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Ion chromatography to detect salts in stone structures and to assess salt removal methods

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Stone – and in general all materials- from built heritage is very often damaged by salt crystallisation processes. Such processes usually derive into a loss of material compactness, as salts – given specific conditions and parameters- crystallize inside the material pores, exerting a pressure against the material pore walls higher than what they can resist – similar to the effect of liquid water when converts to solid water or ice-, thus breaking and disrupting the material by generating fissures and increasing the pore volume ratio, loosing its initial cohesion.
When these deterioration processes take place inside a structure, salts – from different sources: material itself, restoration materials, from the ground, etc.- may come up to the stone surface – either temporarily or in permanently-, from beneath it, as efflorescences, depending mainly on the microclimatic conditions of the environment and the salts source.
Efflorescences can be analysed and their nature identified (e.g. by means of X ray diffraction, in which the mineralogical composition of the salt is obtained), which can be, general, of aid not only for restoration but for preventive conservation measures. But what we do not know a priori when only characterising salt compounds- is the extent of the damage due to the presence of salts inside a structure (sub- and cryptoefflorescences).
In this work we present a procedure in which the depth of the salt content can be measured, and its nature identified, based on the use of the ion chromatography technique. This technique allows identifying the existing ions in a specific sample, both anions and cations. The procedure consists of drilling (with a drilling core ranging from 5 to 8 mm in diameter, therefore causing the minimum damage to the material) in a same point at different depths from the surface and several depths from the bottom. The samples obtained are analysed and the ion content determined, qualitative and quantitatively. By means of a thorough previous inspection, we can select the most representative points by a drilling net – as minimum as possible- and make some profiles of the inner salt content of a structure. Moreover, this procedure is not only reliable for determining the nature and extent of salts damage, but to assess the efficacy of salts removal methods in cultural heritage.
Here we present two case studies from relevant buildings of the Spanish cultural heritage in which this procedure was performed with successful and useful results, in both terms of understanding what types of salts were decaying the stones structures, and also whether the salts removal methods that were planned in the restoration project were efficient or not.
It should be remarked that even ion chromatography is not a non destructive technique (can be considered as a minimally destructive one due to the few quantity it is needed for the analysis), the information it can provide is so useful that should not be ruled out from the beginning, depending of each specific case.