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Neutronographic investigation of the effects of CaLoSiL® and Nano Estel® on the water absorption properties of *Pietra d'Aspra* limestone

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Aim of the work

- ✓ Neutron radiography (NR) was here applied to study the effects of two different commercially-available consolidants on the water absorption properties in a particular type of limestone (biocalcarenite), known as *Pietra d'Aspra* stone.
- ✓ The attention was mainly focused on the evaluation, by a fast and non-destructive visualization of the **water motion through capillarity**, of the **effectiveness of such layers as consolidating agents** in the view of preserving and maintaining both old and modern structures.
- ✓ The evaluation of the performances of **consolidating treatments** on this specific limestone is considered, at present, of great attraction and relevance.

1°

Preliminary characterization (PLM, MIP)

2°

Treatment with two commercial products, i.e. Nano Estel® (nanosilica) and CaLoSiL® (nanolime)

3°

Accelerated weathering tests

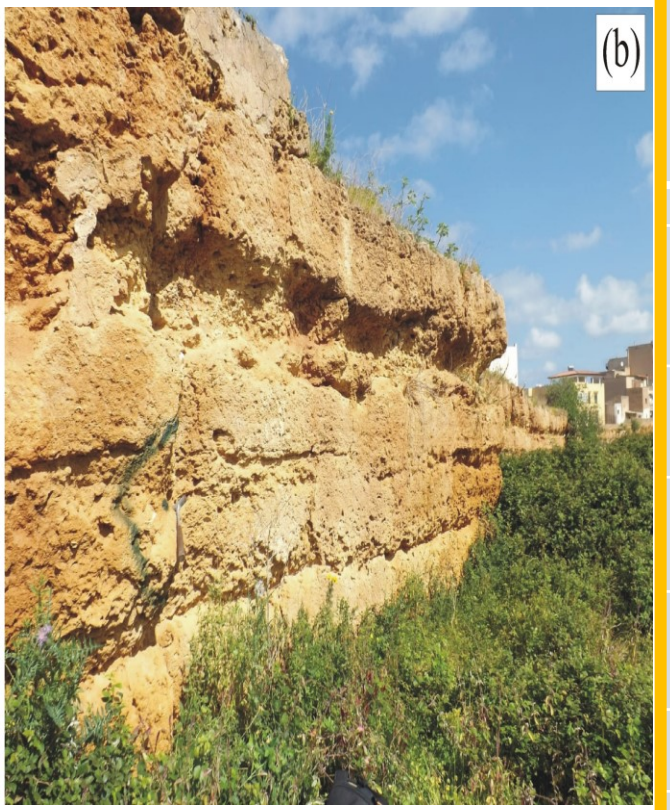
Salt crystallization

T/RH jumps

to simulate the material's response to different natural stresses

Pietra d'Aspra limestone

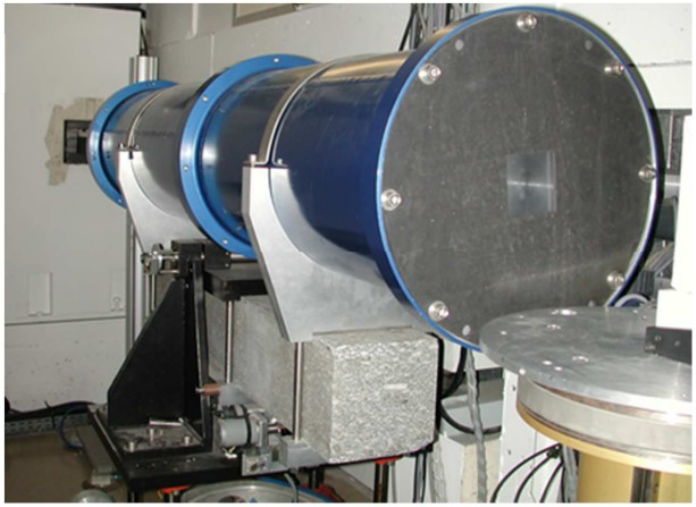
Pietra d'Aspra is a variety of Pleistocene biocalcarenite widely employed in Palermo city (in the North-Western Sicily). The generalized interest this type of porous calcareous stone, widespread employed both in ancient and modern buildings and churches, as well as to realize statues and monuments, derives from its availability in the territory and from the relative easiness of quarrying and workability.

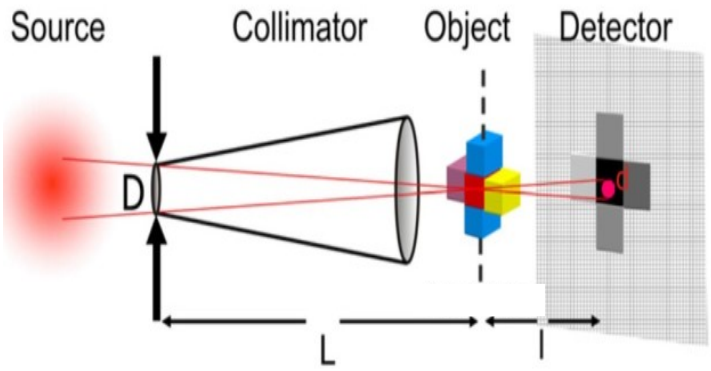


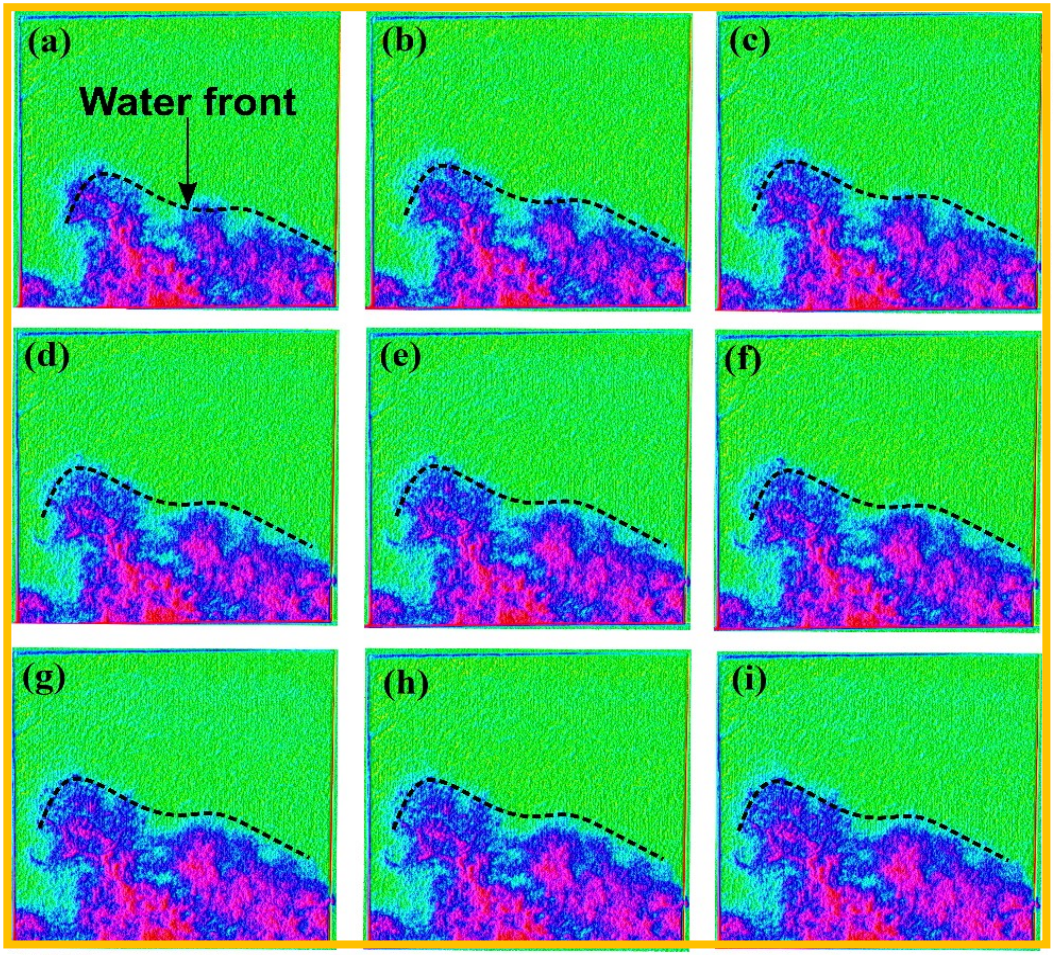
Sample code	Products	Experimentation tests
PA1	Nano Estel® (NS)	Climatic chamber (T, RH) after 3 cycles of salt crystallization
PA2	Nano Estel® (NS)	Salt weathering (15 cycles)
PA3	Nano Estel® (NS)	Not weathered
PA4	CaLoSiL® (NL)	Climatic chamber (T, RH) after 3 cycles of salt crystallization
PA5	CaLoSiL® (NL)	Salt weathering (15 cycles)
PA6	CaLoSiL® (NL)	Not weathered
PA-TQ	Untreated	Not weathered

Cold neutron imaging spectrometer IMAGINE at the Laboratoire Léon Brillouin (Saclay, F)

Organic materials or water are clearly visible in neutron radiographs because of their high hydrogen content, while many structural materials such as aluminium or steel are nearly transparent.

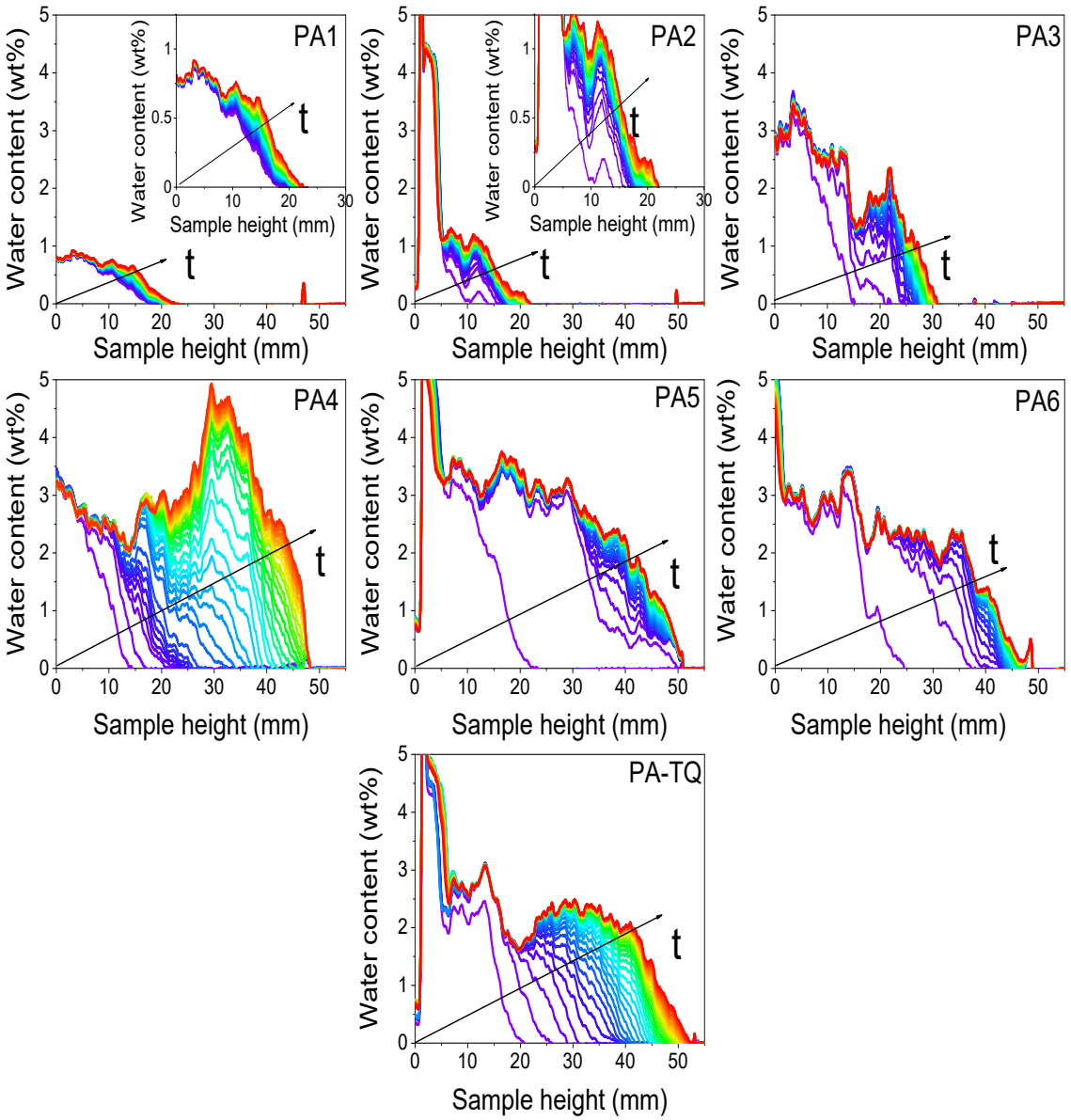




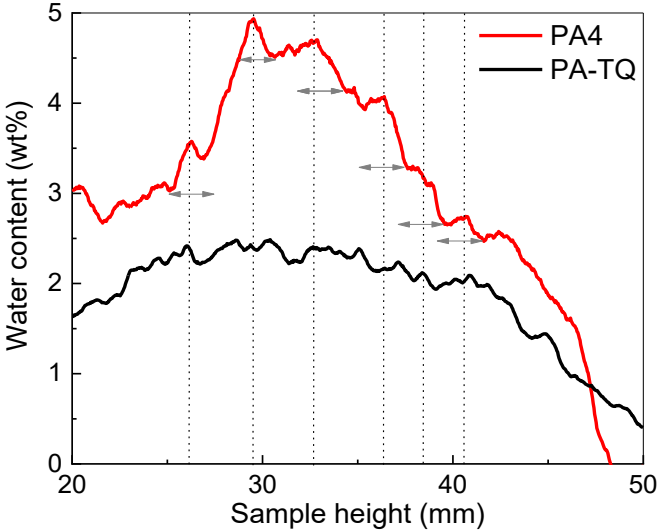


Neutron radiography results

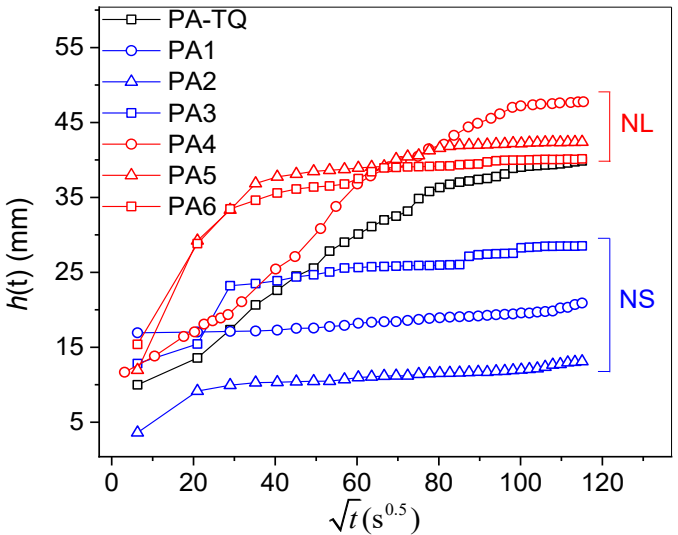
A) Water content profiles vs. Sample height (0 – ~13000 s)



B) Comparison between PA4 and PA-TQ



C) Mean penetration depth of water vs $\sqrt{t}$



Conclusions

- Neutron Radiography allowed us to successfully evaluate the effectiveness of two different consolidating products.

- NS revealed a better performance with respect to NL.

- The performed studies of petrophysical properties and capillary imbibition kinetics are indispensable for understanding the degradation mechanisms of *Pietra d'Aspra*, in order to give an appropriate response for future restoration interventions.