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The compositional and mineralogical analysis of pigments in Nasca pottery from Cahuachi (Perù) by the combined use of the portable PIXE-alpha and portable XRD techniques

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It is well known that the analysis of mineral pigments can give useful information to archaeologists and museum curators. In fact, the results of their compositional and mineralogical investigation allow to understand both the technology used in ancient time to produce and to decorate artefacts and to evidence the differences in the artistic and cultural evolution of different geographical regions.
The Nasca pottery (Peru) dating back to the 2nd-4th century AD represents one of the most interesting cases in which different minerals are mixed in order to produce a large variety of hues of colours.
This typology of pottery has been investigated in the past mainly by using destructive techniques and/or methods that can not distinguish between the pictorial layer and the substratum (1).
However a non destructive approach should be mandatory when the analysis refers with well preserved masterpieces. Moreover the use of portable systems allows the analysis of whole artefacts that can not be moved to laboratories due to their artistic and historical value.
In the last years at the LANDIS laboratory of the LNS-INFN and IBAM-CNR of Catania (Italy) many efforts have been made in order to realize innovative portable PIXE-alpha and XRD systems for in situ applications in the cultural heritage field (2,3,4).
Recently, these systems have been combined for the investigation of ancient mineral pigments (5). In fact the PIXE analysis, due to the analytical depth limited to few microns, is particularly suited for the elemental analysis of surface without any contribution of the substratum. In the case of pigments the analysis is limited to the pictorial layer. However, in order to operate the quantitative analysis of the sample being analysed, it is necessary to known the light elements invisible to the PIXE analysis (like oxygen, carbon, etc.) and their stoichiometric composition. Due to the mineralogical nature of pigments under investigation, the XRD technique is particularly suited to obtain this information. The analysis of the experimental diffractogram is performed limiting the search/match only to those mineralogical phases containing the elements already measured by the PIXE measurement.
Finally, the minerals identified by the XRD are in turn used to correctly define the light matrix of the samples and to operate the quantitative calculation of the PIXE measurements.
In the present work some pigments (in particular black, red-brown and white colours) present in some fragments coming form the Nasca site of Cahuachi (Peru), have been analysed by using the portable PIXE-alpha and XRD systems developed at the LANDIS laboratory.
This work has been performed within the scientific activities carried out by the ITACA mission (Italian mission of heritage Conservationa and Archaeogeohysics) of IBAM-CNR in Peru .
The study represents a preliminary result in order to show the potentiality of the combined use of those portable techniques for the in situ analysis of the pigments composing the Nasca masterpieces.
The black pigments resulted to be composed mainly by iron and manganese oxides; the red and brown pigments by iron oxides and, finally the white colour by the use of clay-based minerals.
It should be noted the Nasca pigments are fired; subsequently the raw minerals are subjected to phase transformation during the firing and their identification, especially for the clays composing the white pigments, can be difficult.

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