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Influence of rock petrophysics on the performances of protective and consolidation treatments to natural building stones: the case of Mt. Arzolo Sandstone (Pavia – Italy)

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Petrophysical characteristics of a building stone used in the city of Pavia, Northern Italy, are analysed in the sight of stone conservation through the application of water-repellent and consolidant products. The research focuses on: a) the modification of the petrophysical properties of the building material as a function of the applied products; b) the crytical assessment of the performances of two families of products, i.e. fluorinated and siloxane resins, as a fuction of the variable nature of the same lithotype.

The studied material is a calcareous sandstone (Mt. Arzolo sandstone), Late Miocene – Early Pliocene in age; the stone has been employed during the XI-XII century in small amounts in several civil and religious buildings and in large amount in one of the most beautiful example of Romanesque architecture in Italy, the St. Michele Maggiore Basilica, whose aspect and fortune are strictly connected to the nature of its building material. In fact, besides its artistic value, the Basilica attracts the attention of the public because of its uncontollable weathering process which is making all the ornaments that adorn the whole external masonries fade. For this reason, several studies and interventions were realized during past and recent times, some of which have deeply modified the sandstone nature (e.g. the use of Mg-Zn fluosilicates), speeding up the dacaying processes [1; 2; 3; 4].

Various Authors [1; 5; 6] pointed out the extreme variability of this lithotype with respect to its petrophysical features even in a single quarry. This variability is supposed to be present also in the building site. However, a systematic classification of

the petrophysical parameters has still to be assessed. This aspect is of outmost importance when a conservative intervention is to be planned as pre-consolidation and cleaning techniques and the possible application of protectives and/or consolidants may be influenced by the substrate characteristics [7]. In order to increase the knowledge on physical and mechanical modifications imparted to the building material by consolidants and water repellents, experimental investigations on 56 samples of fresh stone taken from historic and documented quarries have been performed, such as: a) petrographical and textural analyses on thin sections; b) determination of indexes of anisotropy by means of ultrasonic measurments; c) determination of open porosity by means of mercury porosimeter; d) tensile strenght and abrasion resistance measurments; e) contact angle measurments; f) capillary water absorptions; g) low pressure water absorptions; h) water vapour permeability; i) colour measurments by means of spectrocolorimeter. All the tests from c) to i) have been performed before and after treatments, according to the Italian normative UNI [8].

As a result, two main different lithotypes of Mt. Arzolo Sandstone coming from historic quarries have been recognised according to their petrophysical features. Being similar the open porosity of the studied materials (13.3 – 13.7%), differences exist concerning their texture: one lithotype is a moderately sorted medium sandstone (mean grain-size = 0.3 mm) with mean pore-size of 0.3 μm and 10,8% of macropores (i.e. $>$ 2,5 μm). The second lithotype is a moderately sorted fine sandstone (mean grain-size = 0.2 mm) with a different pore-size distribution: the mean pore-size equals to 0.15 μm while macropores are almost absent ($\leq$ 2%).

These differences have a direct effect on the physical-mechanical properties of the building materials and consequently on the performances of the applied products. In particular, the difficulties in penetration of water-repellent and consolidant products when sandstone of smaller pore-size is treated, can led to a significant reduction of overall performances which is more evident for products with high molecular weight. Being valid for this specific case study, the results provide useful indications on the more general dispute of establishing the interactions between building materials and conservation organic polymers.

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