EPSC Abstracts
Vol. 12, EPSC2018-901, 2018
European Planetary Science Congress 2018

Spectroscopy on silicate glasses from two magmatic series: implications for planetary studies.

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Abstract

Silicates are the main constituent of terrains on terrestrial planets in the solar system [1, 2]. Silicate glasses represent the amorphous phase of silicate crystals. Typically, volcanic rocks are afanitic or porphyric rather than holocrystalline: the fraction of amorphous material is therefore more relevant than the fraction of crystalline material. Thus it is of paramount importance to study silicate melts and glass properties to better interpret available and future remotely sensed spectra from past and future missions [3]. Other works focused on the spectral investigation of natural samples along the Total-Alkali-Silica diagram [4,5]. Here we report on our study concerning synthetic glasses: two series of silicate glasses were synthesized starting from natural samples in order to be spectroscopically characterized in the near- and mid-IR.

Samples preparation

Samples were produced by melting and mixing two couple of natural endmembers, related to volcanism generated in two different geodynamic settings: a subduction zone volcanism (Vulcano, Aeolian islands, Italy; 5 samples) and an intraplate-derived volcanism (Snake River Plain, hereon SRP Yellowstone, USA; 6 samples). Chemical compositions are respectively ranging between shoshonitic and rhyolitic, and basaltic and rhyolitic, The main difference is lying in the alkali content, wich is constant in Vulcano series and varying in SRP series. We know that alkali play important structural roles in glasses and may influence their physical properties [6] and spectral response [7].

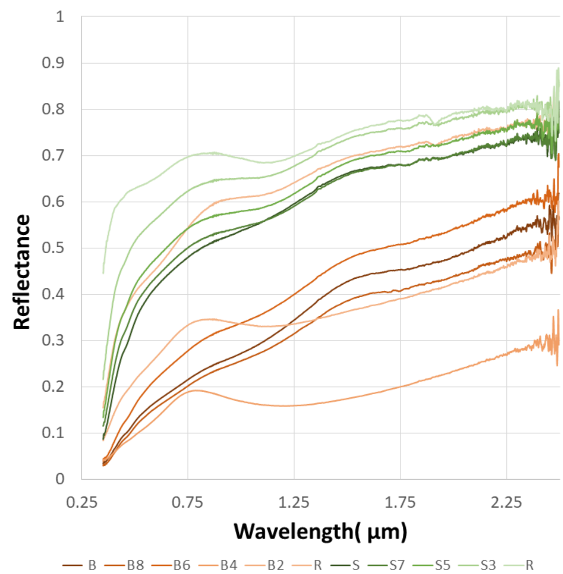

Figure 1: Set of spectra obtained in the near-IR range. Vulcano alkaline samples are green-shaded, SRP samples al orange-shaded. The darkest the colour, the more mafic the composition, the higher the iron content.

Samples analysis

Samples were analysed using electron probe microanalyses, and spectroscopically characterized in different laboratories and under different conditions.

Planetary Emissivity Laboratory: mid-IR data at different temperatures, at the Planetary Emissivity Laboratory of the German Aerospace Center in Berlin (DLR), have been acquired. Reflectance (fresh and after heating at 700°C, spectral range 1-18 µm) and emissivity (150°C, 300°C, 450°C, 700°C; spectral range 5-16 µm) spectra were collected [8].

Institute for Space Astrophysics and Planetology: near-IR spectra (fresh sample, spectral range 0.35-2.5

μm) at the *Institute for Space Astrophysics and Planetology* (IAPS-INAF) in Rome, has been acquired in reflectance (Figure 1).

For what concerns mid-IR, characteristic Christiansen Feature (CF) was observed for all samples ranging between 7.3μm and 8μm. Reststrahlen bands were observed to dominantly characterize the spectra between CF and ca. 13 μm. Transparency feature typical of fine material was observed at 11.7 μm, especially for reflectance measurements.
For reflectance measurements the shift of CF is observed to be in linear correlation with SiO_2 content, and in particular with depolymerisation degree NBO/T (Figure 2), whereas for emissivity measurements the same dependency was observed with a little but important dependence on temperature. Variations in alkaline content seems to strongly influence the shape of RB, and secondarily the temperature dependence of CF shift.

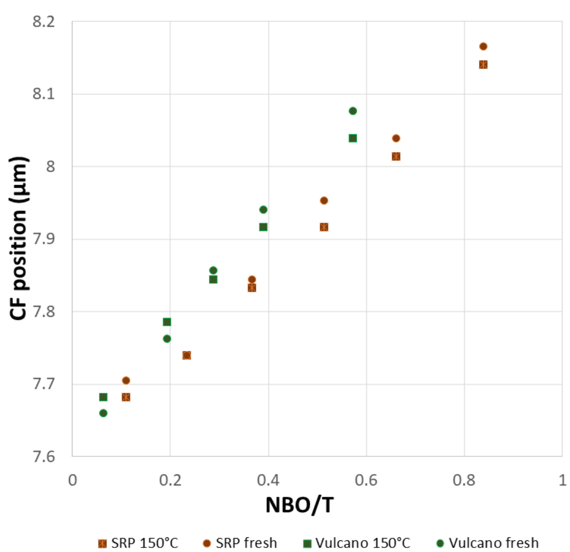

Figure 2: Example of the shift observed for CF in relationship with polymerization degree NBO/T, regarding the reflectance spectra obtained in the mid-IR range for two different temperatures.

For what concerns near-IR reflectance (Figure 1), for the shoshonite-rhyolite series an expected inverse relationship was observed between the albedo of spectra and the iron content. For SRP series, where alkali content is varying sensibly, the same relationship is not observable.
These observations may help the interpretation of remotely sensed spectra, characterizing not only chemical composition but also a possible geodynamic setting of planetary volcanic products.

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