INTRODUCTION

The aim of this research is to establish reliable criteria to distinguish mobile sediments collected from Veneto rivers that are expected to be of very similar composition since they share nearby hydrographic basins. In particular, sediments from the riverbeds of Adige, Brenta, and Bacchiglione were collected and investigated by IBIL and DRIFT spectroscopy. Since it was recognized that likely sources for Roman building materials were rivers flowing close to the corresponding locations, results from the present study are expected to be useful in identifying the origin of sands obtained from mortars belonging to some 1-century-AC Roman villas located in the X Regio [1].

In this work FT-IR and Ion Beam Induced Luminescence (IBIL) spectroscopies have been used for the first time for analyzing mobile sediments. In particular, the main spectral features, suitable for the identification of the provenance of the different samples, are examined.

EXPERIMENTAL

Since the river sediments composition is known to be strongly dependent on the grain size [2], we subjected all our samples to wet sieving in order to restrict the investigation to grains with dimensions comprised between 63 and 420 microns.

Such samples were subsequently reduced by an adequate grinding mill cycle to a finer grain to reduce the strong influence of grain size on DRIFT spectral features [3] and to obtain reproducible spectral features from IBIL measurements.

The prepared sand samples were diluted in a KBr powder matrix and placed in a Pike DiffusIR measurement unit; a Bruker Optik Vertex 70 spectrometer was employed to record the DRIFT spectra in the 370 - 4000 cm\(^{-1}\) range with a nominal resolution of 4 cm\(^{-1}\); in each run five hundred scans were averaged and subjected to Norton - Beer (medium) apodization before Fourier transformation and conversion into Kubelka-Munk units.

Samples were irradiated at the AN2000 LNL accelerator with a 2.0 MeV \(^1\text{H}\) beam of about 1 mm\(^2\) area. IBIL spectra were collected with a silica optical fibre (600 \(\mu\)m diameter) and processed by a FL QE-65000 spectrometer (Ocean Optics Inc.), allowing to record the luminescence spectrum in the range between 250 and 900 nm, within 1 s of integration time.

RESULTS

Visual inspection of the DRIFT river sand spectra shows the presence of carbonate minerals (bands labelled C in figure 1), namely calcite and dolomite, of silicates (S-labelled bands), mainly crystalline quartz (typical doublet labelled Q in figure 1), and of feldspars (F-labelled bands).

Fig. 1. DRIFT spectra of two representative samples in the most significant 450-1650 cm\(^{-1}\) region (main features are labeled; see text); 4 cm\(^{-1}\) resolution, 500-scan average; 2.9% sample in KBr.

Fig. 2. Gaussian peak fitting of the spectral features in the 680-740 cm\(^{-1}\) range; fitted peak intensities give ID = 48.

From the study of the 680-740 cm\(^{-1}\) region where the carbonates \(\nu_4\) band occur it is possible to evaluate the different content of dolomite (double carbonate of calcium and magnesium in ratio 64.65:46.35 of trigonal-rhombo-
part of the spectrum, peaked at 620 nm and 645 nm for Brenta and Adige spectra, respectively. Moreover, in Adige spectrum the red peak exhibits a faint shoulder at about 575 nm. This band is ascribed to Mn$^{2+}$ in different environments. In particular, the 620 peak is characteristic of Mn$^{2+}$ in calcite cathodoluminescence spectra, while the asymmetric peak in Adige spectrum is due to Mn$^{2+}$ in dolomite, where the ions occupies a Ca-site (645 nm) or a Mg-site (575 nm). The NIR feature at about 865 nm has been ascribed in literature to feldspar intrinsic luminescence [4]. The blue-green part of the IBIL spectra, i.e. the broad bands around 275, 335 and 450 nm, is related to intrinsic emissions, which have to be further investigated for a correct assignment. Moreover, the changes of the spectra with the irradiation fluence will be examined in order to acquire more information on the suitability of IBIL in the analysis of geological samples.

Fig. 3. Normalized IBIL spectra of Brenta and Adige sands.

In figure 3 are shown the normalized spectra collected from Brenta and Adige sands. As can be observed both spectra are characterized by a well evident band in the red

hedrahedral structure with $\nu_4$ band centered at about 729 cm$^{-1}$) and calcite (calcium carbonate of trigonal-hexagonal scalenohedral structure with $\nu_4$ band centered at about 713 cm$^{-1}$) to give the so-called dolomiticity index, $ID = 100 \times \frac{[\text{dolomite}]}{([\text{calcite}] + [\text{dolomite}])}$. In figure 2 an example is given of the interpolation of such features.

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**References**