute error	16,1	8,9	8,2	6,0	11,4	9,5
Relative Error	-	11,7	-	-	-	-

Table II. Resumen on the mean values for the total area, intersecpts and for the partial areas corresponding to the pore size distribution.

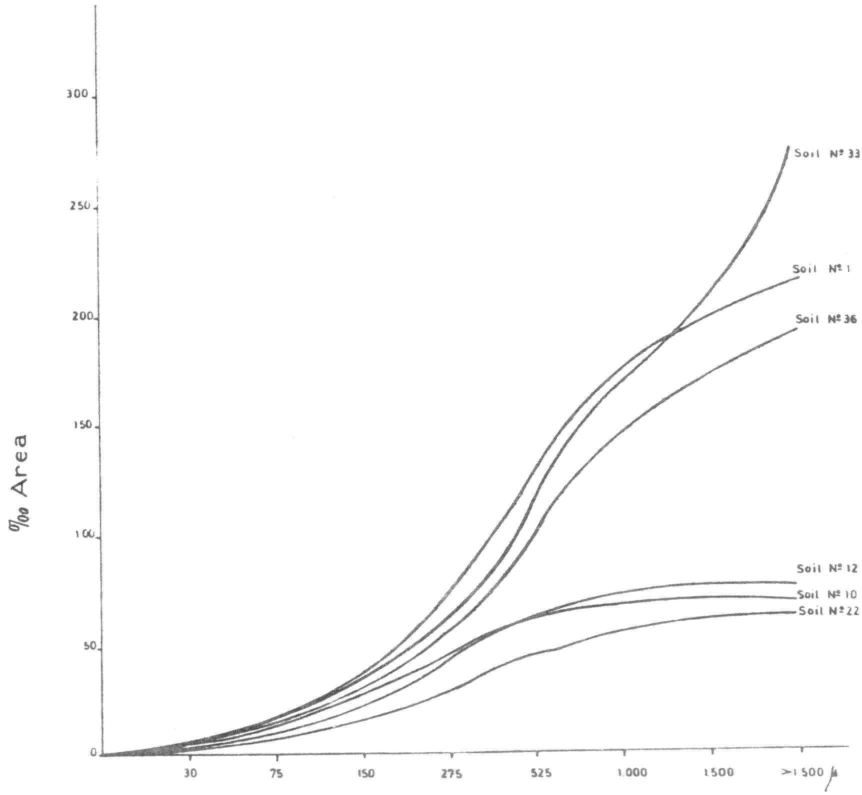

Fig. 1. Accumulated curbs of the mean values for the partial areas on the six soils behing revued.

According to the graphic classification advanced by Jongerius (1972 a, 1972 b), there is another way in which the porosity values may be represented. It consists in a classification of void patterns wherein the porosity measurements for each soil are represented by virtue of their coordinated values of area and intercepts (number of intercepts for each T.V line). Thus, the types of pores are included in a series of categories according to their area and to the structural complexity of each field.

This classification of voids patterns is most illustratibe but can only be applied to the measurements taken with identical magnification of work, for, when these change, the values for the areas and the intercepIts will also undergo a change on a different scale.

In Fig. 2. we reproduce a diagram considered by us as the most suited to represent the soils measured in the research work we have done. (31 , 2 magnifications on the monitor display) i.e. using an objective x 1 optovar in position x 1.25 and the x 25 on the T.V. system and employing a 475 line square T.V. display for measurement.

As a limit to the various rhomboidal spaces utilized ; we have on the one side, the equidistant line of the axis of ordinates and absissas (adding to 45º) in such a manner that over them is located the region in which the value of the intercepts predominates over the one of the areas, i.e. the zone of pores irregular in size (or also for the fields containing large and small numbers of pores), and on the other side, the line that runs through the origin of the coordinators, represents the pores in which the areas are more important then the intercepts. Thus, we shall be dealing with pores simple in form, fields with few pores and with more or less circular perimeter .

For the other limit we have selected a line which is the geometric spot of the pores, of different sizes, completely circular in form.

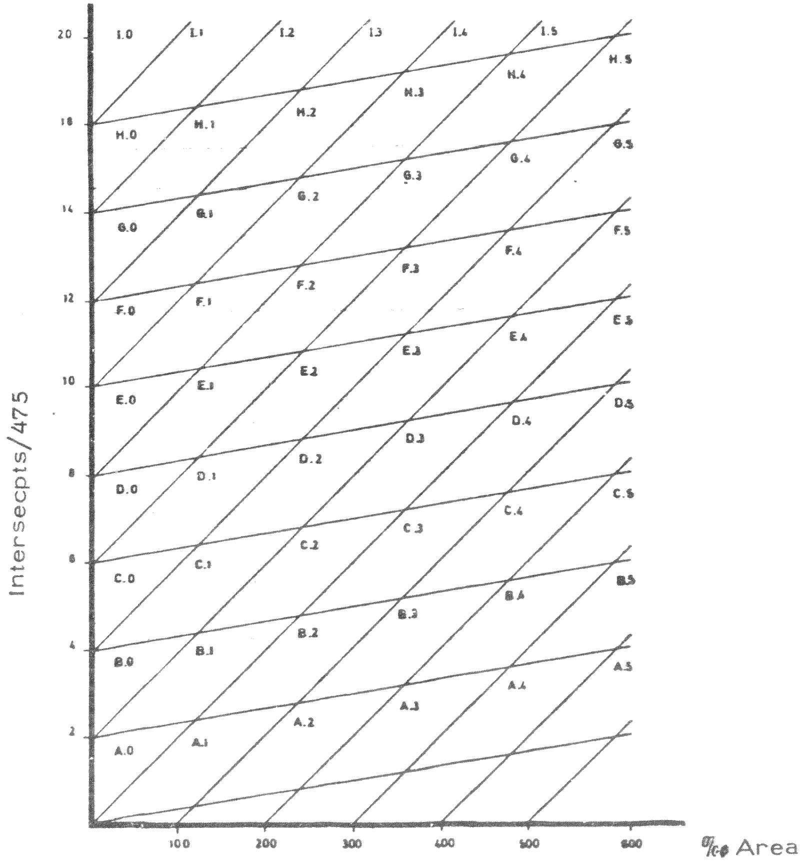

Fig. 2. Propcsed patent for graphic classification of pores

The diagram therefore is made to agree wiht a series of rhomboidal spaces which form rows A, B, C, D.......... and correspond to a magnification of the Intersecepts, while inside a row, classes 1, 2, 3, 4..... represent fields with pores each time larger, the form of these holding on to general lines. Consequently, the lower row will delimit for us the region of the soil surveyed, while the evolution of the soil is patent as we keep entering into rows gradually becoming higher.

In Fig. 3. we show the characteristics of the voids patterns corresponding to each one of the spaces or selected categories.

Although it becomes quite clear that with these graphic classifications only wholly comparable values will be kept so long as these same work conditions are maintained, we believe that this proposed diagram is also valid for the micromorphometric measures performed with other different magnifications to those employed in this work. The results between measurements taken with different magnifications may be compared if we keep in mind the following conditions to find the value of the ordinates which represent the intercepts:

1) using a display of any given size, but it must always be a square one; 2) to divide the number of intercepts read into the number of T.V. lines present of the display; 3) to multiply the number thus found by the quotient by the magnifications of the two measurements that are to be checked. Through experiment we have discovered that the number of intercepts varies proportionally upon modifying the magnifications.

In regard to the values for the areas which are represented in absissas we have experimentally compared that so long as the magnification difference is not excessive these values remain approximately unaltered.

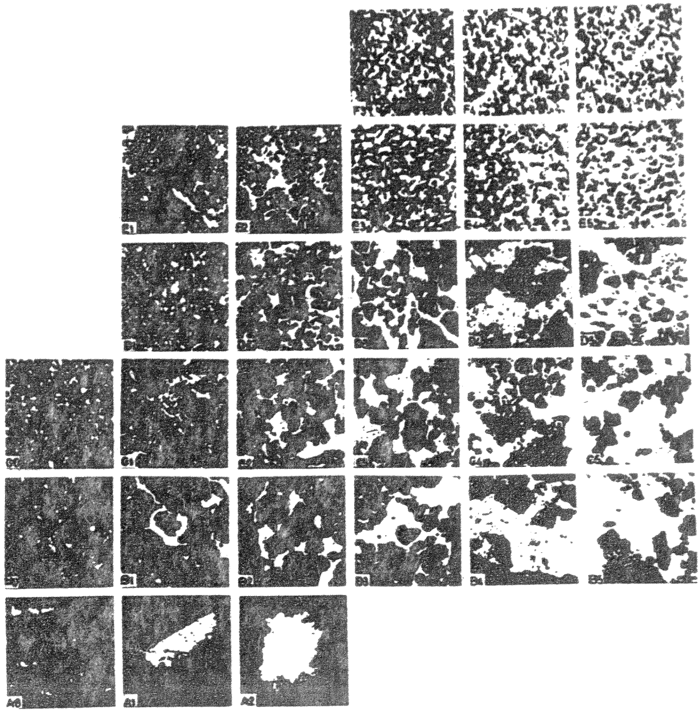

Fig. 3. A few examples of types of porosity corresponding to each of the classes established in Fig. 2.

In Fig. 4 to 9. we show the way in which the measured fields are represented in this diagram for this work for the six soils under study.

An examination of this figure reveals the extraordinary likeness of the voids in soils 12 and 22 on the one had, and of soils 1 and 33 on the other.

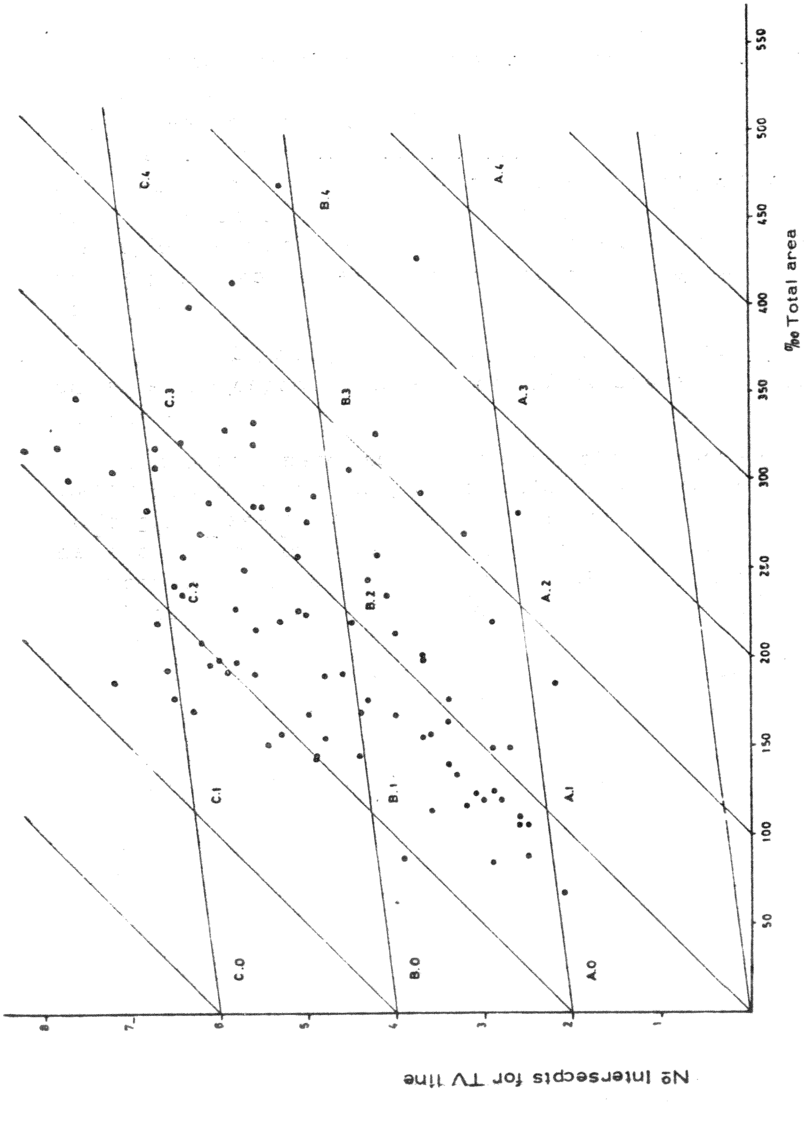

Fig. 4. Classes of porosity on the fields measured for soil: 1

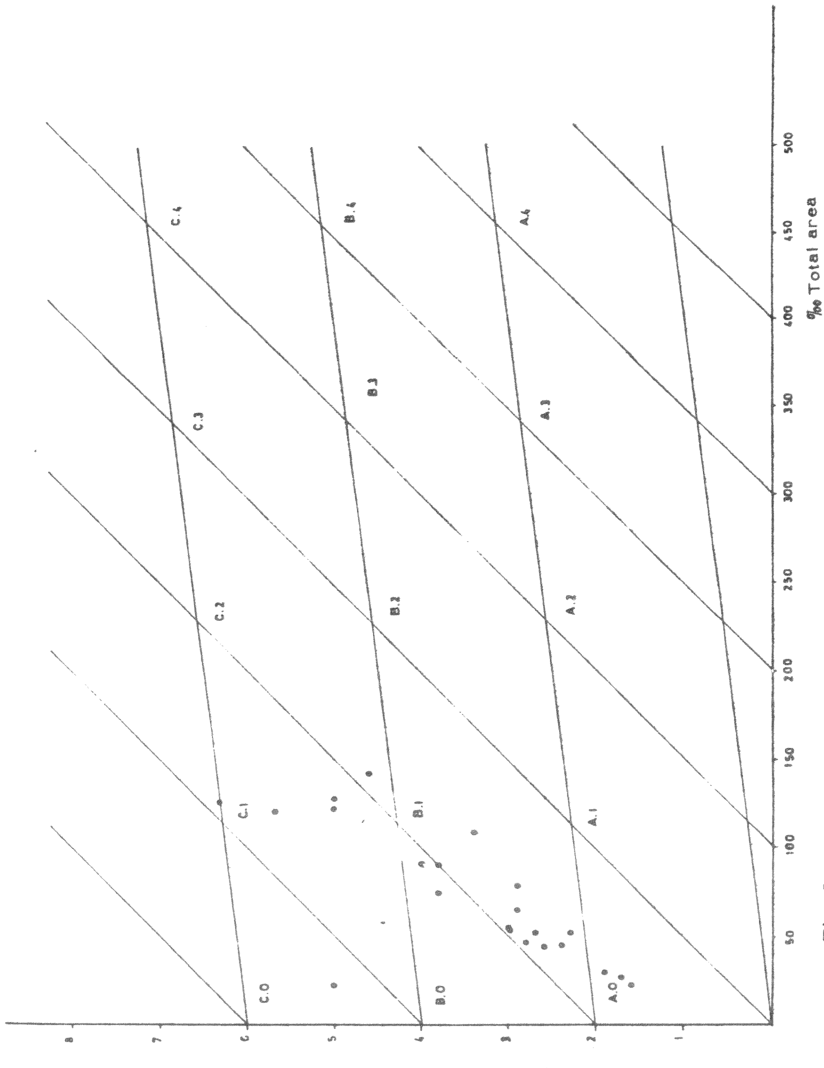

Fig. 5. Classes of porosity on the fields measured for soil 10.

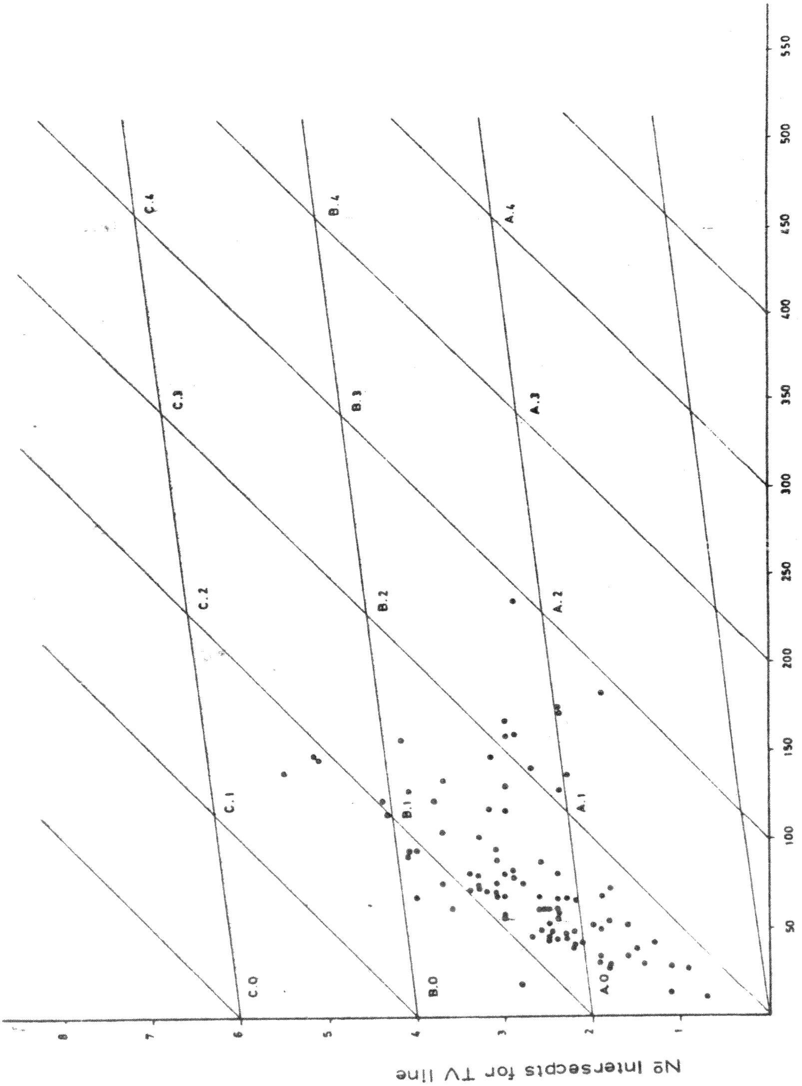

Fig. 6: Classes of porosity on the fields measured for soil 12.

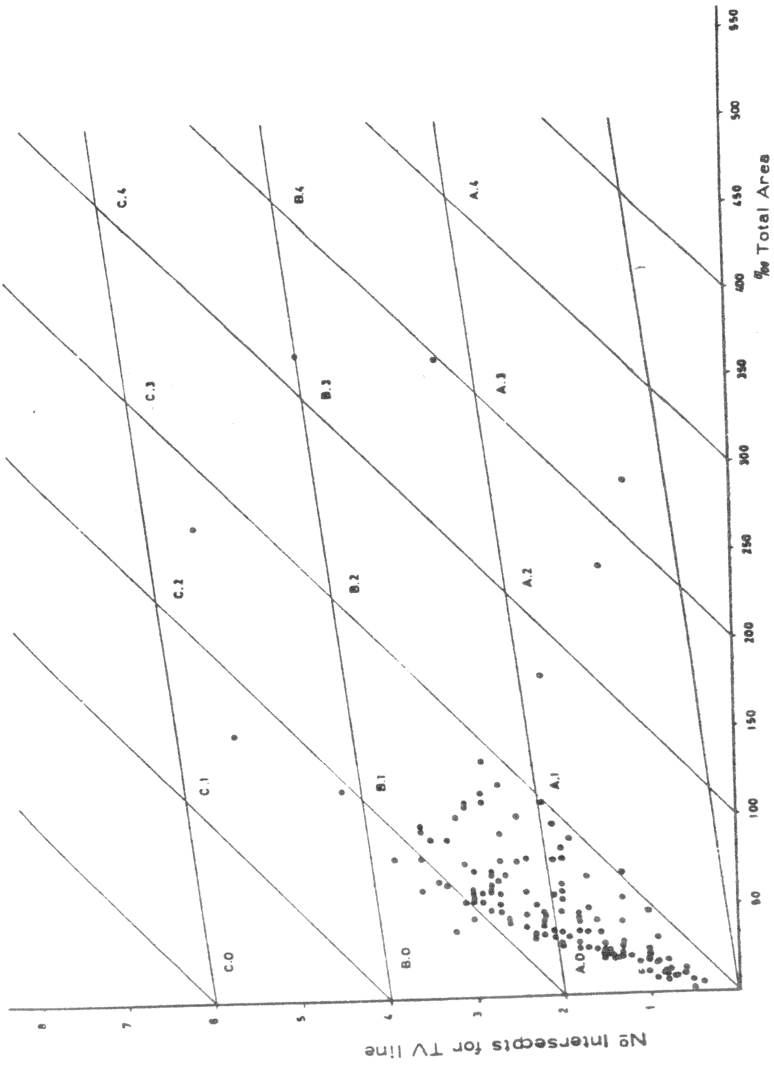

Fig. 7, Classes of porosity on the fields measured for soil 22,

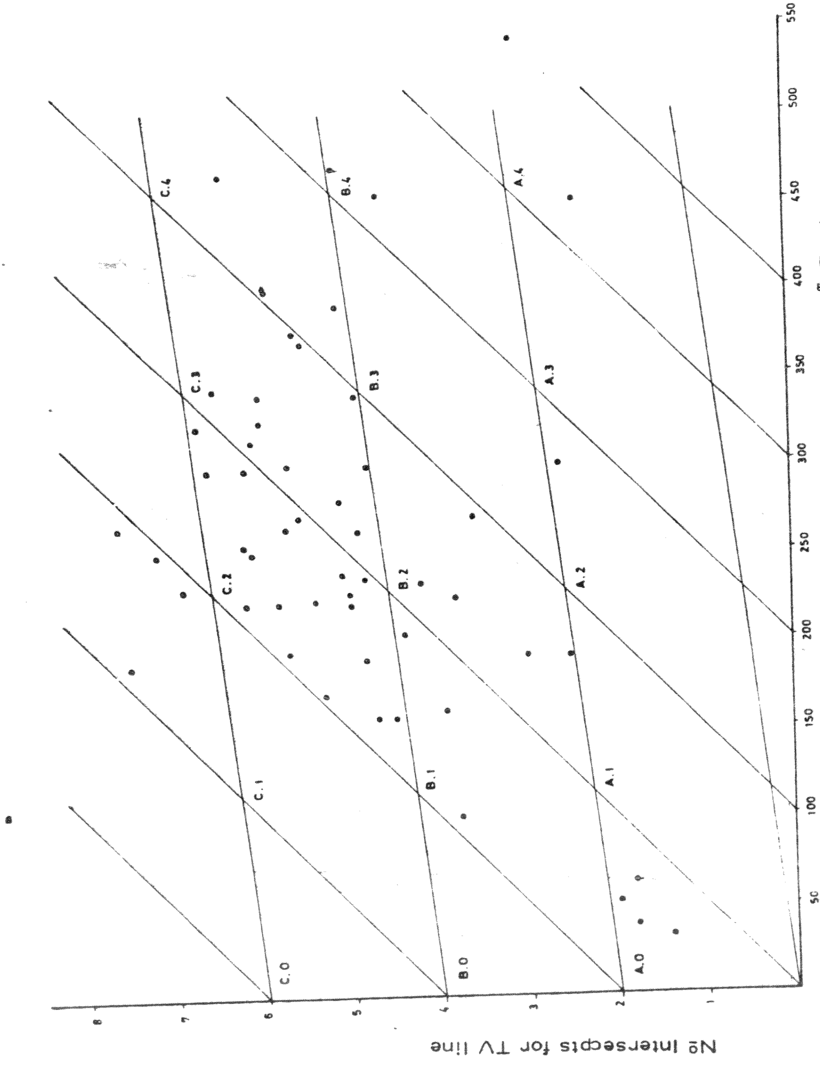

Fig. 8. Classes of porosity on the fields measured for soil 33.

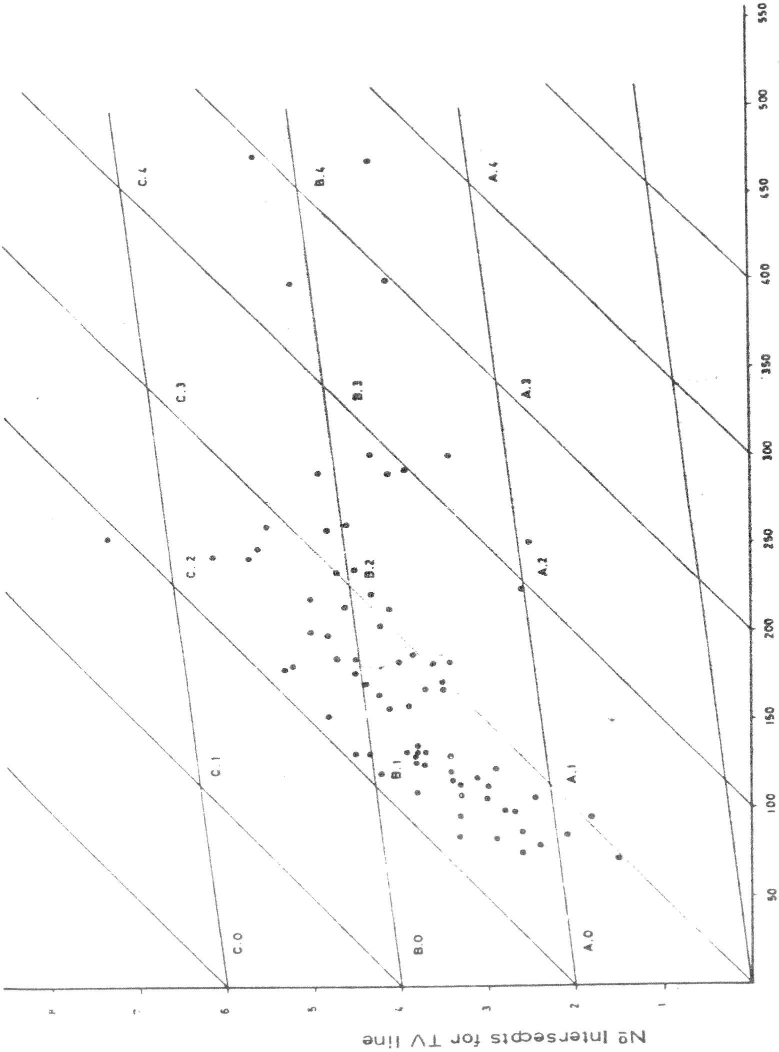

Fig. 9. Classes of porosity on the fields measured for soil 36.

Soils 12 and 22 present a type of voids, very homogeneous of a simple form and are small in size. The pores in soils 1 and 33, on the contrary, present the fields of a larger heterogeneity as far as the existent types of voids is concerned. The present, in general, a value for areas of medium height and of a medium structural complexity.

Soils 36 and 10 present an intermediate grade of heterogeneity between the two pairs under consideration. Finally, soil 10 seems to present voids very small in size and a medium complexity.

Table III shows the frequencies of the related classes for the different types of porosity covering each soil. The classes most represented in these soils pertain to diagonal AO, BI, C2, class BI being the one most widely represented for 5 of the soils under study. On soil 1, the only classes represented with a percentage higher than 10 % are BI, B2, C2 and C3; classes AO, BI, and C1 for soil 10 ; AC and BI for soils 12 and 22; C2 and C3 for soil 33; and BI, B2 and C3 for soil 36. As we see, within the logical heterogeneity of the soils, none of these present more than 4 classes of pores with a frequency higher than 10 %. Only six classes, AO, BI, B2, CI, C2 and C3 exceed this percentage.

In Fig. 10-15. that follow we show a series of related photographs. Four varieties for each one of the classes most representative of these soils.

Finally, it is interesting to point out that in Ap horizon of soils under study, it is difficult to establish relations between the porosity values obtained and the grade of evolution of these soils. Therefore, starting out from porosity values, we have found a great similitude between a typic palexeralf (soil number 10), a calcic xerochrept (soil number 12), and a salorthid (soil number 22) on the one hand and a typic palexeralf (soil number 36) by an eutric

SUELOS	A.0	A.1	A.2	A.3	A.4	A.5	B.0	B.1	B.2	B.3	B.4	B.5	C.0	C.1	C.2	C.3	C.4	C.5	D.0	D.1	D.2	D.3	D.4	D.5
1	1,1	1,1	1,1	-			1,1	21,7	12,0	3,3	1,1			8,7	23,9	12,0	1,1	1,1			4,3	6,5		
10	13,6						9,1	5,0					4,5	18,2	4,5									
12	19,6	4,3					7,6	56,5	6,5					4,3	1,1									
22	51,8	1,4	0,7	0,7			5,8	36,5		0,7				1,4	0,7									
33	7,3		1,8		3,6			5,4	9,1		3,6				34,5	20,0	7,3				7,3			
36	2,7	1,3	1,3					49,3	12	2,7	1,3				22,7	2,7	2,7				1,3			

Table III. Class frequencies concerning the different kinds of porosity as established for the six soils under study.

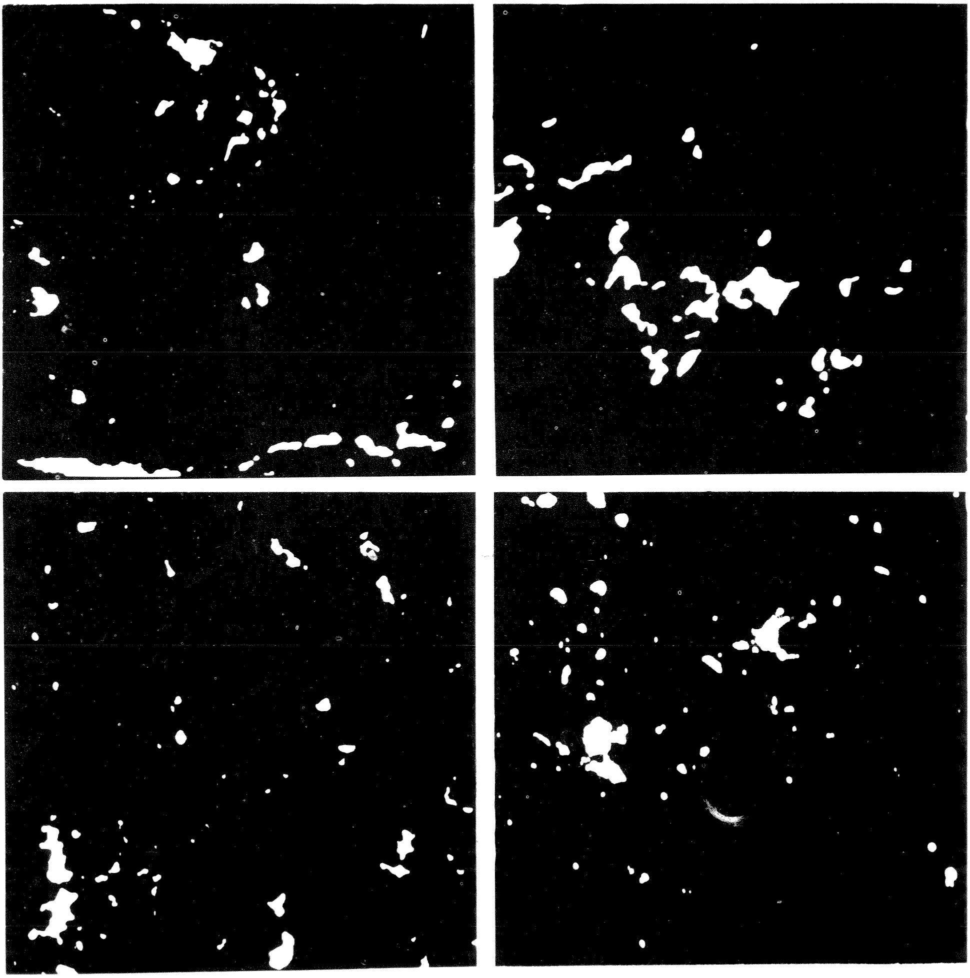

Fig. 10. Examples (or patents) of porosity for class AO.

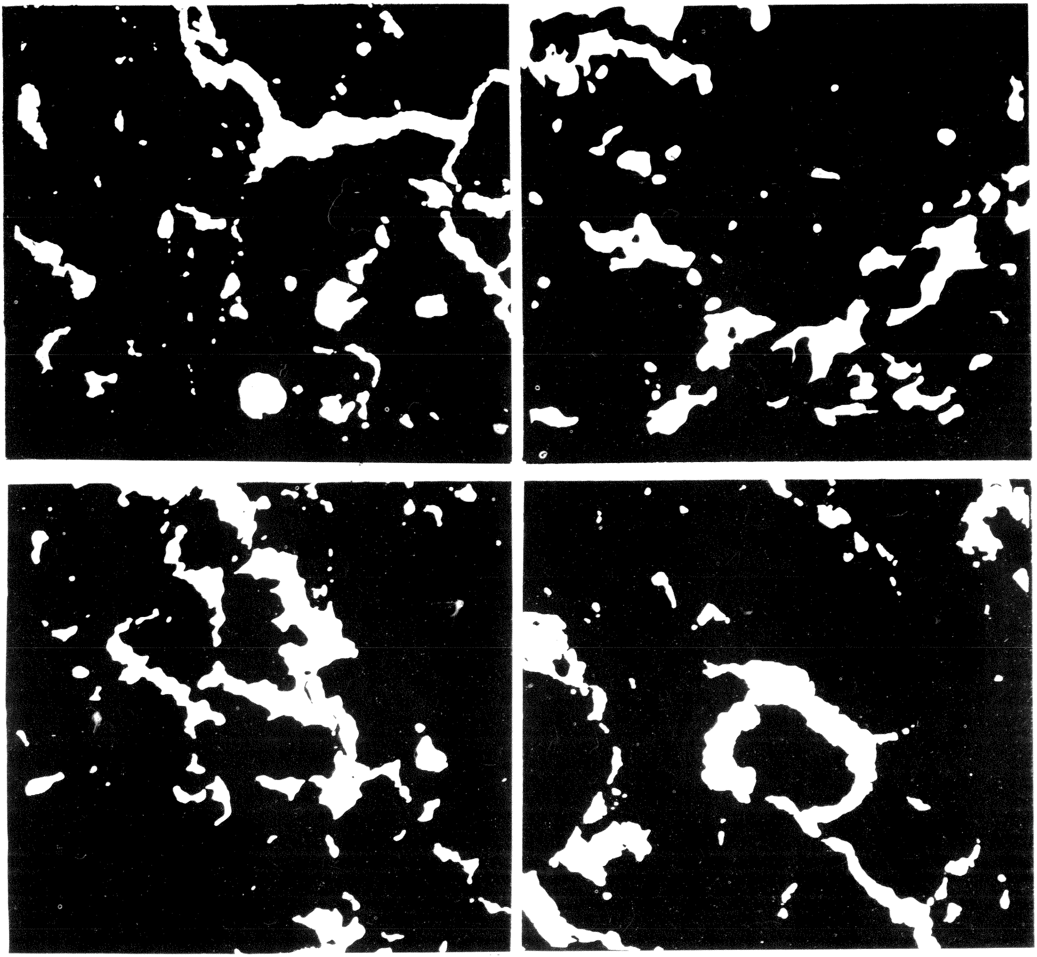

Fig. 11. Examples (or patents) of porosity for class B. 1.

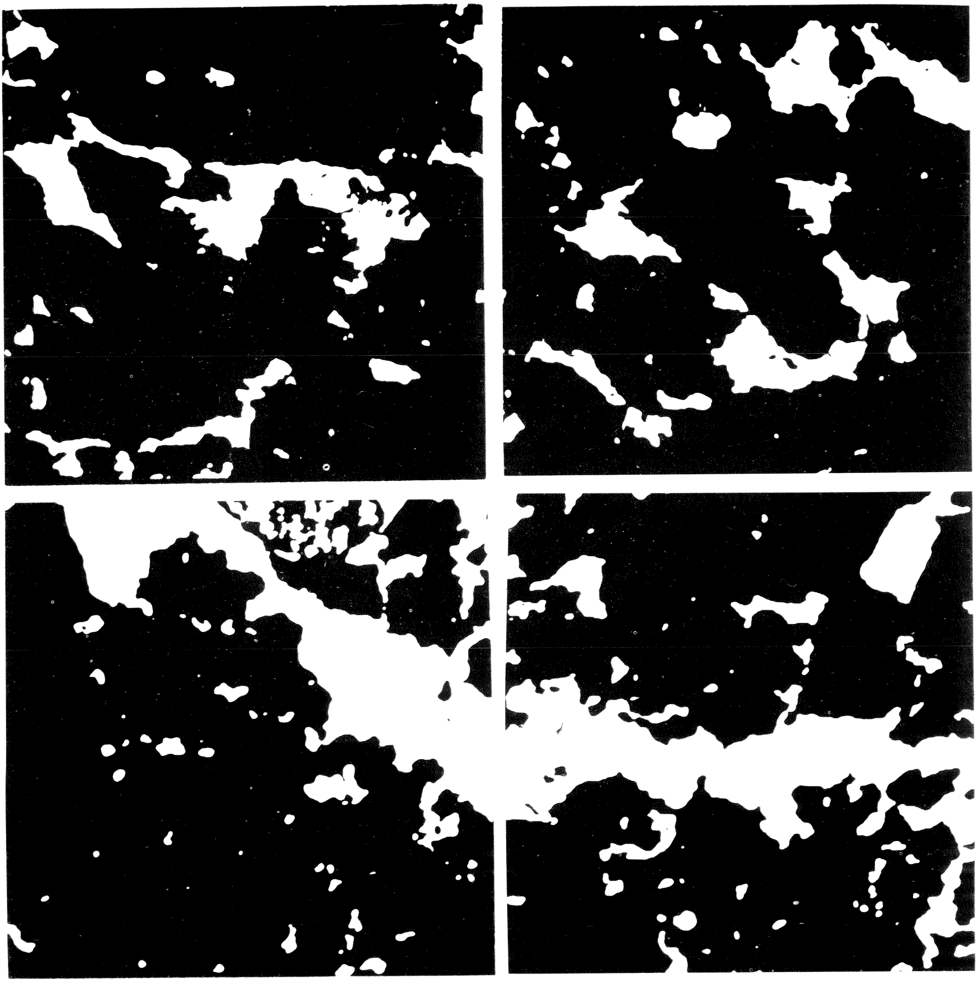

Fig. 12. Examples (or patents) of porosity for class B. 2.

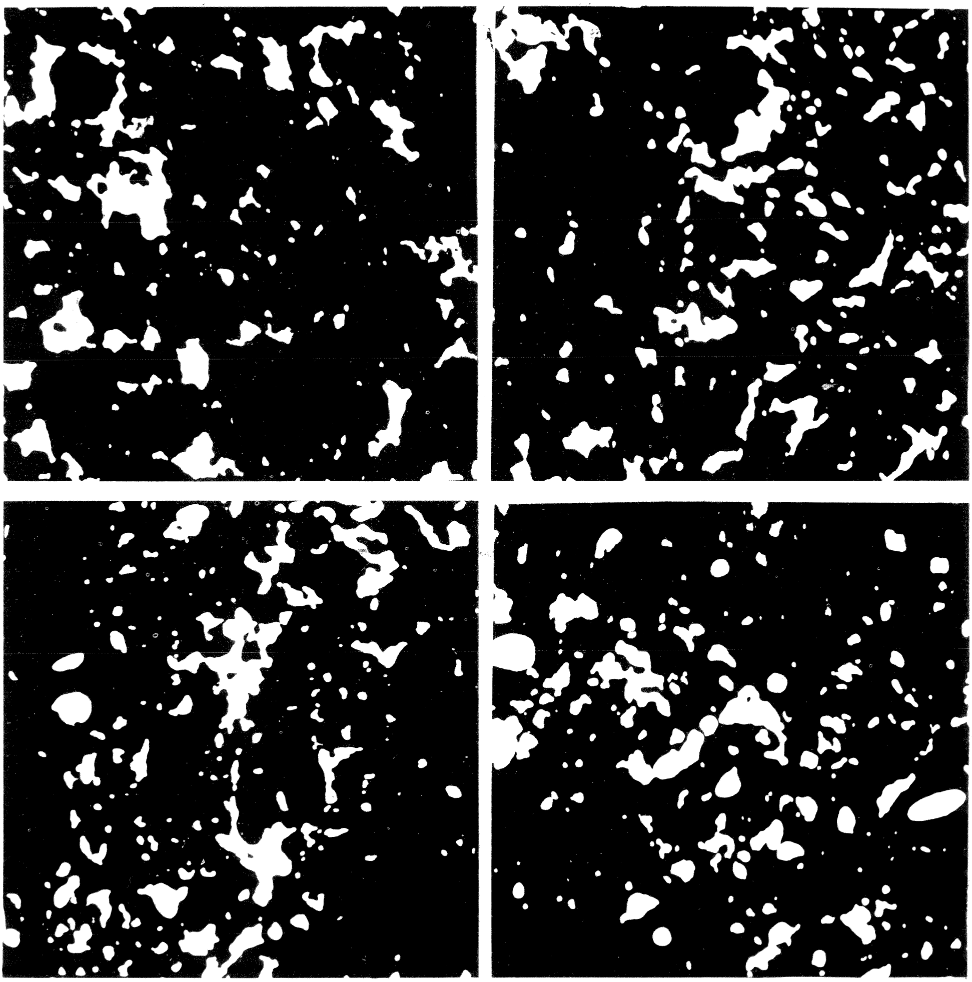

Fig. 13. Examples (or patents) of porosity for class C. 1.

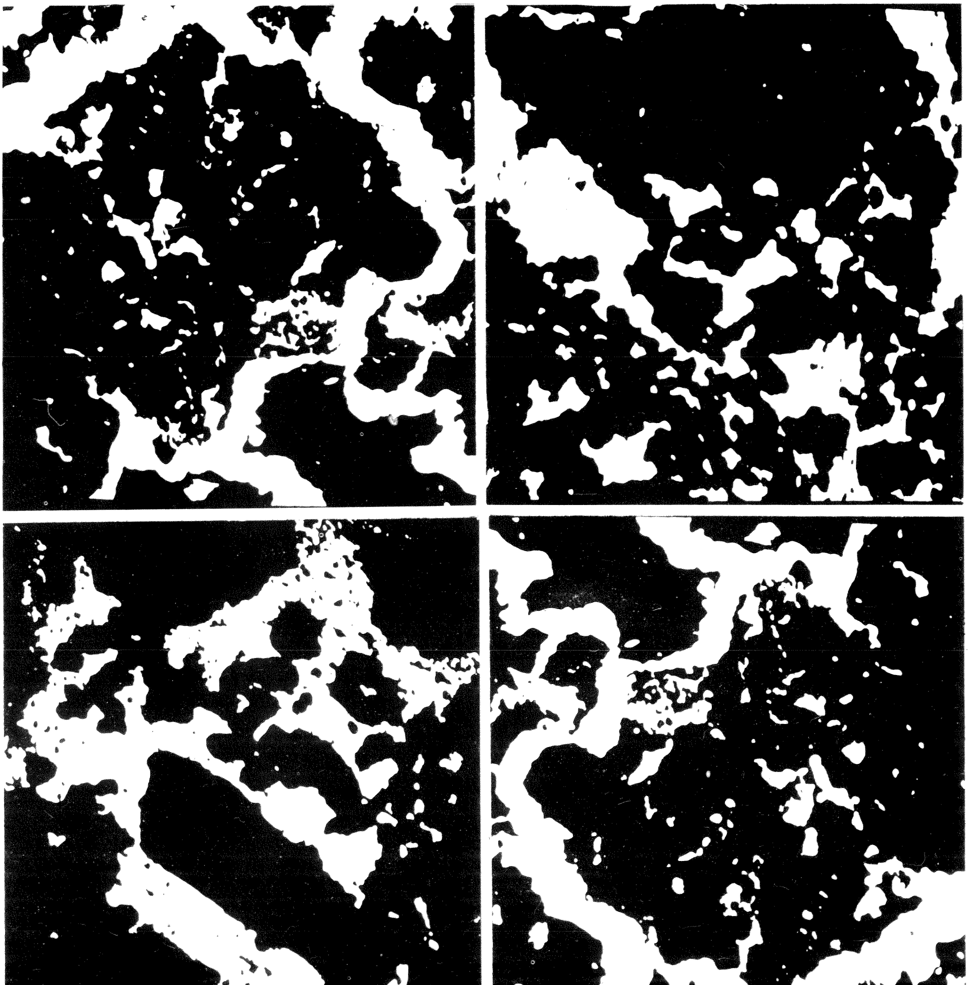

Fig. 14. Examples (or patents) of porosity for class C. 2.

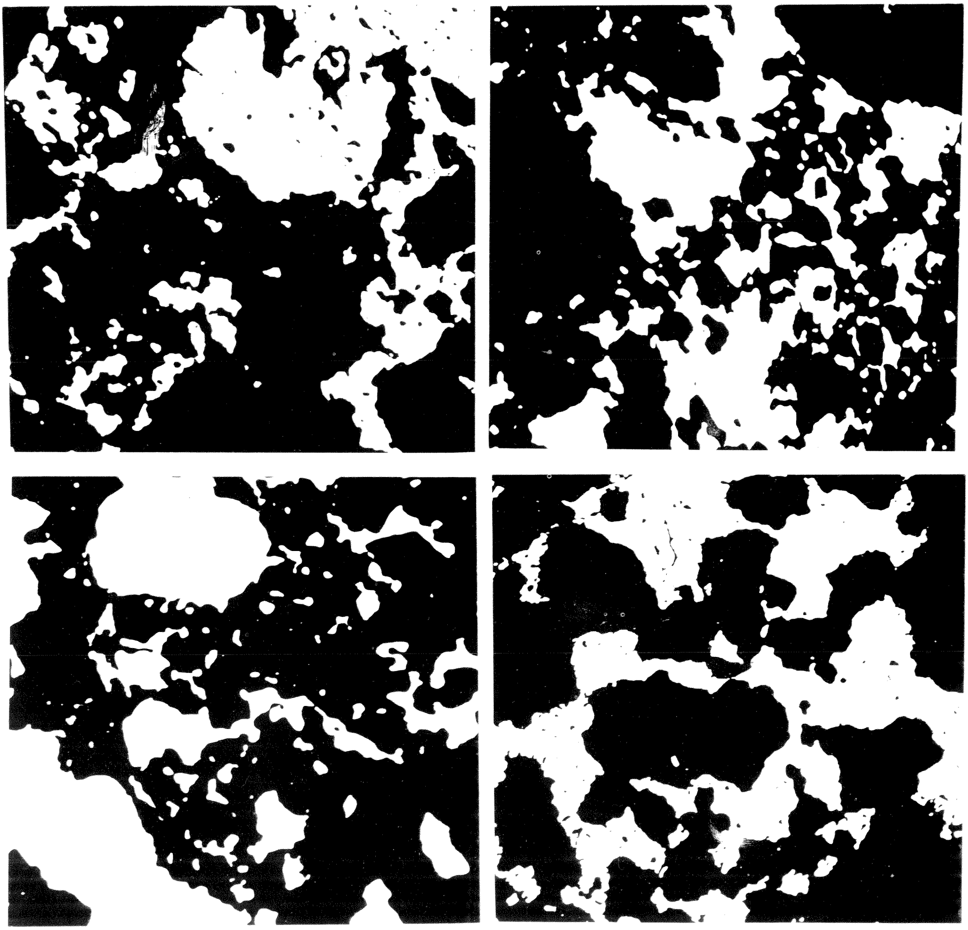

Fig. 15. Examples (or patents) of porosity for class C. 3.

xerochrept (soil number 33) and a calcic xerochrept (soil number 1) on the other. These are very important facts as they can be indicative of the extent of influence that plowing and cultivation exert on the evolution of the porosity in the upper horizons of the soils.

SUMMARY

The porosity of soils under olive -grove in the province of Granada (Spain is being studied. For micromorphometric purposes, a Microvideomat set from Zeiss has been utilized together with the negative-positive photographic technic. The soils have been grouped into two clearly defined groups. A new manner of graphic classification of void patterns is envisaged together with some conservative criticism to same.

REFERENCES

JONGERIUS, A. SCHOONDERBEEK, D. JAGER, A. KOWALINSKY, S.T. 1972 a. "Electro-optical soil porosity investigation by means of Quantimet-B Equipment". Rev. Geoderma 7 , 177-198.

JONGERIUS, A. SCHOONDERBEEK, D. y JABER, A. 1972 b. "The application of the Quantimet 720 in soil Micromorphometry". Rev. Microscope. 20 , 243-254.

LAFEBER, D. y KURBANOVIC, M. 1965. "Photographic reproduction of soil fabric patterns". Nature. Lond. 208 , 609-610.

SIERRA, C. y DELGADO, M. 1970. "Algunas consideraciones acerca del clima y suelos de olivar en la zona de Alhama (Granada). Rev. Ars. Pharm. XI, 521-537.

SIERRA, C. 1971. "Productividad y desarrollo del olivo en la provincia de Granada en relación con suelo y clima. Tesis Doctoral.