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Ion Beam Analysis for the provenance attribution of lapis lazuli used in glyptic art: The case of the "Collezione Medicea"

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ABSTRACT

The first part of this study reports on the wide campaign for the extension of the database of both trace and minor elements concentration in diopside by means of μ-PIXE measurements and of luminescence spectra in diopside and wollastonite by means of μ-IL measurements. Diopside and wollastonite are actually two of the most common lapis lazuli-forming minerals. For this former part of the study, we analysed rocks of known provenance at the microbeam line of the LNL laboratories in Legnaro (PD) of the Istituto Nazionale di Fisica Nucleare (INFN).

The latter part of the paper is dedicated to the non-invasive Ion Beam Analyses (IBA) characterisation of six pieces of the "Collezione Medicea". The collection is exhibited at the Museum of Natural History (University of Firenze) and belonged to the Medici family. It includes artworks made of lapis lazuli manufactured in the 16th and 17th centuries but there is not precise information about the provenance of the used raw material.

Results on the artworks show, as expected, that the Chilean provenance of the material used for the analysed artworks has to be excluded. Lapis lazuli used for five of the analysed artworks can be ascribed to the Afghan quarry district, while one object cannot be attributed only on the base of diopside and wollastonite analysis.

1. Introduction

Lapis lazuli is a blue semi-precious stone that requires peculiar conditions to be formed, and for this reason it occurs in few places in the world [1]. Even so, it has been widely used in glyptic since the antiquity and by different civilizations. Although the Badakhshan mines in Afghanistan (the most famous being Sar-e-Sang) are now widely considered as the only source of lapis lazuli in ancient times, other sources have been taken into account [2,3]. A systematic and exhaustive provenance study of the raw material employed for artworks is still lacking, even if over the last few years different approaches, all exploiting non-invasive techniques, have been used to discriminate among different geological sources [4–6].

In previous works we have already analysed samples of rocks of known provenances by means of focalized ion beam techniques, in particular μ-PIXE (Particle-Induced X-ray Emission) and μ-IL (Iono-Luminescence). These techniques were chosen because they allow to analyse single crystals of different minerals, a fundamental aspect in a heterogeneous material as lapis lazuli, and also because of their non-invasivity, being often impossible to take samples from artworks or to work in vacuum. Some markers were found and proposed to distinguish among the four different provenances: Afghanistan (Badakhshan), Tajikistan (Pamir Mountains), Siberia (near Lake Baikal) and Chile (Ovalle) [7–10].

In this work we focused on two among the several mineral phases of lapis lazuli proposed as markers: diopside ($CaMgSi_2O_6$) and wollastonite ($CaSiO_3$). Twelve samples were already analysed

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