Europlanet TNA Report

PROJECT LEADER

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Date of TNA visit:	07.03.2011-12.03.2011 (Ionuț Prundeanu) 02.05.2011-07.05.2011 (Gabriel Ovidiu Iancu)
Host laboratory:	Dust Analogue Simulation Facility (INAF - Osservatorio Astronomico di Capodimonte - Napoli, Italy)

Project Title – Spectral characterization of impact glasses from major terrestrial fields for remote sensing applications

- Report on the outcomes of the TNA visit

Laboratory measurements of tektites in INAF-OAC Naples: Preliminary results

Terrestrial tektites reflect the composition of the crust that was reshaped during the impacts, and is usually similar to upper crust composition, with advanced volatile depletion. Water in tektites is low, reflecting the high temperature at which the terrestrial samples have been exposed (Beran and Koeberl, 1997; Koeberl and Beran, 1988). The measurements are intended to serve as completion for spectral libraries that serve for the characterization of planetary surfaces in the solar reflection range (UV/VIS/NIR), as well as a fast method for unknown glasses characterization.

The spectral diffuse characterization in the UV/VIS/NIR range is important as it is the only mean to asses composition of planetary crusts, using remote sensing techniques. This spectral range was covered using combined measurements from a Perkin Elmer Lambda 950 (for the UV/VIS range) spectrophotometer and a Bruker Equinox 55 FTIR spectrometer (for the NIR range). On both spectrometers and Harrick Praying Mantis diffuse reflectance accessory was used to obtain the spectra.

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.

Two samples of tektites were analyzed: i) an Indochinite sample (Ward's Natural Sciences sample), and ii) a piece of Darwin glass type sample (Ward's Natural Sciences sample from Mt. Darwin, near Ten Mile, Tasmania). An unknown glassy sample from a private collection in Romania (Brasov hence the abbreviation BV) was added for the analysis, due to macroscopic and microscopic resemblance to tektites. The Indochinite sample has a dark green color, that becomes lighter green as the glass sample is thinner. Macroscopically presents a splash form and the surface presents corrosion markings of various kinds.

The Darwin glass sample has a dark green color. Macroscopically presents clear vesicles and obvious flow structures.

The glassy sample from Brasov is more translucent than the tektite samples above, and has an olive green color. Small Fe oxides grains may be observed inside the glass.

Examined in thin section under the microscope, the samples show a clear amorphous structure and various size vacuoles are dominant. The Indochinite sample posses a particular internal lamination and smaller vesicles than the Darwin and Brasov glasses.

Sample preparation for IR characterisation: The glass samples were crushed in an agate mortar producing grain sizes ranging from more than 200 um down to 25 um. Four grain classes were obtained using 200, 100, 50, and 25 um sieves. Each resulting grain class was further treated separately using a non polar liquid (ethanol) in an ultrasound bath. This treatment was performed in order to remove the smaller grains electrostatic bounded at the surface of larger grains.

The grain samples thus prepared were measured using a Harrick diffuse reflectance accessory against a KBr standard. The overall results of the tektites spectra show a similar general trend for all the samples analyzed. The spectra present strong ultraviolet absorption centered around 0.3 um. There is a variable centered intense refection around 0.55 um that is best defined in the case of BV glass explaining its green color. In the case of Indochinite and Darwin Glass the maximum of the reflection shifts toward longer wavelengths (0.61 and 0.65 um) as well as becoming broader, thus explaining the darker green color of the bulk samples.

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 presence. This absorption is due to crystal field (CF) absorptions between unpaired d- and/or f 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 feature for tektites.

In the particular case of Indochinite the band at 2.2 µm may indicate the presence of some alteration. This region is characteristic for 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 (Milliken and Mustard, 2005).

Water or hydroxyl (OH) presence is confirmed by the presence absorption band centered at 2.7 µm (Figure 1). 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). This band 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 impact glasses.

Chemical analysis: The thin sections were investigated by means of a Cambridge S360 SEM equipped with an Oxford Inca Energy 200 for quantitative electron microprobe analyses. In order to ensure the thermal conductivity for the diffusion of the heat produced from the electron beam and the samples, the thin sections were covered with Cr film. The chemical composition of the samples are reported in Table 1.

The Indochinite sample has a similar composition in terms of major elements, with the Normal Indochinites (Chapman & Scheiber, 1969). The Darwin glass resembles the Normal Indochinites as well but chemical analyses of trace elements are necessary to confirm or not this observation.

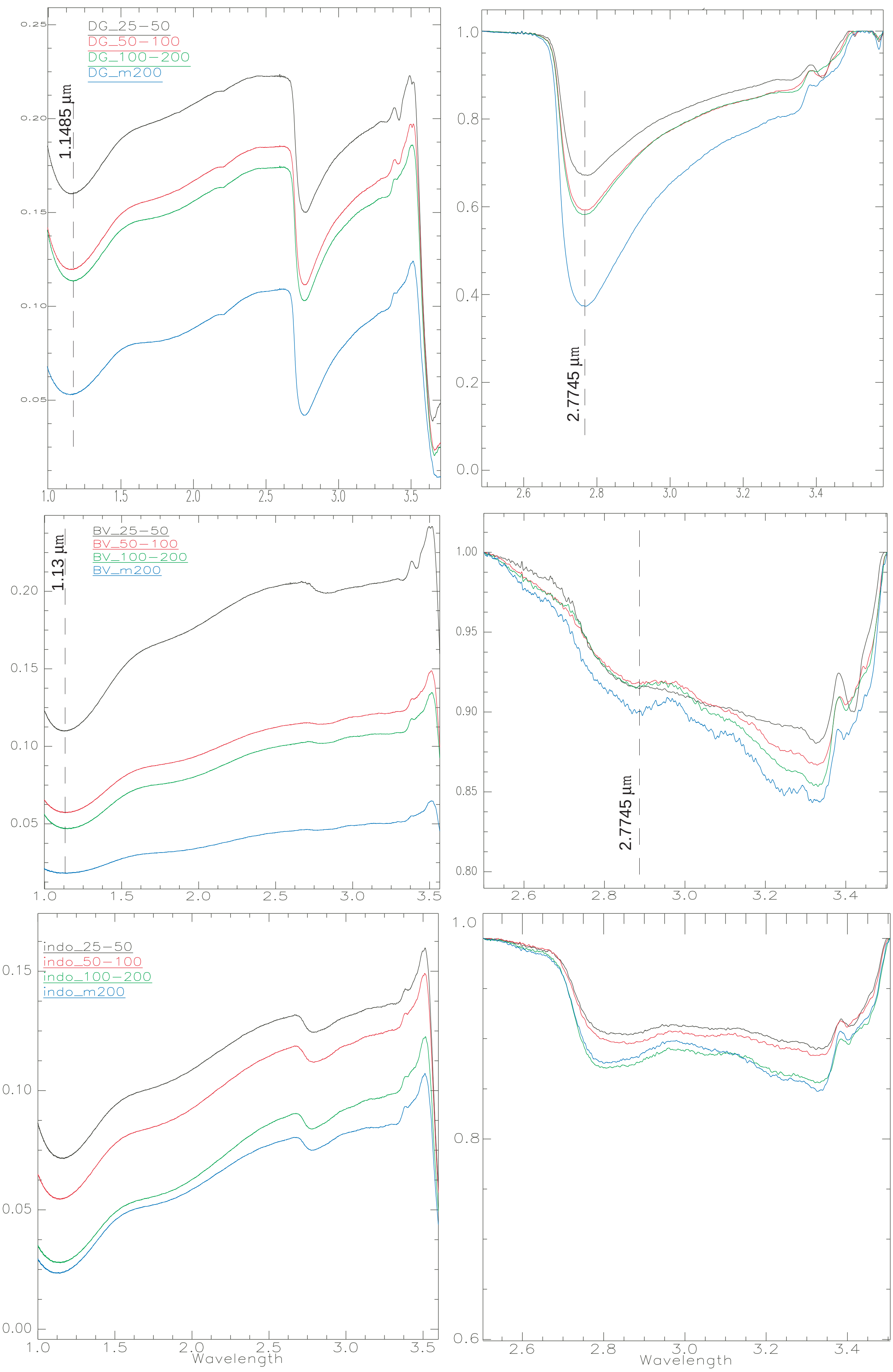

Figure 1 Diffuse reflectance NIR spectral range (measured with Bruker Equinox 55 FTIR spectrometer) for the samples measured (left column). Right column detail of 3 µm band region (continuum removed).

Type of sample	**Normal Indochinites**		**Darwin Glass**					**Brasov Glass**
Major Elements	Chapman and Scheiber, 1969 (%)	Napoli - INCA (%)	Hills, 1915 (%)	Howard, 2008 (1) %	Howard, 2008 (2) %	Meisel et al., 1990 (18 samples) %	Napoli – INCA (%)	Napoli – INCA (%)
SiO2	72.9-73.3	74.53	88.764	85	81.1	84 - 89.3	90.51-92.04	75
Al2O3	13.1-13.5	12.35	6.127	7.3	8.2	6.75 - 8.47	7.95	12.82
FeO	4.47-4.49	4.95	1.238	2.2	1.5	1.06 - 3.78	0	4.73
MgO	2.00-2.04	2.11	0.575	0.9	1.3	0.61 - 2.51	0	1.76
CaO	2.17-2.41	2.51	0.174	0	0	0.03 - 0.23	0	2.33
K2O	2.36-2.40	2.44	1.363	1.8	0	1.51 - 2.93	1.54	2.2
Na2O	1.17-1.27	1.09	0.129	0	0	0.21-0.71	0	1.16
TiO2	0.72-0.89	0	1.24	0.05	0	0.52 - 0.62	0	0

Table 1 Major elements chemical composition of the analyzed samples.

References

Beran, A., Koeberl, C. (1997) Water in tektites and impact glasses by fourier-transformed infrared spectrometry: Meteoritics & Planetary Science, p. 211-216.

Chapman, D. R., Scheiber, L. C. (1969) Chemical investigation of Australasian tektites: J. Geophys. Res., 74, p. 6737-6776.

Hills, L. (1915) Darwin Glass, a new variety of the tektites, Geological Survey Record, 3, 20 p.

Howard, K. T. (2008) Geochemistry of Darwin glass and target rocks from Darwin crater, Tasmania, Australia: Meteoritics & Planetary Science, 43 (3), p. 479-496.

Koeberl, C., Beran, A. (1988) Water Content of Tektites and Impact Glasses and Related Chemical Studies: Lunar and Planetary Science Conference, v. 18th, p. 403-408.

Meisel, T., Koeberl, C., Ford, R.J. (1990) Geochemistry of Darwin impact glass and target rocks: Geochimica et Cosmochimica Acta, 54, p. 1463-1474.

Milliken, R.E., Mustard, J.F. (2005) Quantifying absolute water content of minerals using near-infrared reflectance spectroscopy: J. Geophys. Res., v. 110, p. E12001.

Please include:

- Publications arising/planned (include conference abstracts etc)

Iancu O. G., Popa I. C., Prundeanu I. (2011) IR Spectral characterization of some impact glasses from major terrestrial fields for remote sensing applications, conference abstract EPSC-DPS Joint Meeting, Nantes (MT4 Analogue materials and sample preparation)

- Host approval

The host is required to approve the report agreeing it is an accurate account of the research performed.

I confirm that the previous report is an accurate description of the scientific activity performed by Ph.D. student Prundeanu and prof. Iancu during the two TNA visits at the Laboratorio di Fisica Cosmica e Planetologia in Napoli.

Vito Mennella