Sintering of glass as solution for reduction mine wastes from the Pyrenees

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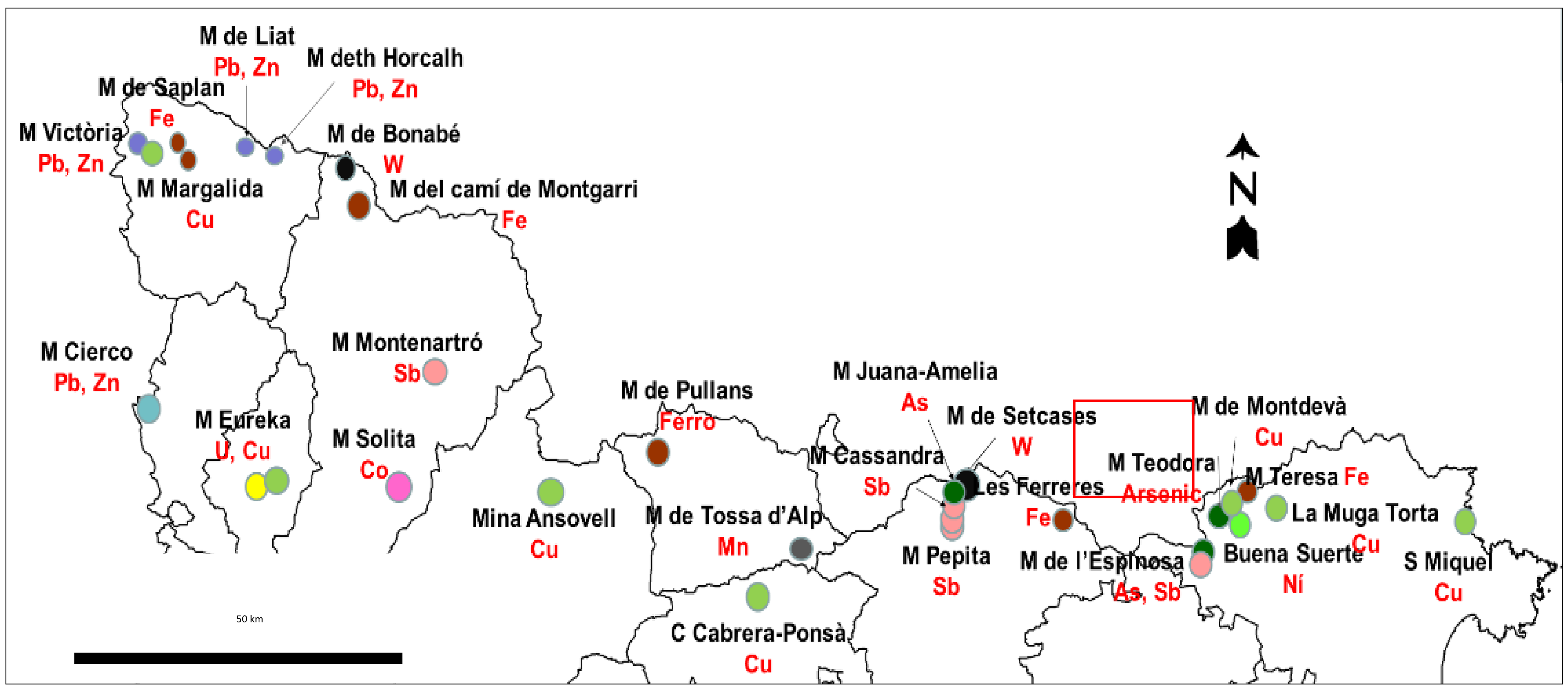
ЕВРОПЕЙСКИ СЪЮЗ
ЕВРОПЕЙСКИ ФОНД ЗА РЕГИОНАЛНО РАЗВИТИЕ

ОПЕРАТИВНА ПРОГРАМА
НАУКА И ОБРАЗОВАНИЕ ЗА ИНТЕЛИГЕНТЕН РАСТЕЖ

INTRODUCTION

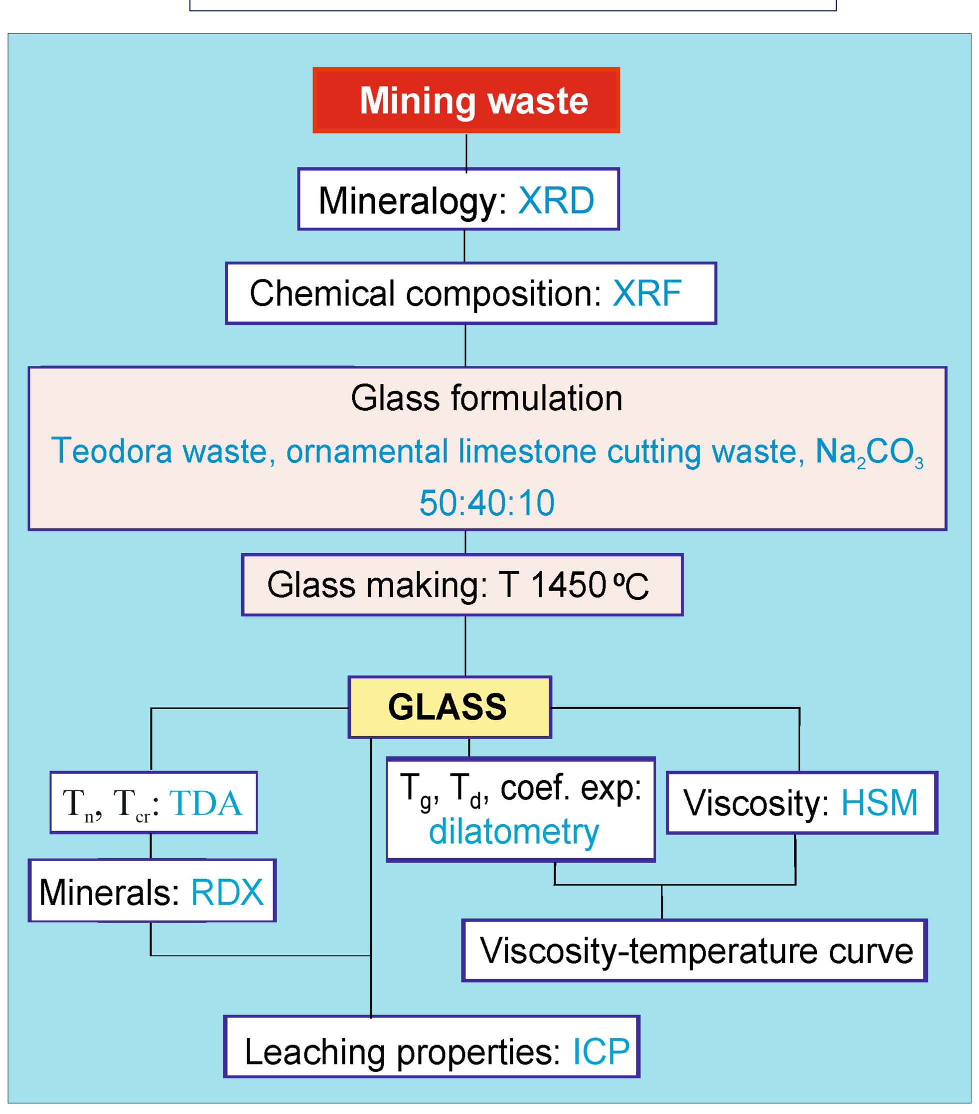


The exploitation of mineral resources raised greatly in the last decades, and its consumption is expected to continue increasing throughout the 21st century, generating a large amount of mining waste, which constitutes a serious environmental problem. The use of tailings as raw materials for glass-ceramic production is an environmentally friendly solution to the disposal of mining waste. The advantage associated with the use of this type of material settle down in the fact that they were already industrially processed, hence, often have good homogeneity and fine particle size. Furthermore, the material extraction costs are minimal, due to the surface disposal. Therefore, the mining activity income an additional application which promotes the circular economy by vitrification processes applying the mining waste reuse.

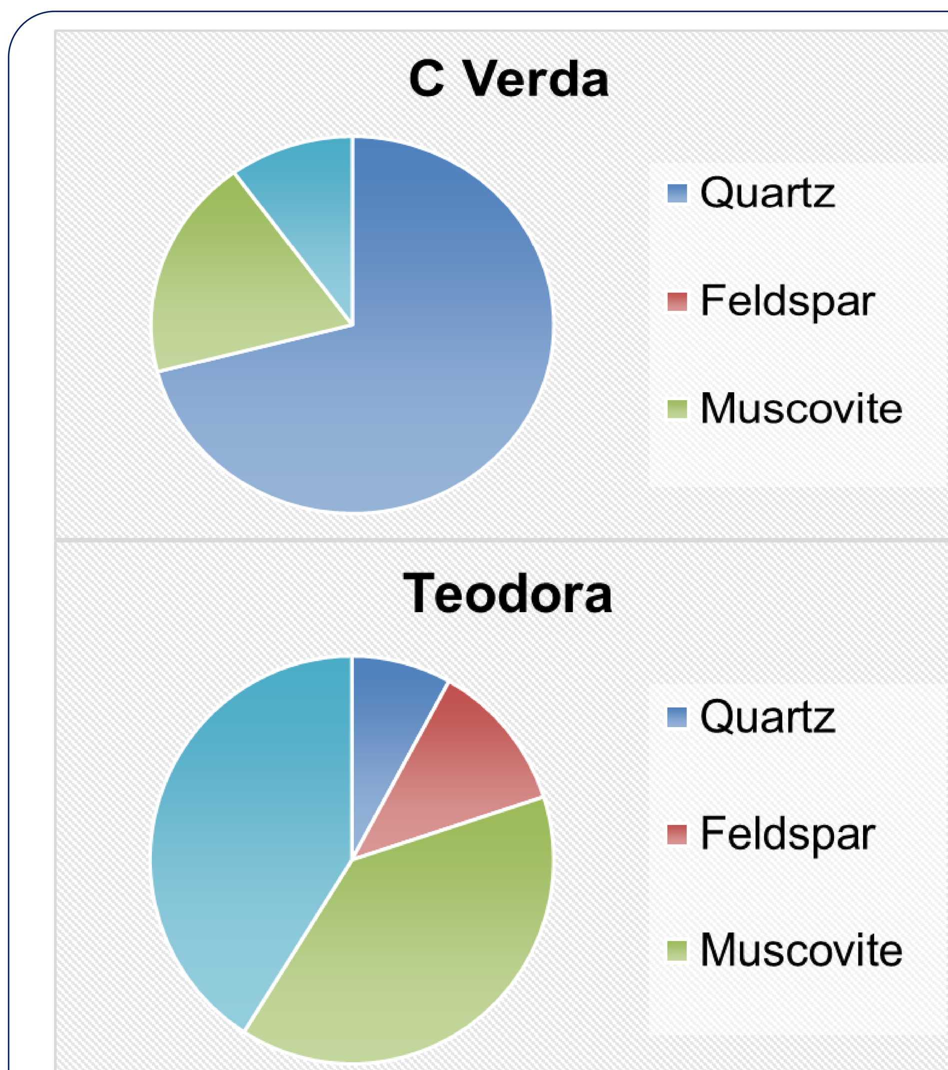
The aim of this study was to determine the potential as glass raw material of several tailings from the Pyrenean range, Spain) to be used as a commercial product as a remediation solution.

Map of the area of Spanish Pyrenees, with the different mines that operated in the past times.

METHODS



RAW MATERIALS



Mineralogy of raw materials (semiquantitative Rietveld analysis)

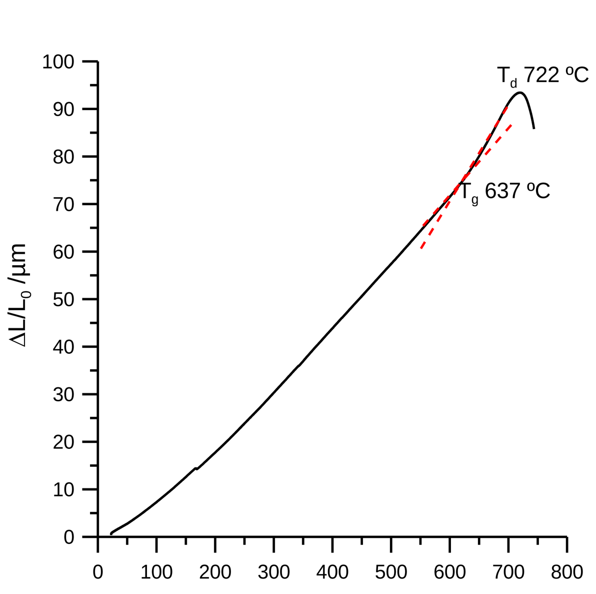
Chemical composition of tailing, determined by XRF, and from the glass produced with 50 wt% of waste from the Teodora mine, 40 wt.% of of waste from cutting a calcarenite-type ornamental rock and 10 % of Na2CO3 were added to make the glass.

Chemical composition of waste sample and the formulated glass.

Oxide (wt %)	Waste Collada Verda	Waste Teodora	Limestone waste	Glass (Teodora)
SiO_2	70.20	57.61	30.81	49.35
Al_2O_3	11.45	16.93	3.30	11.74
TiO_2	0.52	0.74	0.18	0.53
Fe_2O_3	5.68	8.89	1.17	5.90
Na_2O	0.24	1.31	0.12	7.86
MgO	0.30	2.08	4.38	3.08
CaO	0.16	0.39	29.50	14.39
K_2O	2.16	5.29	0.94	3.63
P_2O_5	0.14	0.14	0.05	0.11
MnO	0.08	0.08	0.02	0.07
ppm				
As	15494	134	-	-
Sb	181	12291	-	-
Pb	202	12152	-	-
Zn	61	441	-	

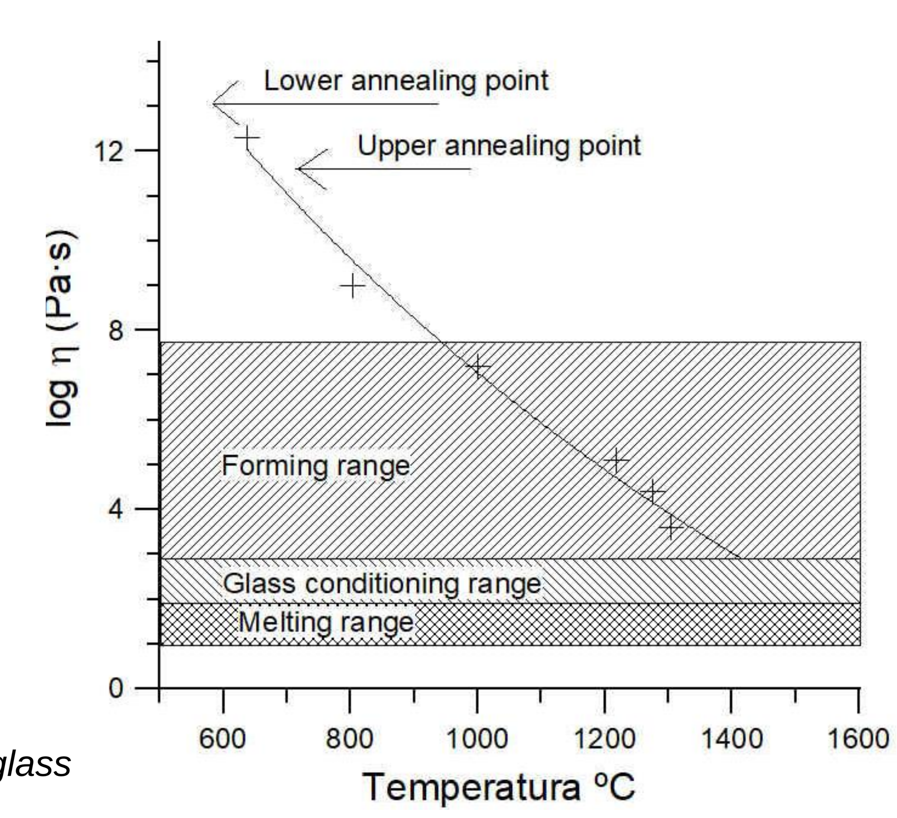
GLASS CHARACTERISATION

RHEOLOGY



Dilatometric curve of the Teodora glass

Expansion coefficient (25-450 °C): $12 \cdot 10^{-6}$ °C^{-1}.

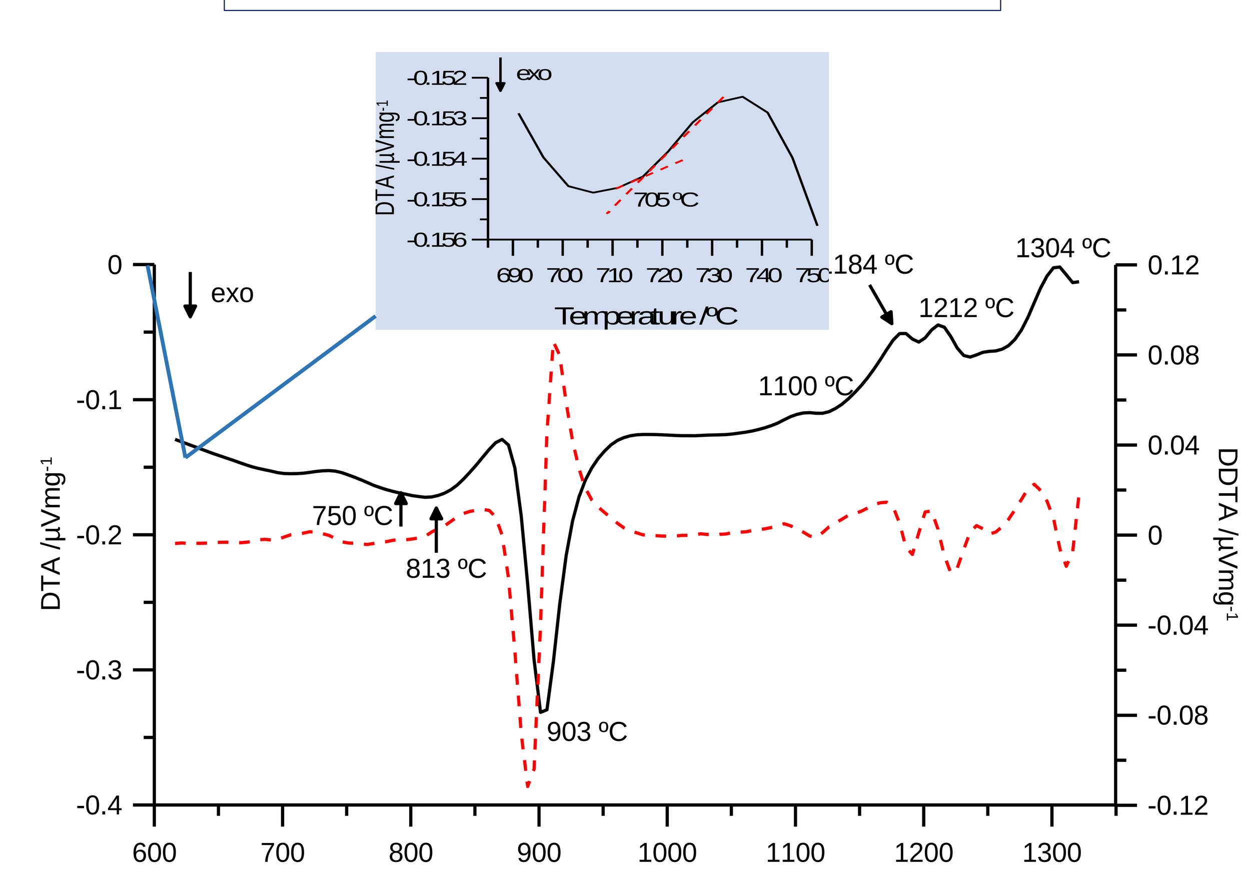


Viscosity-temperature experimental curves

Temperatures of viscosity fixed points (HSM), glass transition point and workability

Glass viscosity, Pa s	Temperature, °C
Glass transition point, 10^{12}	630
First shrinkage, $10^{7.9}$	803
Maximum shrinkage, $10^{6.9}$	1000
Softening, $10^{5.6}$	1217
Half ball, $10^{3.5}$	1304
Flow, $0^{2.1}$	1406
Calculated temperatures of the significant production viscosities	
Lower annealing point/$10^{13.5}$	542
Upper annealing point/10^{12}	634
Forming range/10^{8}-10^{3}	921-1402
Glass conditioning range/10^{3}-10^{2}	1402-1522
Melting range/10^{2}-10^{1}	1522-1650
Workability interval/10^{5}-10^{2}	1190-1522

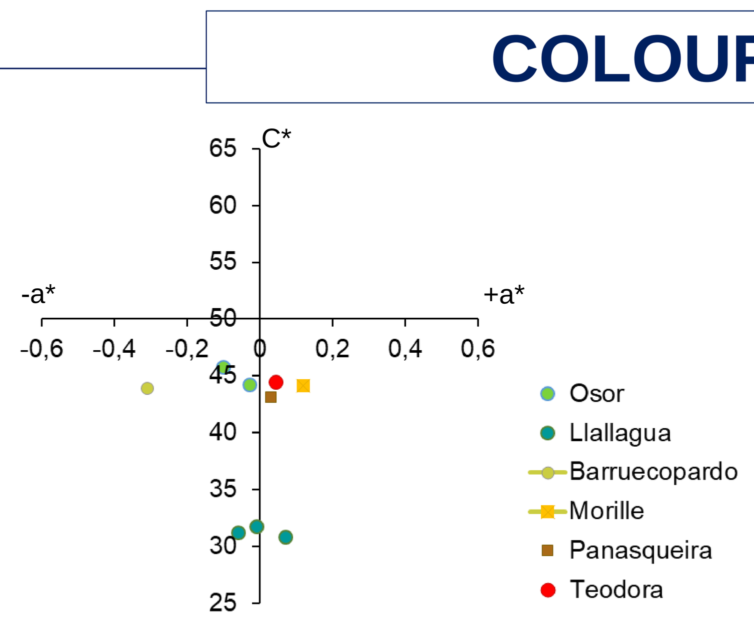
THERMAL ANALYSIS

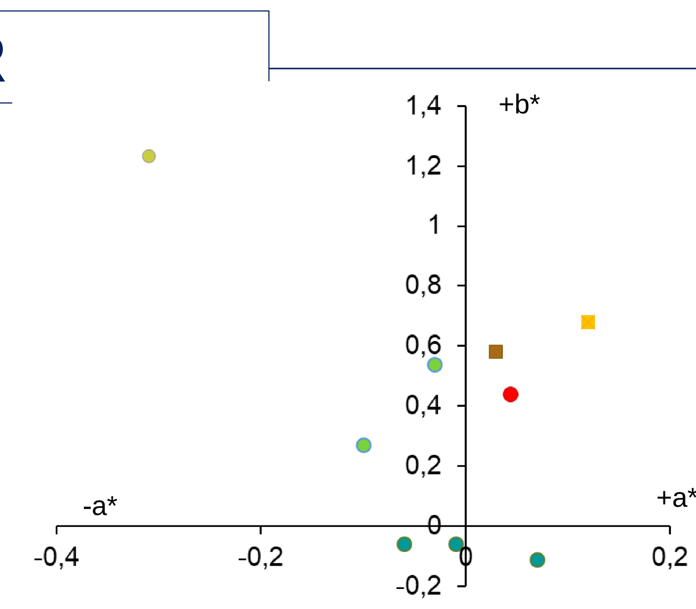


DTA (black) and DDTA (red) curves of the obtained glass from Teodora.

COLOUR

The colour of the glass obtained from the waste from the Teodora mine is dark and has a yellowish-reddish hue. Its low C* value indicates that it has a low purity colour. These results are common when dealing with glasses made from mining waste, due to the large number of metals or chromophore elements they contain.





Colour parameters of the Collada Verda glass compared to glasses from other mining wastes.

CONCLUSIONS

The tests carried out show that a commercial glass with good workability conditions can be obtained. In the case of waste from the Teodora Mine, the high content of forming elements means that for its application as a raw material for the manufacture of glass, large quantities of supplementary material must be added in order to obtain an adequate fluidity and manufacturing temperature. The use of other Ca-rich wastes makes their use possible.