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Modern restoration products based on nanoparticles: The case of the Nano-Lime, interaction and compatibility with limestone and dolostones surfaces, advantages and limitations

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Calcium hydroxide (also known as lime) is one of the oldest products used in construction, mainly as a binder in mortars (joint mortars, renderings, wall fillings, etc), in mural paintings, as a consolidant product, together with other materials such as rammed-earth. .
In Conservation Science it can be used to restore the cohesion loss by filling the porosity of the limestone. When calcium hydroxide is exposed to atmospheric CO_2 in wet conditions, the layered network of its hexagonal packing crystal structure favors the incorporation of such CO_2 to the structure producing the carbonation process, which consists of reacting and transforming into calcium carbonate. However, this approach has resulted in many cases unsatisfactory by the poor penetration of the dissolution inside the stone material and its inability to achieve complete consolidation of the damaged area of the material. The development in recent years of nanoscience and nanotechnology has opened the possibility for different scientific areas. This new science enables new applications of materials that were previously unfeasible, since the behavior of materials at the nanoscale is modified as a result of particle size reduction. Nanotechnology contributes to the science of cultural heritage conservation with new products that can modify its properties and that among other applications, are used in protection and consolidation of geomaterials. However, it is important to assess whether their characteristics are compatible or not with petrological aspects, diagenetic and geochemical conditions and/or mineralogical, or local environmental conditions they are exposed and amend the process and therefore its effectiveness. Like all products used in treatments of consolidation, consolidating products based on nanoparticles, different agents are susceptible to extrinsic and intrinsic factors that influence its stability and can, at a given time, alter their specific properties. That is why the same factors that affect the stone surface such as relative humidity, exposure time, temperature changes, are some of the factors that may influence in their efficiency and performance at short or long terms. Differences in the carbonation process in nanoparticles are associated with several factors among which are the presence of CO_2 in the environment and the presence of water (liquid or vapour phase) as an accelerator of the process, producing differences in the nucleation and growth of different calcium carbonate polymorphs. This behaviour affects the reactivity of minerals, their crystallinity, and the porosity and petrophysical properties of the stone surface to which nano lime has been applied.