Europlanet TNA Report

PROJECT LEADER

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Date of TNA visit:	24.10.2012-29.10.2012 (Lucian Olteanu) 21.04.2012-01.05.2012 (Gabriel Ovidiu Iancu)
Host laboratory:	Dust Analogue Simulation Facility (INAF - Osservatorio Astronomico di Capodimonte - Napoli, Italy)

Project Title – Analysis of alkali feldspar as possible material analogues for planetary surfaces

- Report on the outcomes of the TNA visit

Laboratory measurements of alkali feldspars in INAF-OAC Naples: Preliminary results

Alkali feldspars are main forming constituents of terrestrial rocks. All rock classification schemes include them (or their constitutive chemicals) as main constituents of rocks, ranging from acid to mafic rocks. This class of minerals can also be present in rocks present at other planetary crusts (e.g. Mercury, Mars etc.). The thinner atmospheres characterizing planetary surfaces can potentially expose the mineral constituents of rocks to highly energetic irradiation. The thermal and irradiative stress at surfaces can produce structural reordering, separation of constituents (e.g. iron and iron/titanium oxides, etc.) that implicitly change their spectral response and could provide information about outcrops exposures time (e.g. via spectral reddening). This information is of interest for supporting the interpretation of data from visible and infrared instruments for planetary remote sensing, as suggested by the map in Figure 1. Bandfield (2002), though shows that potassium feldspar, low-Ca pyroxene, basaltic glass, olivine, sulfate, carbonate, quartz, and amphibole are not detected with confidence in TES spectra at 1 pixel per degree (~ 16 km/pixel) resolution.

The idea of possible K-feldspar presence on Mars is furthermore strengthened by the K map distribution from Gamma Ray Spectrometer NASA Mars Odyssey mission (Figure 2). This is also consistend with the minor amounts of alkali feldspar found in Chassigny meteorite which may be the only sample from the lavas exposed at surface (Floran et al., 1978).

Linear unmixing (or deconvolution) of laboratory rock spectra into pure mineral components works fairly well in the MIR. For feldspars a 5% minimum fraction has to be present in the rock to still be detectable (Hecker et al., 2010).

The spectral diffuse characterization in the UV/VIS/NIR range is important, as it is the one of the few methods to assess composition of planetary crusts, using remote sensing techniques (spectral reflection). This spectral range was covered using combined measurements from a Bruker Equinox 55 FTIR spectrometer (for the 1-25 µm range). A Harrick Praying Mantis diffuse reflectance accessory was used to obtain the spectra. The measurements are intended to support as completion for spectral libraries that serve for the characterization of planetary surfaces in the solar reflection range (UV/VIS/NIR) and emission using Kirchhoff law (for the TIR).

Five samples of alkali feldspar were chosen for the analysis:

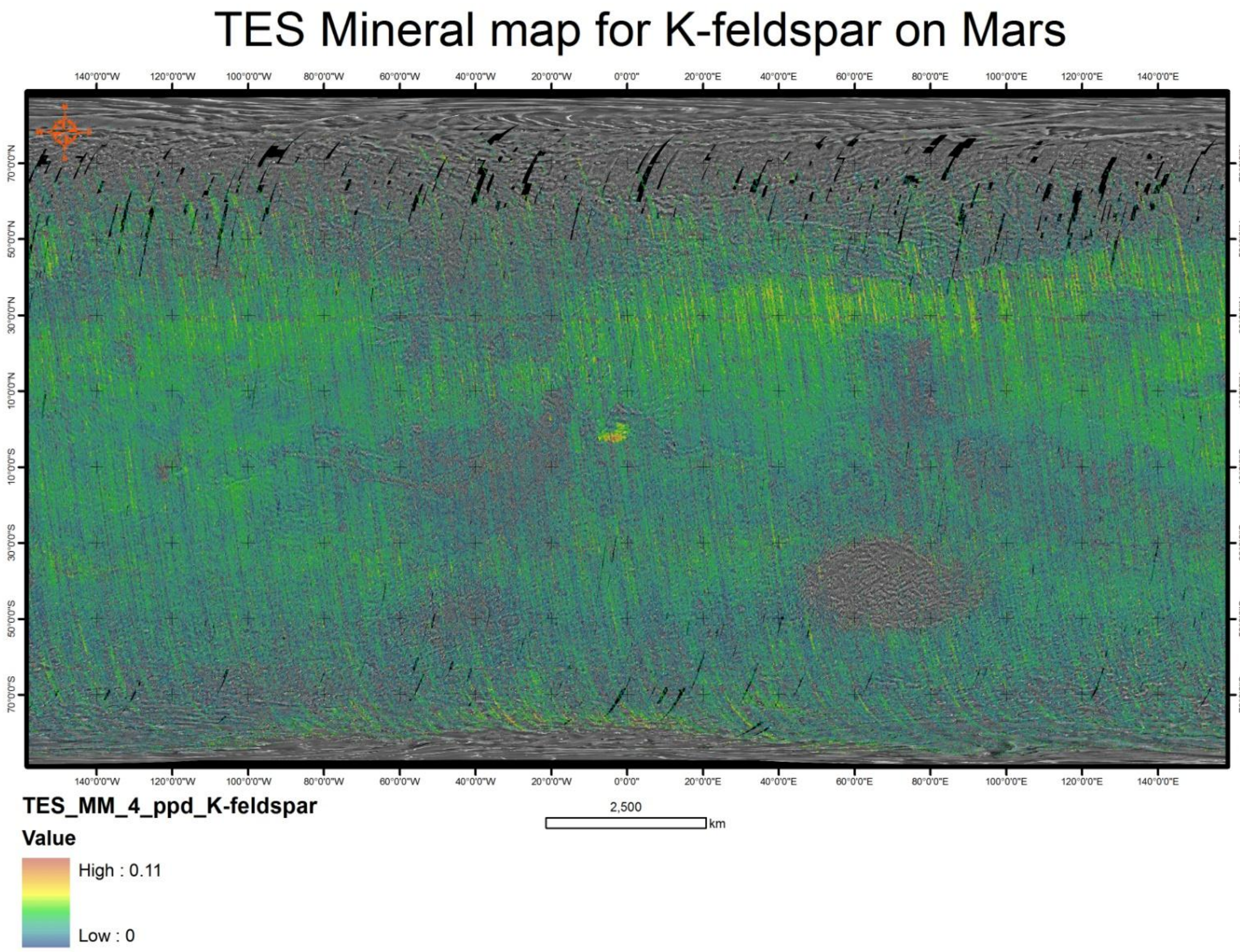

Figure 1. TES MGS K-feldspar global distribution for Mars, using fundamental bands related to K feldspars (Bandfield, 2002)

i) **anorthoclase** - $(Na,K)AlSi_3O_8$ - from Larvik, Norway[1],

ii) **amazonite** - $KAlSi_3O_8$ (triclinic) - from Lake George, Park County, USA[1],

iii) **sanidine** - $KAlSi_3O_8$ (monoclinic) - from Cretaceous trachites and trachy-latites (Keban Magmatics), Keban, Elazig, Eastern Taurid region, Turkey[2],

iv) **orthoclase** - $KAlSi_3O_8$ (Monoclinic) - from Saint Guirec, France (main mineral of the Pink Granite Coast)[2] and

v) **albite** (cleavelandite) - $NaAlSi_3O_8$ - from White Queen Mine, Pala, California, USA[1].

[1] Ward's Natural Sciences

[2] Sample from our personal collection

Sample preparation for IR characterisation: The samples were crushed in an agate mortar and grain classes were obtained using 500, 200, 100, 50, and 25 µm sieves. Each resulting grain class was further treated separately using a non-polar liquid (ethanol) in an ultrasound bath, in order to remove the smaller grains electrostatically 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 K-feldspars spectra show a similar general trend for all the samples analyzed in the NIR. The spectra present mostly a flat response with no particular absorption band related directly to feldspar composition. The samples do not show any bands related to Fe presence as a substitute for (Si, Al) (Adams and Goullaud, 1978). The Spectra on the other hand present clear evidences of clay presence as alteration products of low temperature water interaction which will require careful analysis for the range of fundamental bands region (TIR) (Figure 3).

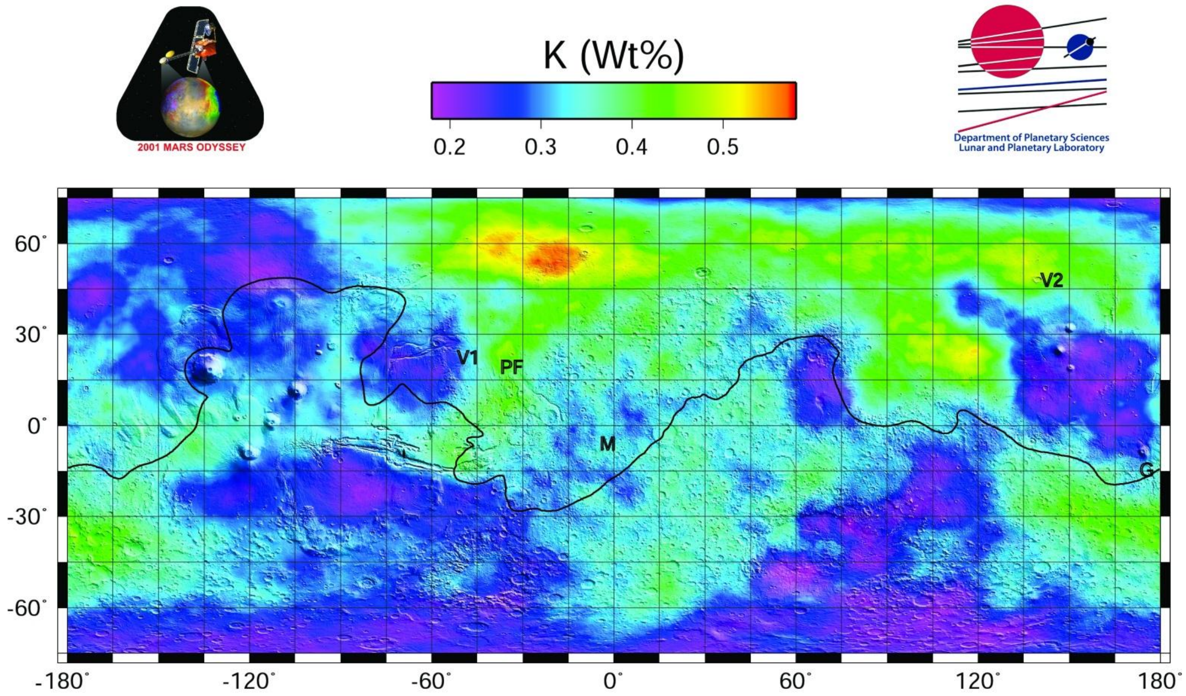

Figure 2. Potassium distribution on Mars (likely connected to alkali feldspars) (Boynton et al., 2007)

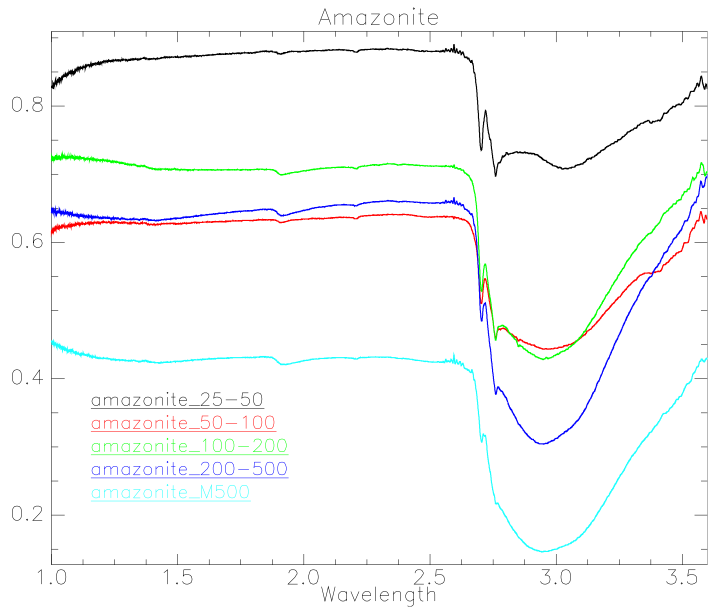

Figure 3. Spectral response of amazonite sample in the 1 - 3.5 µm range. H2O overtones are present in the 1.9 µm region, that together with M-OH bands in the 2.2 µm region point to the presence of clay alterations (low to medium temperature). The region of 3 µm points to large amounts of water in the sample, also pointing to water interaction.

References

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Bandfield, J. L., 2002, Global mineral distributions on Mars: Journal of Geophysical Research-Planets, v. 107, no. E6.

Boynton, W. V., Taylor, G. J., Evans, L. G., Reedy, R. C., Starr, R., Janes, D. M., Kerry, K. E., Drake, D. M., Kim, K. J., Williams, R. M. S., Crombie, M. K., Dohm, J. M., Baker, V., Metzger, A. E., Karunatillake, S., Keller, J. M., Newsom, H. E., Arnold, J. R., Brückner, J., Englert, P. A. J., Gasnault, O., Sprague, A. L., Mitrofanov, I., Squyres, S. W., Trombka, J. I., d'Uston, L., Wänke, H., and Hamara, D. K., 2007, Concentration of H, Si, Cl, K, Fe, and Th in the low- and mid-latitude regions of Mars: J. Geophys. Res., v. 112, no. E12, p. E12S99.

Floran, R. J., Prinz, M., Hlava, P. F., Keil, K., Nehru, C. E., and Hinthorne, J. R., 1978, The Chassigny meteorite: a cumulate dunite with hydrous amphibole-bearing melt inclusions: Geochimica et Cosmochimica Acta, v. 42, no. 8, p. 1213-1229.

Hecker, C., der Meijde, M. v., and van der Meer, F. D., 2010, Thermal infrared spectroscopy on feldspars — Successes, limitations and their implications for remote sensing: Earth-Science Reviews, v. 103, no. 1–2, p. 60-70.

Please include:

- Publications arising/planned (include conference abstracts etc)

Iancu O. G., Popa I. C., Olteanu L. (2012) IR Spectral characterization of alkali feldspars for remote sensing applications, conference abstract, European Planetary Science Congress, Feria de Madrid, Spain (EPSC September 2012)

- 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 Lucian Olteanu and Professor dr. Gabriel Ovidiu Iancu during the two TNA visits at the Laboratorio di Fisica Cosmica e Planetologia in Napoli.

Vito Mennella