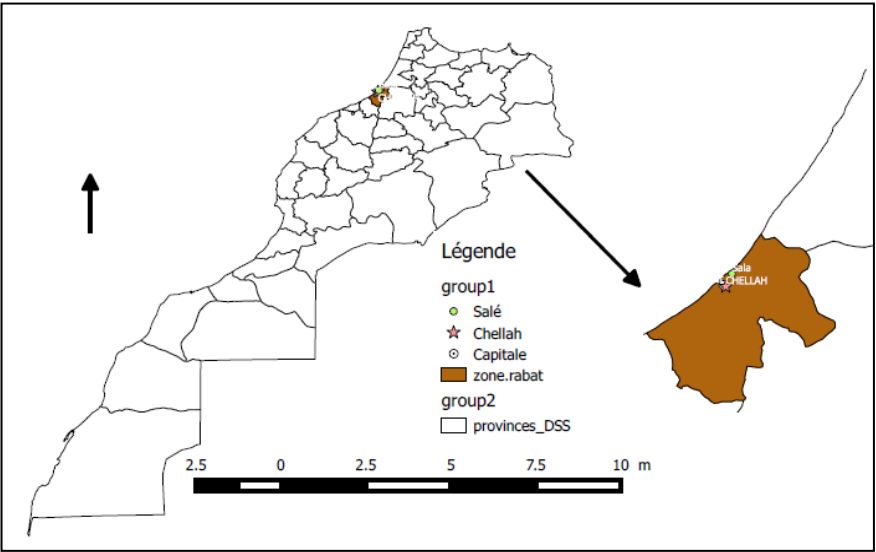


# Study and Comparison of Solid Bricks Used by Merinids and those For Restoration Within the Chellah Historical Site

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X = -6,8330340° / 6°49'58.9224"W  
Y = 34,0070770° / 34°0'25.4772"N  
S = 7 ha



Vienna, 26th may 2022

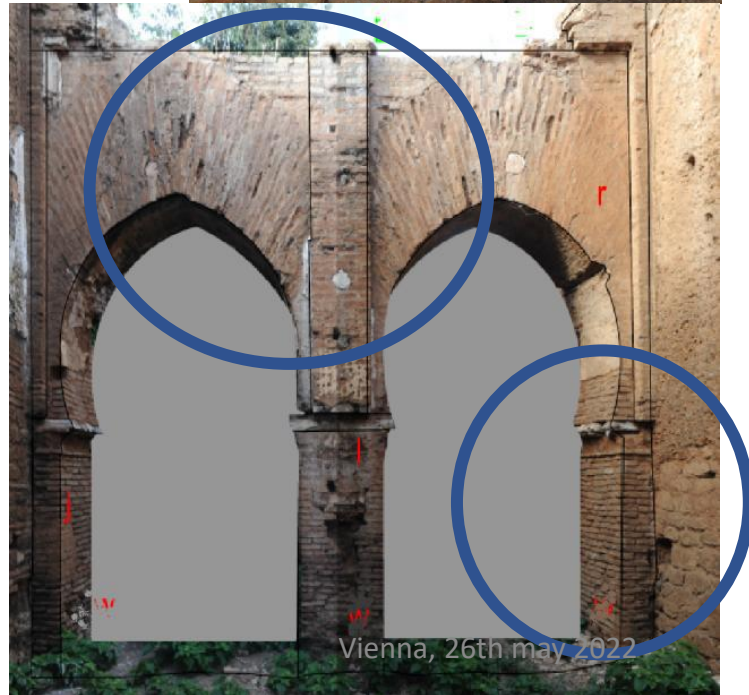
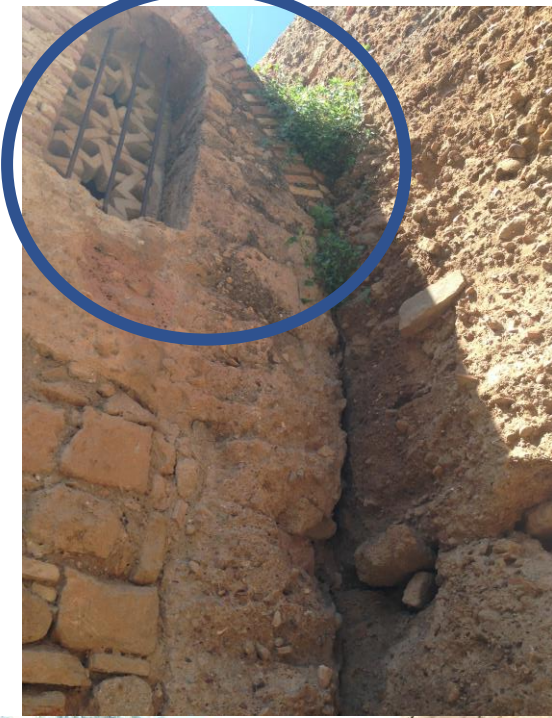




# Chellah in 1929











Bricks: solid with regular dimensions:

0.12m wide,

0.26m long ,

0.04m thick ,

joints of 0.03m - change with the equipment-

Bricks are encountered at the level of the merlons of the towers, arches and as well as on localities of the wall which are products of later restorations

Vienna, 26th may 2022

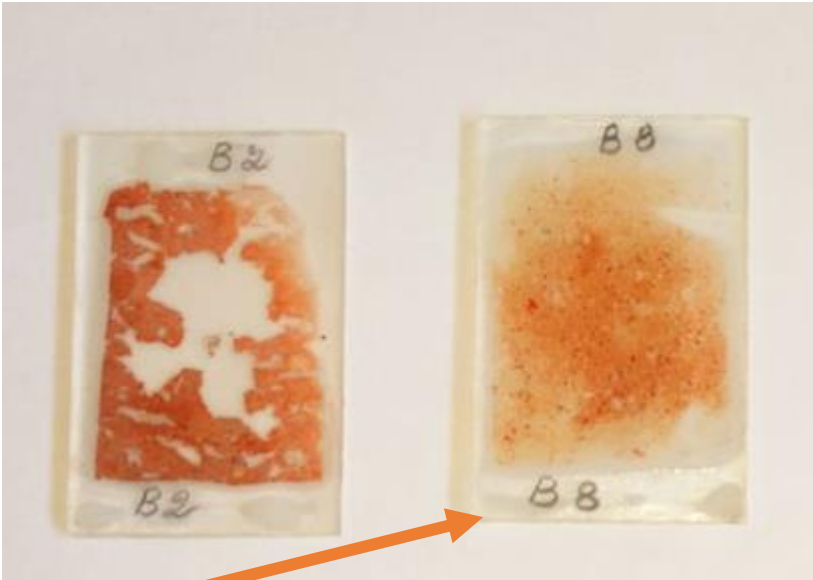




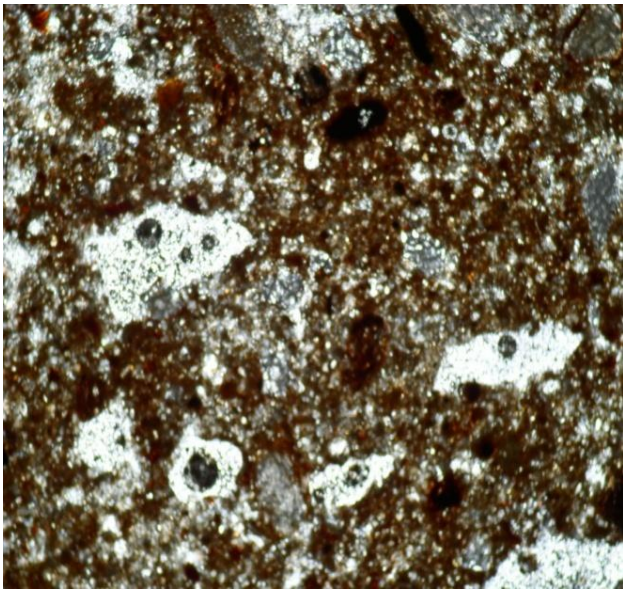
Vienna, 26th may 2022





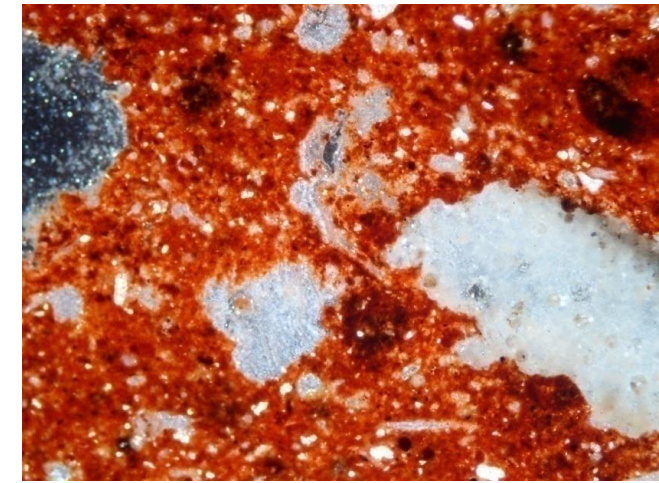




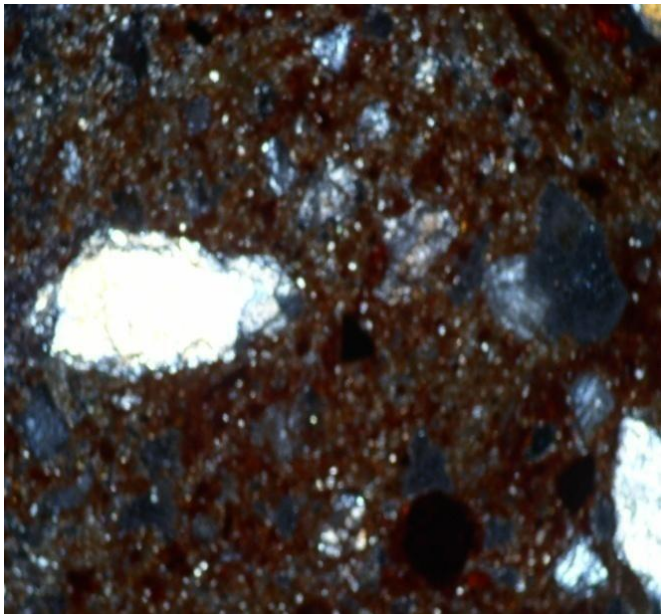


The merinid brick under white and polarized light under 4X objective

The restoration brick seen under a microscope is a slightly silty clay. It is a Triassic red clay, with sharp grains of quartz 50 to 80  $\mu\text{m}$  in diameter coming from the river, with finer marine deposits of minimal grains. The matrix is clayey



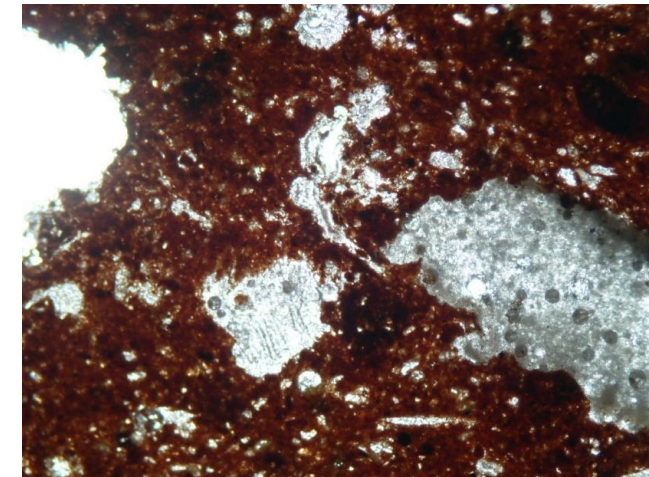
Chellah site restoration brick under polarized and white light, 10x objective.



It is weakly carbonated sandstone clay with large grains, sandy with sea or wadi sand, the dispersion of the grains shows a mediocre dosage of elements and therefore a poor quality.

Composed of 10 to 15% quartz 50 to 100  $\mu\text{m}$  in diameter, sub-rounded in shape, 5% of the contiguous quartz is 0.5 to 1 mm in diameter.

The matrix is essentially clayey with the presence of calcite slots.



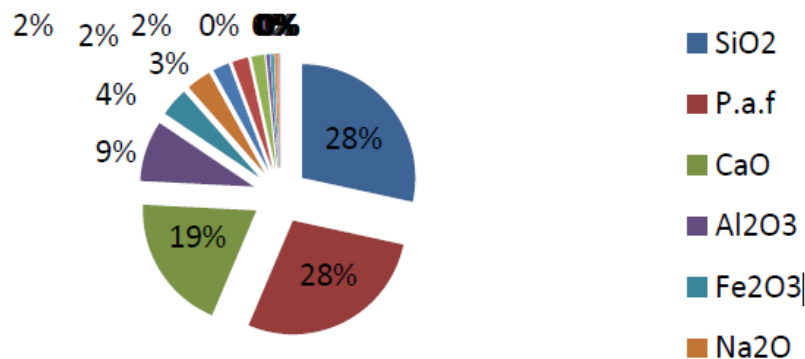


The apparent phases are:

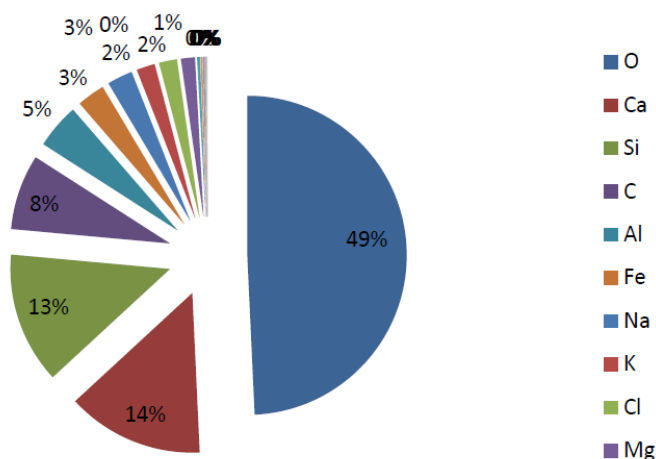
Calcite  $\text{Ca}(\text{CO}_3)$  under  $2\theta = 23.0730$ ,  $d = 3.85484 \text{ \AA}$ ,  $I = 337.34 \text{ cts}$

Quartz low, syn SiO<sub>2</sub> 2θ= 20.8644, d= 4.25764 Å, I= 684.52 cts

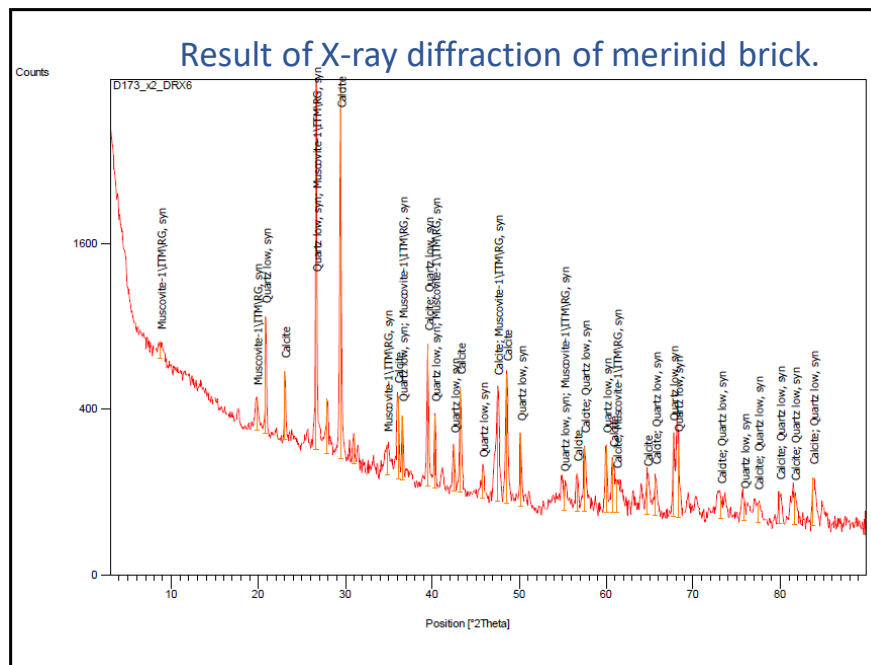
Muscovite-1\ITM\RG, syn  $\text{KAl}_2\text{Si}_3\text{AlO}_{10}(\text{OH})_2$  under  $2\theta = 8.7743$ ,  $d = 10.07819 \text{ \AA}$ ,  $I = 102.52 \text{ cts}$



## Merinid brick X-ray fluorescence result



### Distribution of chemical elements of merinid brick



The XRD and FX analyzes for the Chellah site restoration brick are unavailable given the frequency of machine breakdowns, the number of tests, the unavailability of the crusher and the relocation of the CNRST center.

The composition of the merinide brick is more siliceous than carbonated with percentages of 28% for silica and 19% of calcium oxide and 28% loss of fire the percentages of the other oxides are similar to those of the earth found on site. And so the origin of the component materials of these bricks comes from the site of Chellah. The major elements are oxygen, calcium and silica.



# conclusion

The original construction brick consists of coarse quartz grains with 10 to 15% dosage therein, while the restoration bricks are of good quality with minimal quartz grains of accepted diameters.

Good quality bricks must imperatively have a chemical composition of 50% to 80% silica, 0 to 30%  $\text{Al}_2\text{O}_3$  with almost 30% for the others oxides which is not verified by the building brick of Merinid origin.

In fact, the quartz in the mixture is a filler material which, according to its dimensions, represents the skeleton of the brick, the alumina improves the plasticity of the mixture and favors the obtaining of well-pressed products with significant relief, iron oxides and iron hydroxides are fluxes allowing the acquisition of different colors in the final product (red, grey, yellow, etc.). The alkaline oxides  $\text{Na}_2\text{O}$  and  $\text{K}_2\text{O}$  participate in and promote the sanding reactions and the formation of the vitreous phase, these two phases are important insofar as they condition the properties of the final product (mechanical resistance, porosity).

The clay used for the manufacture of bricks is the same as that of rammed earth and which comes from Oued Bouregreg.