EPSC Abstracts
Vol. 6, EPSC-DPS2011-1064, 2011
EPSC-DPS Joint Meeting 2011

IR spectral characterization of some impact glasses from major terrestrial fields for remote sensing applications

O. G. Iancu (1), I. C. Popa (2) and I. Prundeanu (1)

(1) Department of Geology, University „Alexandru Ioan Cuza”, Iasi, Romania (2) INAF-Astronomical Observatory of Capodimonte, Napoli, Italy (ogiancu@yahoo.com / Fax: +40-232-201474)

1. Introduction

Tektites are amorphous glass samples that form during the quenching of molten rock resulted after a meteorite impact or thermonuclear detonations. The terrestrial tektites reflect the chemical composition of the rocks from which they derive, with an advanced volatile depletion. The most used volatile to define the origin from an impact process is water. Water in tektites is low, reflecting the high temperature at which the terrestrial tektites have been exposed [1,2]. A terrestrial glass sample with unknown origin (with strong tektite macroscopic and microscopic characteristics) was analyzed along with other two tektite samples from known terrestrial strewnfields. The measurements are intended as a possible mean to positively identify new tektite samples, as well as to serve as completion for spectral libraries that are used for the characterization of planetary surfaces in the UV-VIS-NIR (0.3 – 3.3 µm) solar reflection range (SR).

2. Samples and methods

Two samples of tektites were chosen for analysis both from Ward’s Natural Sciences: i) an Indochinite sample, and ii) a piece of Darwin glass (DG) type sample (from Mt. Darwin, near Ten Mile, Tasmania). An unknown glassy sample from a private collection in Brasov Romania (hence the abbreviation BV) was added to the set of samples for the analysis. The samples were crushed in an agate mortar producing grain sizes ranging from more than 200 to 25 µm, obtaining four grain sizes. Each resulting grain class was further treated separately using a non polar liquid (ethanol) in an ultrasound bath. This treatment was done to remove the small grains bounded electrostatically at the surface of larger grains. The samples thus prepared were measured against a KBr standard using a Perkin Elmer Lambda 950 (for the UV/VIS range) spectrophotometer and a Bruker Equinox 55 FTIR spectrometer (for the NIR range) with a Harrick Praying Mantis diffuse reflectance accessory. In order two characterize the sample from the structural and chemical composition point of view, thin sections of the samples were prepared. Petrographic polarized microscopy analysis and SEM EDS chemical analysis was done on thin sections.

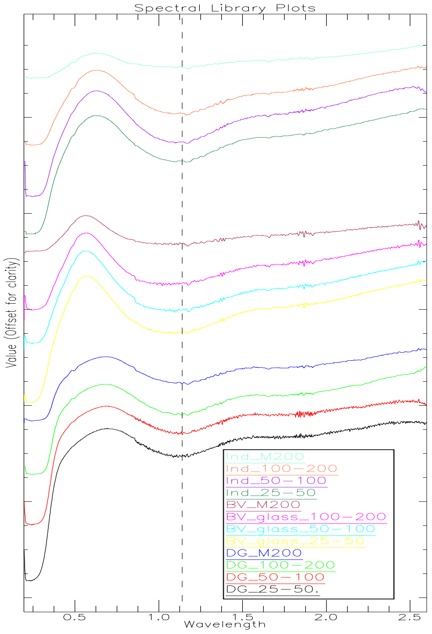

Figure 1: Spectral response in the 0.3-2.5 µm range

For major elements chemical composition a Cambridge S360 Oxford Inca Energy 200 SEM/EDX was used for quantitative electron microprobe analysis using Cr film cover.

3. Results

The overall results of the samples show a similar spectral trend for all the samples analyzed. The spectra present strong ultraviolet absorption centered around 0.3 µm. There is a variable centered intense refection around 0.55 µm that is best defined in the case of BV glass explaining its green color. In the case of Indochinite and DG, the maximum of the reflection is broader and shifts toward longer wavelengths (0.61 and 0.65 µm respectively), thus explaining the darker color for bulk samples (Figure 1).

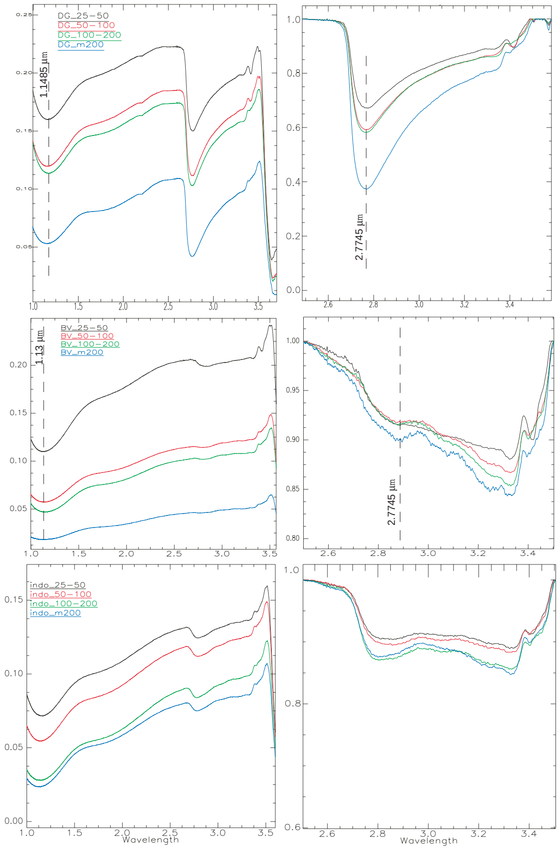

Figure 2: Diffuse reflectance NIR spectral range (measured with Bruker Equinox 55 FTIR spectrometer) for the samples measured (left column). Right column detail of 3 µm band region (continuum removed).

The NIR infrared part of the spectra is dominated by the broad absorption band centered around 1.1 µm due to the presence of FeO. This absorption is due to crystal field (CF) absorptions between unpaired d-orbitals of transition minerals (mostly Fe^{2+}). Similar CF absorptions are present in other Fe bearing minerals like olivines, pyroxenes, amphiboles, and feldspars. Position of the band minimum and the overall shape of the band appears to determine a fairly diagnostic spectral features for tektites. In the particular case of Indochinite the band at 2.2 µm may indicate the presence of some alteration as Al – OH vibration in clays. The lack of clear bands at 1.9 and 1.4 may indicate that the alteration was prior to tektite formation and the water lost during heating. Water or hydroxyl (OH) presence is confirmed by the presence absorption band centered at 2.7 µm (Figure 2). Tektites are notoriously water depleted materials, pointing to high temperatures of formation that eliminated highly volatile elements from the melt prior to quenching (with water down to 0.01% or less). The method of quantifying the water was chosen as depth of the 2.7 µm absorption band [3].

4. Discussion and conclusion

The presence of the 2.7 µm combined with the FeO absorption centered at 1.1 µm is diagnostic for the presence of terrestrial tektites in this spectral range. This analysis needs to be further detailed for synthetic glasses in order to see if the method is diagnostic for unknown glass phases.

From the chemical and spectral point of view BV glass has a similar composition to Indochinites. So far the unidentified glass sample presents very good reasons to classify it as possible result from an impact.

Acknowledgements

A Transnational Access visit under the EU Framework programme Europlanet at the Dust Analogue Simulation Facility at INAF - Osservatorio Astronomico di Capodimonte in Napoli, Italy supported this work. We are particularly grateful to Francesca Esposito and Vito Mennella.

References

[1] Beran, A. and Koeberl, C.: Water in tektites and impact glasses by Fourier-transformed infrared spectrometry, Meteoritics & Planetary Science, pp. 211-216, 1997.

[2] Chapman, D. R. and Scheiber, L. C.: Chemical investigation of Australasian tektites, J. Geophys. Res., 74, pp. 6737-6776, 1969.

[4] Koeberl, C. and Beran, A.: Water Content of Tektites and Impact Glasses and Related Chemical Studies, Lunar and Planetary Science Conference, Vol. 18th, pp. 403-408, 1988.

[3] Milliken, R.E. and Mustard, J.F.: Quantifying absolute water content of minerals using near-infrared reflectance spectroscopy: J. Geophys. Res., Vol. 110, p. E12001, 2005.