THE *ALBARIZAS* AND THE VITICULTURAL ZONING OF JEREZ-XÉRÈS-SHERRY AND MANZANILLA-SANLÚCAR DE BARRAMEDA REGISTERED APPELLATIONS OF ORIGIN (CADIZ, SPAIN)

LES *ALBARIZAS* DANS LE ZONAGE VITIVINICOLE DES APPELLATIONS D'ORIGINE JEREZ-XÉRÈS-SHERRY ET MANZANILLA-SANLÚCAR DE BARRAMEDA (CADIZ, ESPAGNE)

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Key words: *albarizas*, Jerez-Xérès-Sherry; Sanlucar de Barrameda, viticultural zoning; terroirs

Mots clés : *albarizas*; Jerez-Xérès-Sherry; Sanlucar de Barrameda; zonage vitivinicole; terroir.

ABSTRACT

The term *albariza* (L. *albus*, white) was originally applied to a special type of calcareous terrains. Nowadays it is also applied to soils and, in recent geological bibliography, to sedimentary rocks from the Betic Neogene with a particular origin, composition and structure.

In this work, we report the distribution and the geomorphology of the *albarizas* as well as its presence in diverse UTB in Jerez-Xérès-Sherry and Manzanilla-Sanlúcar de Barrameda Registered Appellations of Origin (AOC) zones. The soil cover, subsoil and geological substratum horizons from a number of vineyards have been studied, being the predominant cultivar Palomino Fino.

The soil profile type is ApC with its variations (ApC_1C; ApC_kC), being high the effective soil depth (>4 m). Organic matter content in fine earth is very low (<20 g Kg^{-1}), and total carbonates very high (≈ 400 g Kg^{-1}); active lime content is diverse (120–300 g Kg^{-1}). The CEC is about 20 $cmol_c$ Kg^{-1}, with a 100% base saturation, mainly due to Ca^{2+}. The predominant soil textural classes are silty clay and silty clay loam.

Bulk density, in unaltered samples, ranges from 850 to 1300 kg m^{-3}, being the average total porosity of 58 %. The air capacity is extremely high in the plough horizon (≈ 20 %). Available soil-water varies from 6 to 21 %. Permeability in saturated samples is slow (0.2–4 cm h^{-1}).

The parameters cited above are completed and explained through the study of thin sections from that material. This information together with other data (climate, geomorphology, vitivinicoles data…) are used for the zoning of the *albarizas* terrains in Jerez-Xérès-Sherry and Manzanilla-Sanlúcar de Barrameda AOC zones.

RESUME

Le terme *"Albariza"* (du latin "albus", blanc) déterminait à l'origine un type particulier du terrain calcaire, mais à présent il sert aussi à définir les sols et la bibliographie géologique actuelle le cite également pour de roches sédimentaires originaires du Neogene Betic.

Dans ce travail, les auteurs montrent la distribution et la géomorphologie des formations *"albarizas"* et sa participation aux UTB des Appellations d'Origine Contrôlée citées (AOC). Les horizons du sol, du sous-sol et la roche mère des parcelles viticoles avec le cépage Palomino Fino sont décrits.

Le profil type du sol est ApC avec des variantes (ApC_1C; ApCkC) et avec une profondeur > 4 mètres. Dans le terre fine (Ø < 2 mm) le niveau de matière organique est très faible (< 20 g kg^{-1}), les niveaux des carbonates très élevés ($\cong 400$ g kg^{-1}) et la calcaire actif variable (120-300 g kg^{-1}). La CEC est de 20 $cmol_c$ kg^{-1} environ et la saturation en bases du 100% (Ca^{2+} prédominant). La texture est argilo-limoneuse.

Le densité apparente (Da), dans des échantillons inalterés, variable (800-1400 kg M^3) et la porosité totale (Pt) du 58%. Le capacité d'aireation (CA) est très élevée dans l'horizon superficiel (30% environ) et faible quoique variable dans le sous-sol (7-17%). L'eau disponible (RU) est de 12-20% et la permeabilité des echantillons saturés lente.

Ces paramètres dont nous venons de parler se complémentent avec des études en lame mince.

L'information ainsi obtenue ajoutée aux données climatiques, géomorfologiques, viticoles... est utilisée pour la delimitation des terroirs *"albarizas"* dans le zonage des AOC citées ci-dessus.

INTRODUCTION

The term *ALBARIZA* (L., *Albus*, white) has been used, for time immemorial, by Andalusian farmers to name a special type of deep calcareous terrains, of medium texture, white or very light coloured. In regional viticultural, this name is applied to soils with similar characteristics to those mentioned calcareous terrains; and, in Geology, it has been used since 100 years ago to name a sedimentary rock. These facts confirm the importance that traditionally viticultural farmers gave to that geological material.

According to IGME (1988 a, b), the *albarizas* or *moronitas* are marls with diatoms, who have been described and located near Morón (Seville) (CALDERÓN and ARANA, 1896). The *albarizas* are very calcareous sediments having roughly a 10 % of quartz, a 35 to 50 % of calcite, a 40 to 55 % of phyillosilicates and traces of feldspars and opals; among the clay minerals, the most abundant are the smectites (63 to 75 %), the illites (14 to 27 %) and, finally, the kaolinites, which only represents a 11 to 17 % of the total. The *albarizas* are fine textured earthy material, with an insignificant percent of particles of more than a 63 µm diameter (∅), being the most abundant the particles sizes between 2 to 20 µm (∅). They can be considered as silty clay textural class because, in general terms, more than the 80 % of the samples have, at least, a 75 % of particles with a size <20 µm de ∅.

This earthy material has a low specific weight and a platy structure, which in presence of some moisture becomes spongy and easily penetrable by the roots (this fact has a great importance to determine the productivity of the vine); and it is also characteristic the presence of diatoms, calcareous nanoplacton (microflora), radiolarians, foramineferes and sponge spicules (microfauna). Through the study of these microfossiles is possible to differentiate the ages (which is a very controversial fact), the origin and the paleoenvironmental conditions of the deposit, and the autochthonous, parautochthonous or aloautochtonous character of these geological sediments.

For COLOM (1952) the *albarizas* or *moronites* date from the Aquitanian-Burdigalian period, while for GAVALA (1959) and CHAUVE (1968) from the Oligocene. However, according to the PERCONIG and GRANADOS (1973), the *moronites* date from the Medium Aquitanian to the Tortonian-Andalucian, and they can be grouped in *old moronites* (Medium Aquitanian to Inferior Laughian) and in *young moronites* (Serravalian to Superior Tortonian - Andalucian), being predominant the youngest (CALVO, 1981). For PLIEGO and BABIANO (1982), the *moronites* from Seville and Cadiz belong to the Superior Tortonian.

The *albarizas* or *moronites* are distributed all along the Guadalquivir River basin, from Jaen to Sanlúcar de Barrameda (Cadiz) (IGME, 1988 a, 1988 b). The average depth of the *albarizas* in the zone of Jerez is estimated in 250 meters, being the minimum 200 meters; and they take up a surface of 42,500 hectares. (GARCÍA DEL BARRIO, 1979).

In this work, the authors study a possible viticultural zoning of *albarizas* terrains belonging to Jerez-Xérès-Sherry and Manzanilla Sanlúcar de Barrameda Registered Apellations of Origin (AOC), taking into account some geological maps (IGME, 1988 a, 1988 b) and previous soil surveys (CEBAC, 1971; GARCÍA DEL BARRIO, 1988; PANEQUE *et al.*; 2000 a, b).

These AOCs are situated at the SW of Spain, Region of Andalusia and the total vineyard surface attached to the cited AOCs in 2000 was of 10,496 ha. More of the 75 % of the vine growing surface is located on the *Albarizas* Unit.

The area object of study is characterised for the following climatic features: warm weather, dry and hot summers softened by the nearby ocean influence; annual Tm of 17,3 °C, annual precipitation of 582 mm; moisture index of 0,67; potential evapotranspiration of 875 mm and Papadakis index CiO (HIDALGO, 1999).

There are different physiographies and slopes in the terrains attached to the AOC. It is defined as *Llano* (flat land) the terrains with a slope of 0-3 %, which represents the 16 % of the total surface; *Ladera* (hillside), those with a 3 to 10 % slope, being the 72,8 % of the surface; and *Cerro* (hill), those terrains characterised by a slope >10 % and which take up a 11,2 % of the total surface. So, although existing an unique geological substratum, depending on the physiographical positions, different units of basic *terroir* can be found, according to the complex soil/subsoil/geological substratum.

In the area of Jerez, the term *Pago* defines each one of the vineyard groups which have homogeneous terrains (generally delimited by topographical accidents) in which the viticultural zone of Jerez has been traditionally divided in (PEMARTÍN, 1965). This concept is nowadays valid but, from a pedological point of view, it is necessary to take into account possible changes in the structure of the soil cover.

MATERIAL AND METHODS

Representative samples from soil surface, subsoil and geological substratum of typical vineyards within *pagos* on *albarizas* which are considered as Superior Quality have been taken. The predominant vine cultivar is Palomino Fino. For the characterisation of the soil and geological materials the following parameters were performed in triplicate: in *non altered* samples, bulk density (cylinder method); and differential porosity and hydraulic conductivity (Ks) in saturated samples (Official Methods, MAPA, 1994). In *fine earth* samples (∅< 2,00 mm): total organic carbon (SIMS and HABY, 1974); total nitrogen, total carbonates, active lime, cation exchange capacity (CEC), and texture (Bouyoucos method) as described by

MAPA (1994). And, finally, Chlorotic Power Index (JUSTE *et al.*, 1972) according to PORTA *et al.* (1986).

Thin layer for optical microscope description of soils and sedimentary rocks were prepared as ALTERMÜLLER (1962), and microstructural features, composition and pedofeatures were described according to BULLOCK *et al.* (1985).

According to the information on the viticulture of the Jerez, and using as reference geomorphological and pedological data of the zone as well as the information obtained from the fieldwork, we propose the zoning of the *albarizas* area, by photointerpretation and superposition methods, whose validation is currently being carried out by the authors.

RESULTS AND DISCUSSION

The typical *albarizas* soils resulted to have an ApC type of profile with the following variations: ApC_1C and ApC_kC; an effective soil depth of 4 meters and a silty clay textural class in most of the cases.

Available nutrient elements contents were, in general terms, low or very low (table 1); the total carbonates and active lime (table 2) turned out high or very high (VILLALBI FORCADELL *et al*; 1988; SAÑA VILASECA *et al*; 1996). Carbonates were quite evenly distributed all along the soil profile, being slightly higher in the subsurface horizons and lower in the deeper ones. Chlorotic power indexes (PCI) pointed out a strong chlorotic effect which makes it necessary the election of well-adapted rootstocks (GARCÍA DE LUJÁN, 1997). Finally, the CEC ranged from 15 to 30 $cmol_c\ Kg^{-1}$ and the base saturation was practically total (100 %).

The geological substratum (*albarizas*) showed a prismatic and angular blocky, moderately-strongly developed, accommodated microstructure. Compound packing plane voids were the most predominant, with slightly serrated walls and a banded basic pattern distribution. Generally, they showed a parallel referred (to soil surface) distribution pattern, but some perpendicular and inclined patterns were also found. The presence of intra-aggregate globular shaped, 80 µm diameter sized voids was related to fossiliferous structures; while intra-aggregate blocky shaped, 20 µm diameter sized voids were related to groundmass mineral grains. The groundmass consisted of a crystallitic b-fabric micromass of fine particles of calcite; abundant mica, some quartz and sporadic feldspar and opals grains; finally, diatoms, sponge spicules, foramineferes and others microfossiles were quite abundant.

In the other side, the micromorphology of the upper horizons showed crumbs and subangular blocky, strong development and unaccommodated peds. Compound packing voids were also the most predominant, and intra-aggregates voids were analogous to those found in the geological substratum. In the micromass, although it showed similar characteristics to that previously described, acicular and ovoidal recrystallizated calcite within the voids was frequently observed.

The bulk density in *albarizas* ranged from 850 to 1,300 kg m^{-3}, these fluctuations in the values were mainly influenced by the soil moisture content (table 3, figure 1).

The total porosity increased together with the depth of the soil, which is beneficial for the roots development. The aeration capacity was elevated, between 8,36 and 26,44 %; this fact explains the excellent drainage of these lands in which predominates the fast drainage, since the pores greater to 60 µm represent more of the 10% of the soil volume.

Although the values of the maximal hydric retention capacity ranged from medium to low (between 26.9 and 52.57 %, being the average of 42.89 %), the available soil-water values were even lower than those expected (from 6.19 % to 20.76 %) because of the abundance of micropores smaller to 0.2 µm (figure 2).

These differences, far from representing a disadvantage for water take up by plants, are in fact an agronomic advantage: the presence of numerous micropores make it very important the upward movement by capillarity of moisture from deeper layers of the soil.

However, in spite of being so porous the matrix of the *Albarizas,* which allows the absence of flooding, the saturated hydraulic conductivity values were slower of those which could be expected to be found (FAO, 1965), ranging in most of the cases from 1 to 2 cm h^{-1} (figure 3). The evolution of the hydraulic conductivity in relation to the time demonstrated the great structural stability of aggregates in these lands.

CONCLUSION

The *albarizas* represent the geological substratum of most importance for the viticultural zoning of the Jerez framework. On the hills (slope > 10 %) and high hillsides (slope of 5-10 %), *antric-calcic Regosols* (an-cc RG) can be found. In these soils the *albarizas* material plays an important role, appearing in the soil and subsoil horizons. *Haplic Calcisols* (ha CL) and *calcic* and *vertic Cambisols* (cc CM; vt CM) can be found on hillsides of 3-5 % slope, having a poorly developed B horizon, and a dark, not deep Ap horizon, with not much vertic characteristics. These soil units, which are intimately related to the geological substratum (*albarizas*), are considered as Superior Quality terrains for the vineyard in the Jerez framework.

Finally, in flat lands (slope < 3 %), with accumulation of fine clay materials, in which the *albarizas* material appears at a higher depth, *calcic Vertisols* (cc VR), sometimes showing hydric characteristics, and *gleyic calcic Fluvisols* can be found. These soils and terrains, which in part originated from the *albarizas*, however, are not suitable for a fine quality vineyard.

The pedological systems on *albarizas* together with the constituents and soil structures previously mentioned, allowed a first approach to viticultural zoning of these terrains (figure 4).

Finally, these results are being currently contrasted by the authors through the monitoring of different properties (water and mineral nutrition of vines, crop and quality of musts and wine) in a large number of vineyard plots, which have been previously selected according to different soil Units, meso- and pedoclimatic conditions.

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Table 1. Mean values of chemical fertility parameters (pH; organic matter (OM); Kjeldahl Nitrogen; Phosphorus content; C/N relation; Exchange Cation Capacity (ECC); base saturation (%V); and Fe, Cu, Mn and Zn micronutrients) for 5 profiles of *albariza* soils in Jerez-Xérès-Sherry and Manzanilla-Sanlúcar de Barrameda Registered Appellations of Origin zone.

Profile	Horizon	DEPTH (cm)	pH		g Kg^{-1}		C/N	g Kg^{-1}					cmol$_c$ Kg^{-1}	%V
			H$_2$O	KCl	O.M.	N		P	Fe	Cu	Mn	Zn	ECC	
MX-V	Ap	0–70	8,36	7,55	7,3	0,6	7,05	0,015	0,010	0,006	0,015	0,003	30,7	86,8
	C1	70–140	8,40	7,50	5,1	0,4	7,32	0,005	0,011	0,002	0,013	0,004	24,4	100
	C2	>140	8,35	7,54	5,0	0,3	9,60	0,004	0,011	0,002	0,011	0,004	25,5	100
MX-VII	Ap	0–50	8,43	7,75	13,6	0,7	11,30	0,067	0,007	0,009	0,016	0,004	19,1	100
	C1	50–200	8,24	7,51	1,7	0,1	10,00	0,004	0,009	0,002	0,008	0,004	19,2	100
	C2	>200	8,41	7,46	1,4	0,1	8,30	0,003	0,009	0,002	0,008	0,003	18,6	100
MX-IX	Ap	0–60	8,60	7,56	5,4	0,3	10,33	0,020	0,003	0,006	0,008	0,004	14,8	100
	A/C	60–100	8,57	7,60	4,4	0,2	12,75	0,011	0,002	0,002	0,006	0,003	17,5	100
	Ck	>100	8,50	7,46	0,0	0,0	-	0,004	0,003	0,002	0,006	0,003	26,6	100
MX-XII	Ap	0–70	8,28	7,44	18,6	0,9	11,95	0,012	0,006	0,003	0,009	0,003	28,5	100
	C1	70–140	7,92	7,38	2,5	0,2	7,3	0,003	0,006	0,002	0,007	0,002	24,4	100
	C2	>140	8,13	7,45	1,9	0,15	7,5	0,003	0,010	0,002	0,008	0,001	22,8	100
MX-XIX	Ap	0–30	8,21	7,50	8,9	0,4	12,9	0,024	0,005	0,007	0,012	0,003	23,4	75,3
	B/C	30–60	8,22	7,53	13,8	0,6	13,35	0,040	0,005	0,010	0,010	0,003	23,5	78,6
	C1	60–110	8,27	7,47	1,8	0,1	10,7	0,007	0,008	0,002	0,010	0,001	24,5	78,1
	C2	>110	8,33	7,54	0,9	0,1	5,4	0,005	0,008	0,002	0,013	0,001	21,4	91,2

Table 2. Mean values of chemical fertility parameters (total carbonates, active lime; ammonium oxalate extracted Fe and Chlorotic power index) for 5 profiles of *albariza* soils in Jerez-Xérès-Sherry and Manzanilla-Sanlúcar de Barrameda Registered Appellations of Origin zone.

Profile	Horizon	DEPTH (cm)	g kg^{-1} Carbonates	% Active lime	Chlorotic power index
MX-V	Ap	0–70	334,5	12,0	7,9
	C1	70–140	351,0	17,3	8,1
	C2	>140	233,7	16,7	9,6
MX-VII	Ap	0–50	377,7	23,5	28,6
	C1	50–200	390,0	21,3	16,4
	C2	>200	361,9	15,9	8,8
MX-IX	Ap	0–60	529,9	36,3	>60
	A/C	60–100	535,2	27,3	>60
	Ck	>100	403,7	17,8	60
MX-XII	Ap	0–70	336,7	17,9	13,4
	C1	70–140	330,9	19,2	21,3
	C2	>140	322,9	18,2	13,8
MX-XIX	Ap	0–30	400,0	21,4	41,0
	B/C	30–60	407,6	23,6	38,4
	C1	60–110	339,4	21,5	22,9
	C2	>110	406,3	17,0	19,4

Table 3. Mean values of physical parameters (Bulk density; saturated hydraulic conductivity and soil textural classes) for 5 profiles of *albariza* soils in Jerez-Xérès-Sherry and Manzanilla-Sanlúcar de Barrameda Registered Appellations of Origin zone.

Profile	Horizon	DEPTH (cm)	Bulk density. (Kg m^{3})	Ks (cm hour^{-1})	Textural class
MX-V	Ap	0 – 70	1.070	1,3	Silty clay
	C1	70 – 140	1.260	1,2	Silty clay
	C2	> 140	1.230	1,4	Silty clay
MX-VII	Ap	0 – 50	970	1,2	Silty clay
	C1	50 – 200	1.030	++	Silty clay
	C2	> 200	990	++	Silty clay
MX-IX	Ap	0 – 60	1.040	2,3	Silty clay
	A/C	60 – 100	850	4,0	Clay loam
	Ck	> 100	1.050	0,35	Silty Clay loam
MX-XII	Ap	0 – 70	1.300	0,9	Clay
	C1	70 – 140	970	0,6	Silty clay
	C2	> 140	1.200	0,2	Silty clay
MX-XIX	Ap	0 – 30	900	2,0	Silty clay
	B/C	30 – 60	910	1,8	Silty clay
	C1	60 – 110	970	0,8	Silty Clay loam
	C2	> 110	1.020	0,7	Silty Clay loam

Figure 1. Relation between the moisture content and the Bulk density of *Albarizas* soils.

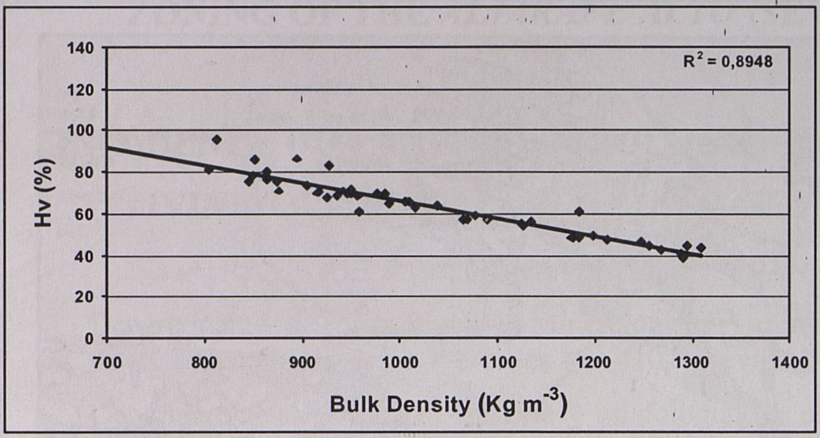

Figure 2. Differential Porosity in samples of three depth sections of *Albarizas* soils.

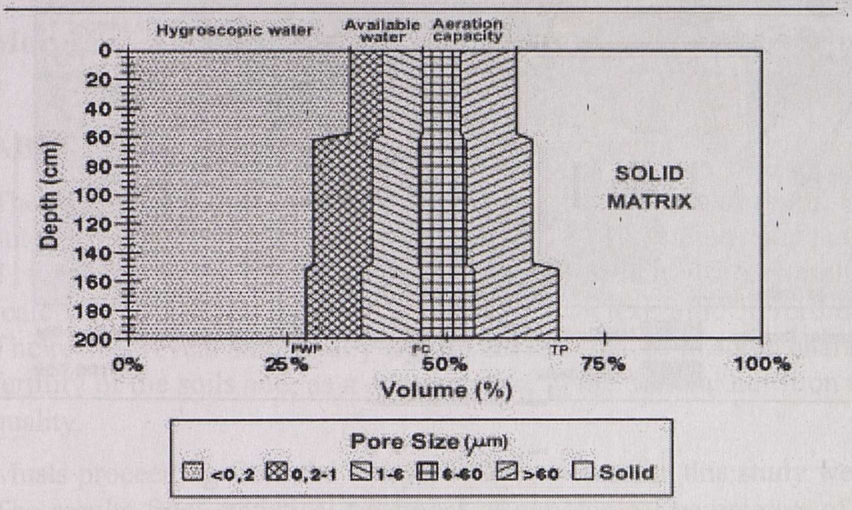

Figure 3. Curve of saturated hydraulic conductivity (Ks) in three depth sections of *Albarizas* soils.

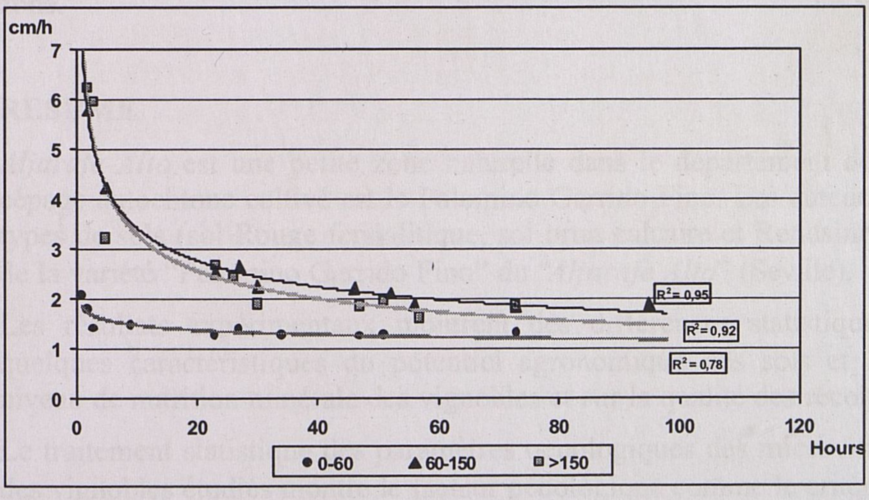

Figure nº 4. First approach to viticultural Zoning of Albarizas