Main viticultural soils in Castilla – La Mancha (Spain).

Principaux sols viticoles dans Castilla – La Mancha(Espagne).

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Summary

Castilla-La Mancha is the biggest vineyard in the world. Once similar soils have been identified in Castilla-La Mancha (soils chosen are very representative of vineyards areas in the region), the results obtained will be very useful in helping us to choose the right varieties, rootstock, cultivation techniques, canopy management, irrigation system, etc… In further studies this typology will help us in works of viticulture zonification in areas where this technique is improving now.

Keywords: Soil, climate, rootstock, variety.

Introduction

Castilla-La Mancha extends over a territory of about 80.000 square kilometres located on the central plateau of the Iberian Peninsula. This region is home to the greatest concentration of vineyards in the world. We are now working on a soil catalogue covering the whole region and we have selected the 5 most representative soils to demonstrate the pedological diversity that brings complexity and variability to our wines.

Material and Methods

A profile description is made by identifying horizons and diagnostic properties to classify it according to the Soil Taxonomy 2006 (USDA) and FAO Soil Classification Systems 2006. Each horizon has data concerning depth, texture, structure, porosity, roots, biological activity, friability, hardness, colour, stones and limit between horizons, as well as chemical data: pH, organic matter, electrical conductivity, nitrogen, phosphorous, potassium, active calcium, exchange capacity, etc. Information is completed with the surrounding vegetation, topography, slope and GPS coordinates. We add climatic data such as an Ombrothermic Graph and DDA (Winkler) as well as a short description of traditional viticulture and future quality wine production capability. Owing to the limitations of space, not all data are shown here (see poster).

Results and Discussion: (See each profile below)

PROFILE Nº 1:	
Local name of the soil: Campo de Criptana. Classification FAO: Petric Calcisol (Ruptic, Skeletic) Classification USDA: Petrocalcic Calcixerept. Date of description: 18 – 10 – 07. GPS coordinates: 39º24'16.1''(N) – 03º04'52.3'' (W) 0493010 (x) – 4361668 (y) Elevation: 705 m. Landform position: Concave slope. Landform topography: Undulating.	Microtopography: Artificial Slope: Class 3 (sloping). Orientation: South. Parent material: Marls sediments. Drainage: Class 4 (well drain). Stoniness: Class 1 Erosion: Water laminar. Salinity: No.

A_{p1}	0 – 20 (cm)	Colour: Light yellowish brown, 10 YR 6/4 (dry); yellowish brown, 10 YR 5/4 (wet). Structure: Moderate (with a particular trend), with subangular blocky. Consistency: Non-sticky, non-plastic, loose and slightly hard. Common roots fine and medium. Many pores. Stoniness: 40%. Boundary with the horizon immediately below: Gradual and wavy.
A_{p2}	20 – 45 (cm)	Colour: Light yellowish brown, 10 YR 6/4 (dry); dark yellowish brown, 10 YR 3/4 (wet). Structure: Strong, prismatic, thick. Consistency: Non-sticky, non-plastic, very firm and very hard. Common roots fine and medium. Common pores. Stoniness: 15%. Boundary with the horizon immediately below: Abrupt and smooth.
$2C_{km1}$	45 – 83 (cm)	Colour: Pink 7,5 YR 8/4 (dry); pink 7,5 YR 8/4 (wet). Horizon for petrocalcic includes sandstone quartzite stones. Common roots coarse. The concretion mass occupies 50%. Boundary with the horizon immediately below: Clear and irregular.
$2C_{km2}$	83 – 120 (cm)	Constituted by angular chants of quartzite sandstone covered with a film of calcium carbonate and turn sausage in a carbonate matrix silty tough and salmon. Without roots. The chants occupy 50%. Boundary with the horizon immediately below: Clear and irregular.
$3C_{k}$	> 120 (cm)	Colour: Pink, 7,5 YR 7/4 (dry); pink, 7,5 YR 8/4 (wet). Structure: Strong, in subangular blocky, thick. Consistency: Non-sticky, non-plastic, very firm and hard. None roots. Common pores. Stoniness: 5%.

HORIZON	**Gravels (%)**	**Sand (%)**	**Silt (%)**	**Clay (%)**	**Clasification**	**pH H_2O (1:2,5)**	**pH KCl (1:2,5)**	**E. C. (dS/m)**
A_{p1}	46,4	60,5	25,3	14,2	Loa-san.	8,3	7,8	0,19
A_{p2}	35,8	48,6	42,0	9,4	Loa.	8,5	8,0	0,21
$2C_{km1}$	95,3	---	---	---	---	8,7	8,4	0,52
$2C_{km2}$	78,8	---	---	---	---	8,8	8,4	6,95
$3C_{k}$	57,3	59,1	35,7	5,2	Loa-san.	8,3	7,9	1,65

HORIZON	**$CaCO_3$ (%)**	**Active Limestone (%)**	**O.M. (%)**	**N (%)**	**C/N**	**P Olsen (ppm)**	**Cations Exchange ($Cmol^+/Kg$)**				**C.I.C ($Cmol^+/kg$)**	**V (%)**
							Ca^{2+}	**Mg^{2+}**	**K^+**	**Na^+**		
A_{p1}	55,4	16,3	1,6	0,05	14,1	1,13	8,3	1,7	0,6	1,7	12,3	100,0
A_{p2}	51,1	14,9	1,5	0,09	14,4	1,9	7,0	1,5	1,1	1,8	11,4	100,0
$2C_{km1}$	87,4	14,7	---	---	---	---	---	---	---	---	---	---
$2C_{km2}$	72,9	13,6	---	---	---	---	---	---	---	---	---	---
$3C_{k}$	49,6	11,9	---	---	---	---	---	---	---	---	---	---

Designation of Origin: It belongs to the D.O. La Mancha, we are at the centre of the largest D.O. in the world and probably this is the most representative soil.
Rootstock: Must be very resistant limestone. In dry lands, 41-B Millardet-Grasset and 161-49 Couderc predominates, in irrigation 140-Ruggeri .

Varieties: Traditionally in rainfed areas the red variety Cencibel and white variety Airén have been cultivated. Good results are obtained with many red international varieties middle – late cycle and budding late. (Syrah, Merlot, Cabernet Sauvignon, Petit Verdot). Good results can be obtained too with native late varieties as Mazuelo, Graciano, Moravia Dulce or Tinto Velasco.

***PROFILE Nº 2*:**	
Local name of the soil: Mahora.	Microtopography: Natural.
Classification FAO: Haplic Cambisol (Calcaric, Yermic)	Slope gradient: Class 2 (gently sloping)
Classification USDA: Typic Haploxerept	Orientation: Northwest
Date of description: 21 – 06 – 07.	Parent material: Marls
GPS's coordinates:39º12'47,2''(N)–01º43'55,3''(W) 0609472 (X) – 4341191 (Y).	Drainage: Class 4 (well drain).
Elevation: 674 m.	Stoiness: Class 1
Landform position: Plain.	Erosion: Water laminar.
Landform topography: Undulating.	Salinity: No.

A_p	0 – 18 (cm)	Colour: Yellowish brown, 10 YR 5/4 (dry); dark yellowish brown, 10 YR 4/4 (wet). Structure: Strong, with subangular blocky, thick. Consistency: Slightly sticky, non-plastic, firm and hard. Common roots fine and medium. Many all size pores. Stoniness: 10%. Boundary with the horizon immediately below: Diffuse and wavy.
B_w	18 – 65 (cm)	Colour: Light yellowish brown, 10 YR 6/4 (dry); yellowish brown, 10 YR 5/4 (wet). Structure: Strong, with subangular blocky, thick. Consistency: Non-sticky, non-plastic very firm y very hard. Few all size roots. Common all size pores. Stoniness: 1%. Boundary with the horizon immediately below: Diffuse and wavy.
C	> 65 (cm)	Colour: Very pale brown, 10 YR 7/4 (dry); brown, 10 YR 5/3 (wet). Structure: Strong, with subangular blocky, thick. Consistency: non-sticky, non- plastic, very firm and very hard. None roots. Common pores. Stoniness: 1%.

HORIZON	**Gravels (%)**	**Sand (%)**	**Silt (%)**	**Clay (%)**	**Clasification**	**pH H_2O (1:2,5)**	**pH KCl (1:2,5)**	**E. C. (dS/m)**
A_p	34,2	55,1	20,0	24,9	Sil-cla-loa.	8,2	7,6	0.15
B_w	30,4	40,0	20.8	32,9	Sil-cla.	8,2	7,5	0.14
C	22,8	36.0	29.8	34,2	Sil-cla.	8,3	7,5	0.16

HORIZON	**$CaCO_3$ (%)**	**Active Limestone (%)**	**O.M. (%)**	**N (%)**	**C/N**	**P Olsen (ppm)**	**Cations Exchange ($Cmol^+/Kg$)**				**C.I.C ($Cmol^+/kg$)**	**V (%)**
							Ca^{2+}	**Mg^{2+}**	**K^+**	**Na^+**		
A_p	42,0	15,4	1,2	0,05	11,27	1,9	12,5	1,3	0,8	1,7	16,3	100,0
B_w	40,9	15,6	0,9	0,04	9,65	1,1	11,2	1,5	0,5	1,6	15,8	100,0
C	---	---	---	---	---	---	---	---	---	---	---	---

Designation of Origin: We are at the boundary of the DO La Mancha with new designations as Manchuela or Rivera del Júcar. The climate is continental with Mediterranean influence.
Rootstock: In these arid lands vigorous, deep-rooted rootstocks are needed to tap moisture throughout the profile: 110-Richter, 1103-Paulsen and. 140-Ruggeri.
Varieties: Traditionally it has been cultivated in the variety Airén (non irrigation), although there is a mixture of varieties, including within the same plot. Potentially it would accommodate all the good quality red varieties , middle - late cycle (Cencibel, Syrah, Cabernet Sauvignon and some native as Garnacha Tintorera or Monastrel).

PROFILE Nº 3:	
Local name of the soil: Cabezamesada. Classification FAO: Calcic Luvisol (Clayic, Chromic) Classification USDA: Petrocalcic Palexeralf Date of description: 08 – 11 – 07. GPS's coordinates: 39º50'32,0'' (N) – 03º10'29,0'' (W) 0485051 (X) – 4410263 (Y) Elevation: 756 m. Landform position: Plain. Landform topography: Flat.	Microtopography: Artificial Slope gradient: Class 1 (nearly level). Orientation: South. Parent material: River sediments. Drainage: Class 4 (well drain). Stoiness: Class 0 Erosion: Water laminar. Salinity: Null.

A_p	0 – 30 (cm)	Colour: Brown, 7,5 YR 4/4 (dry); dark brown, 7,5 YR 4/6 (wet). Structure: Moderate, with subangular blocky, thick. Consistency: Slightly sticky, slightly plastic, friable and slightly hard. Common roots fine and medium. Common pores. Stoniness: 10%. Boundary with the horizon immediately below: Gradual and wavy.
B_t	30 – 55 (cm)	Colour: Reddish brown, 5 YR 3/3 (dry); dark reddish brown, 5 YR 4/4 (wet). Structure: Strong, prismatic, thick. Consistency: Slightly sticky, plastic, firm and hard. Coatings thin zonal. Common roots fine and medium. Common pores. Stoniness: 2%. Boundary with the horizon immediately below: Clear and wavy.
C_{km1}	55 – 90 (cm)	Colour: Reddish brown 7,5 YR 4/6 (dry); dark brown 7,5 YR 6/6 (wet). Structure: Strong, with subangular blocky, thick. Consistency: Slightly sticky, non-plastic, very firm and very hard. Common roots coarse. Few pores. Stoniness: 2%. Boundary with the horizon immediately below: Gradual and wavy.
C_{km2}	> 90 (cm)	Colour: Dark brown, 7,5 YR 5/6, with spotty dispersed mycelia shape spots and with a tendency to pink granules 7.5 YR 8 / 1 (dry). Structure: Strong, prismatic, thick. Consistency: Sticky, plastic, firm and hard. None roots. Few pores. Stoniness: 2%.

HORIZON	**Gravels (%)**	**Sand (%)**	**Silt (%)**	**Clay (%)**	**Clasification**	**pH H_2O (1:2,5)**	**pH KCl (1:2,5)**	**E. C. (dS/m)**
A_p	34,4	44,6	39,3	16,1	Loa.	7,9	7,4	0,47
B_t	50,3	28,6	33,3	38,1	Loa-cla.	8,2	7,4	0,25
C_{km1}	45,3	16,6	52,0	31,4	Loa-cla.	8,3	7,4	0,13
C_{km2}	68,5	9,8	59,3	30,9	Loa-cla-sil.	8,4	7,4	0,08

HORIZON	**$CaCO_3$ (%)**	**Active Limestone (%)**	**O.M. (%)**	**N (%)**	**C/N**	**P Olsen (ppm)**	**Cations Exchange ($Cmol^+/Kg$)**				**C.I.C ($Cmol^+/kg$)**	**V (%)**
							Ca^{2+}	**Mg^{2+}**	**K^+**	**Na^+**		
A_p	20,0	14,1	2,7	0,12	10,22	3,9	17,4	1,8	0,8	1,8	21,8	100,0
B_t	16,4	14,1	1,2	0,03	15,58	1,7	22,6	1,7	0,3	1,7	26,3	100,0
C_{km1}	32,9	19,3	---	---	---	---	---	---	---	---	---	---
C_{km2}	30,5	19,9	---	---	---	---	---	---	---	---	---	---

Designation of Origin: It belongs to the D.O. Uclés, which previously belonged to the northern part of the D.O. La Mancha, and now known for its production of quality wines.
Rootstock: Not very vigorous as the 99-R. 110-Richter and 140 Ruggeri are used too.
Varieties: Airén and Cencibel have traditionally been cultivated; currently good results are obtained with red quality varieties middle-long cycle (Syrah, Petit Verdot, Cabernet Sauvignon) and some native as Garnacha. You can grow some white varieties with medium cycle such as Sauvignon Blanc and Verdejo.

PROFILE Nº 4:	
Local name of the soil: Pedro Muñoz. Classification: FAO: Endogleyic Calcisol (Clayic, Chromic) Classification USDA: Typic Calcixerept Date of description: 22 – 11 – 07. GPS's coordinates: 39º25'48,4'' (N) – 02º55'06,5'' (W). 0507019 (X) – 4364509 (Y). Elevation: 673 m. Landform position: Concave slope. Landform topography: Wavy.	Microtopography: Artificial Slope gradient: Class 1 Orientation: North. Parent material: Poligenic sediments. Drainage: Class 2 (imperfectly drain). Stoiness: Class 1 Erosion: Hydrica surface. Salinity: No.

A_p	0 – 15 (cm)	Colour: Brown, 7,5 YR 6/4 (dry); dark brown, 7,5 YR 7/4 (wet). Structure: Moderate, with subangular blocky, medium and thick. Consistency: Slightly sticky, slightly plastic, very friable and soft. Few roots fine. Many pores. Stoniness: 15%. Boundary with the horizon immediately below: Gradual and wavy.
B_w	15 – 40 (cm)	Colour: Light brown, 7,5 YR 6/4 (dry); reddish brown, 7,5 YR 6/6 (wet). Structure: Moderate, with subangular blocky, thick. Consistency: Slightly sticky, non-plastic, friable and slightly hard. Common all sizes roots. Common pores. Stoniness: 10%. Boundary with the horizon immediately below: Clear and wavy.
$2C_k$	40 – 98 (cm)	Colour: Mixture of colour pink, 7,5 YR 7/6 and reddish yellow 7,5 YR 6/6 (dry); mixture of colours pinkish gray 7,5 YR 7/2 and reddish yellow, 7,5 YR 6/8 (wet). Structure: Strong, (something concretions), wiht subangular blocky, medium and thick. Consistency: non-sticky, non-plastic, firm and hard. None roots. Common pores small and fine. Stoniness: 40%. Boundary with the horizon immediately below: Clear and wavy.
$3C_{gk}$	> 98 (cm)	Colour: Reddish yellow, 5 YR 7/6, with extensive mass reduction white, 2,5 YR 8/0 and dark stains of manganese (dry); reddish yellow 5 YR 6/8 with extensive mass reduction white, 2,5 YR 8/0 and dark stains of manganese (dry). Structure: Moderate, with subangular blocky, thick. Consistency: Slightly sticky, slightly plastic, friable and slightly hard. Coatings moderately thick and discontinuous. None roots. Few pores fines. Stoniness: 5%.

HORIZON	**Gravels (%)**	**Sand (%)**	**Silt (%)**	**Clay (%)**	**Clasification**	**pH H_2O (1:2,5)**	**pH KCl (1:2,5)**	**E. C. (dS/m)**
A_p	32,3	83,8	10,0	6,2	San-loa.	8,4	7,7	0,12
B_w	31,0	57,8	5,3	36,9	Loa-Cla-san.	8,5	7,7	0,11
$2C_k$	84,6	35,1	32,0	32,9	Loa-cla.	8,6	8,8	0,09
$3C_{gk}$	39,0	25,8	37,0	37,2	Loa-cla	8,2	7,6	0,32

HORIZON	**$CaCO_3$ (%)**	**Active Limestone (%)**	**O.M. (%)**	**N (%)**	**C/N**	**P Olsen (ppm)**	**Cations Exchange ($Cmol^+/Kg$)**				**C.I.C ($Cmol^+/kg$)**	**V (%)**
							Ca^{2+}	**Mg^{2+}**	**K^+**	**Na^+**		
A_p	34,1	14,9	1,8	0,17	4,61	2,5	5,9	1,6	0,6	1,7	9,8	100,0
B_w	34,6	18,8	0,5	0,04	5,19	0,7	17,8	1,5	0,2	1,7	21,2	100,0
$2C_k$	42,0	21,0	---	---	---	---	---	---	---	---	---	---
$3C_{gk}$	57,5	17,9	---	---	---	---	---	---	---	---	---	---

Designation of Origin: Land belonging to the D.O. La Mancha, representative of floodplains around the Guadiana River and its tributaries and in the area surrounding the lakes of "Wet La Mancha"
Rootstock: Tradicionally 420-A and 161-49-Millardet-Grasset. With irrigation 1103-Paulsen and 99-Richter.

Variety: Currently the variety Airén is used in dry-lands; potentially almost any variety can be grown subject to the availability of irrigation. To take advantage of cool nights in September and to avoid late frost in April, red varieties with late budding and maturation are preferred.

PROFILE Nº 5::	
Local name of the soil: Malpica de Tajo. Classification: FAO: Cutanic Luvisol (Oxiaquic, Rhodic) Classification USDA: Typic Rhodoxeralf Date of description: 01 – 03 – 07. GPS's coordinates: 39º51'03'' (N) - 04º40'08'' (W). 0357309 (X) - 4412751 (Y). Elevation: 438 m. Landform position: Plain. Landform topography: Plain. Microtopography: Artificial.	Slope gradient: Class 1 (nearly level). Orientation: East. Parent material: Pliocuaternaric sediments. Drainage: Class 2 (imperfectaly drain). Stoiness: Class 0 Erosion: Hidrica surface. Salinity: Little.

$\mathbf{A_p}$	0-50 (cm)	Colour: Yellowish red, 5 YR 4/6 (dry); dark red, 2,5 YR 4/6 (wet). Structure: Strong, with blocky subangular, thick. Consistency: Sticky, very plastic, friable and soft. Without coating. Common roots fine and medium. Common pores. Stoniness: 10%. Boundary with the horizon immediately below: Gradual and wavy.
$\mathbf{B_{t1}}$	50-110 (cm)	Colour: Weak red, 10 R 4/4 (dry); dark red, 10 R 4/6 (wet). Structure: Strong, prismatic, thick. Consistency: Sticky, very plastic, firm and hard. Coating thick and continuous. Common roots fines and few coarse. None pores. Stoniness: 10%. Boundary with the horizon immediately below: Diffuse and wavy.
$\mathbf{B_{t2}}$	110-142 (cm)	Colour: Mixture of colour yellowish red, 7,5 YR 4/6 and red, 10 R 4/8 (dry); mixture of colours yellow, 7,5 YR 6/4 and dark red, 10 R 3/6 (wet). Granules farinaceos sometimes columnar calcium carbonate and clay embedded in the matrix clay. None pores. Stoniness: 30% based boulders coarse and medium. Boundary with the horizon immediately below: Diffuse and wavy.
$\mathbf{B_t/C}$	142-155 (cm)	Colour: Red, 10 R 5/6 with yellowish red stains, 7,5 YR 4/6 (dry); dark yellowish brown, 10 R 4/6 with reddish stains 7,5 YR 5/4 (wet). Structure: strong, with blocks subangular, medium. Consistency: Sticky, plastic, firm and hard. None roots. None pores. Stoniness: 20% based subboulders of cuarcite. Boundary with the horizon immediately below: Diffuse and wavy.
$\mathbf{C_k}$	155-185 (cm)	Colour: Dark red, 2,5 YR 4/6 (dry); dark red 10 R 4/6 (wet). Structure and Consistency similar to the immediate horizon upper. Very few fine roots. None pores. Stoniness: 10%. Boundary with the horizon immediately below: Gradual and wavy.
$\mathbf{C_g}$	>185 (cm)	Colour: Yellowish brown, 10 YR 5/6, with stains light brownish grey, 2,5 Y 6/2 and white, 10 YR 8/2 (dry); dark yellowish brown 10 YR 4/6 with stains pale yellow, 2,5 Y 7/4 and dark yellowish brown, 10 YR 7/6 (dry). Structure: Massive resolved to granular. None roots. Few pores. Stoniness: 5% based stones in a matrix sandy silt.

Analitic Result: (see poster)

Designation of Origin: Without D.O. Soil within the shire of Malpica de Tajo, prestigious in recent times by some wineries specializing in quality wines.
Rootstock: Rootstock resistant to root suffocation SO4 (Vitis Riparia parent), and not too vigorous. Try cultural operations that allow better drainage.
Varieties: This is not a traditional area for growing vines. In the vicinity, the DO Méntrida, has been traditionally cultivated variety Garnacha. Potentially may be suitable for long-cycle red varieties (Cabernet Sauvignon, Mazuelo, Monastrel, Petit Verdot, etc…).

Conclusion

From these 5 soils alone it is possible to assume the great environmental variability in Castilla-La Mancha to obtain different quality wines (both traditional and new).

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