Re.S.Artes

Le Regard de la Science sur les Arts et le patrimoine culturel

Scientific analysis of stone sculptures : some elements of understanding

The scientific study of stone objects is based upon the analysis of a sample of the raw material that will permit to determine the composition of the material and to evaluate the nature and the extent of its weathering.

For authentication purpose, it is possible to state about the compatibility of this information with the presumed antiquity of the object:
if the stone is not or few weathered or if it has been submitted to chemical attacks in order to simulate its aging,
then the object is considered as modern.

This is a complementary approach to the stylistic study of works: it provides objective information that comes support (or refute) the point of view of the expert.
This study can be completed by the analysis of deposits extracted from the surface in order to search for traces of modern work or treatment; this superficial sampling is made where it is not possible to take a part of the sculpture (the face, for example).
It can be also necessary to perform an X-ray imaging in order to confirm the homogeneity of the piece and to extrapolate the analysis results to the whole object.

Principle et measurements

The experimental protocol is based on the observation of the sample with scanning electron microscope (SEM) and the determination of the elementary composition of the stone and some superficial products with EDS analysis (energy dispersive spectrometry) for major and minor elements.

Taken with a handsaw perpendicularly from the surface of the object, then put into a resin (epoxy) and polished, the sample presents a clear section from the surface to the inside part of the object.

SEM technique allows obtaining black and white pictures of the material, with huge magnification, because of an electron beam directed by electromagnetic fields. We used the following observation mode: the backscattered electron imaging (BSE) that shows the chemical element contrast of the material. Furthermore, the energy of the electrons used is enough to produce interactions with the material which emits X-rays detected and transformed in data through a spectrum (X-ray energy-dispersive spectra, EDS), giving the elementary composition of the analyzed material (major and minor elements – more than 0.1%).

Finally, the results obtained on the section, both as regards the imaging and the elemental analysis, allow to determine the composition of the material and to obtain information about its surface state, that are useful to validate their compatibility with the presumed antiquity of the object.

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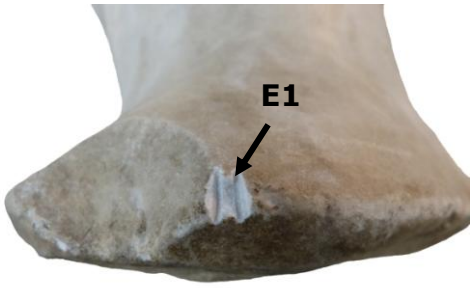
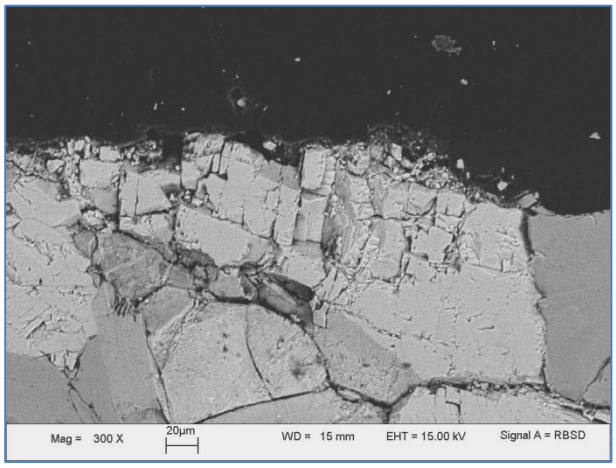
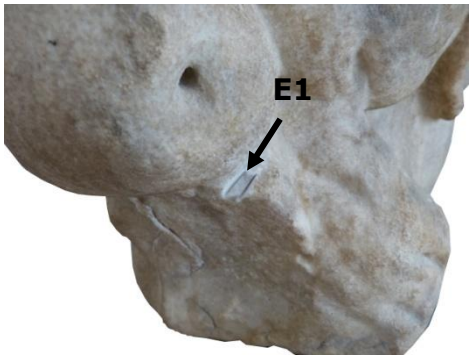
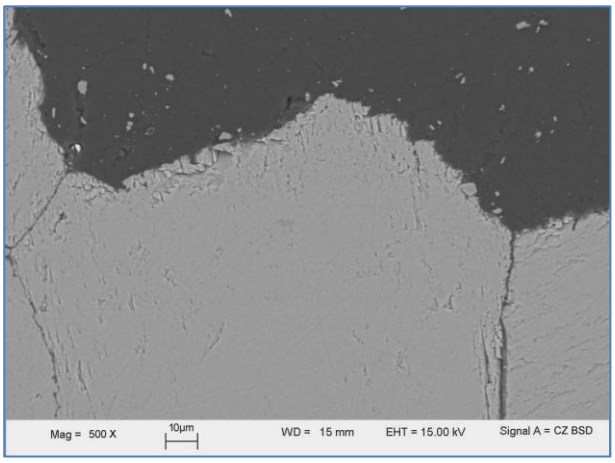
Two examples





Marble sculpture, Italy, presumed from Ancient period
The marble shows extented weathering phenomena at the carved surface, that are characteristic of natural and long time processes. These observations are consistent with the presumed antiquity of the object.





Marble sculpture, Italy, presumed from Ancient period
In this case, the marble shows very few and superficial weathering features corresponding to natural but short time processes. These observations are not consistent with the presumed antiquity of the object.

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