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Mid-Infrared Spectroscopy of Planetary Analogs: A Database for Planetary Remote Sensing

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Abstract

As part of an ongoing study, we report mid-infrared spectra of surface analogs for planetary bodies (Venus, Earth) for a database of spectra for planetary remote sensing.

1. Introduction

The IRIS (Infrared and Raman for Interplanetary Spectroscopy) laboratory generates spectra for a database [1] for the ESA/JAXA BepiColombo mission to Mercury. Onboard is a mid-infrared spectrometer (MERTIS-Mercury Radiometer and Thermal Infrared Spectrometer). This unique device allows to map spectral features and thus mineralogy in the 7-14 µm range, with a spatial resolution of about 500 meters [2-4]. Glass can arise through impacts and in volcanic processes and lacks an ordered microstructure and represents the most amorphous phase of a material [5,6]. It is expected to be a major component of the surface of Mercury [7]. Using synthetic materials allows us to produce infrared spectra of materials of which no rock samples are available, or average compositions of larger areas [8]. Here we present analog glass samples for the surfaces of the two largest terrestrial planets, Earth and Venus.

2. Samples & Techniques

Bulk glasses were synthesized based on the chemical composition for the surface of Venus, based on lander data [9],terrestrial MORB basalts [10] and the bulk continental crust [11]. The samples were characterized using Raman spectroscopy and EMPA.

For the mid-infrared FTIR diffuse reflectance analyses, powder size fractions 0-25 µm, 25-63 µm, 63-125 µm, and 125-250 µm were measured, using a Bruker Vertex 70 infrared system at the IRIS laboratories at the Institut für Planetologie in Münster analyses were conducted under low pressure to reduce atmospheric bands. The results will be made available via a database [1].

3. Results

Results of the EMPA analyses are presented in Tab.1. Analogs for Venus surface and MORB show mafic compositions, while the bulk continental crust has a granodioritic composition.

	(1)	(2)	(3)
Na_2O	0.06	2.76	3.1
MgO	11.6	7.9	4.3
SiO_2	50.1	50.2	61.7
Al_2O_3	17.9	15.7	15.2
K_2O	0.05	0.04	1.75
CaO	9.1	11.3	6.0
FeO	9.3	9.4	6.4
TiO_2	1.15	1.42	0.87
Cr_2O_3	0.01	0.01	0.01
MnO	0.02	0.03	0.01
Total	99.29	98.76	99.34

Table 1: EMPA analyses of glasses in the analyzed samples. (1) Venus surface (2) Earth MORB (3) Earth continental crust.

The surface analog of Venus (Fig.1a) shows a typical spectrum of amorphous material with one dominating band at 9.8 – 9.9 µm. The Christiansen Feature (CF), characteristic reflectance low is at 8.1 µm. A Transparency feature (TF) typical for the fine grained size fractions could not be identified. The Raman spectrum confirms this (Fig.1b). Similar, the bulk continental crust and average MORB basalts have spectra of glassy material. The CF is located at 7.9 µm and 8.1 – 8.2 µm, respectively. The dominating amorphous silicate feature is at 9.5 µm (crust) and 10.2 µm. The weak TF is at 11.7 µm (crust) and 11.8 µm (MORB).

4. Discussion

Similar to earlier studies of synthetic glass based on surface areas of Mercury, samples with low MgO content show spectra typical of amorphous materials with only one dominating RB band [8].

5. Summary and Conclusions

Future studies will include a wider range of planetary compositions, as well as crystallization experiments.

Acknowledgements

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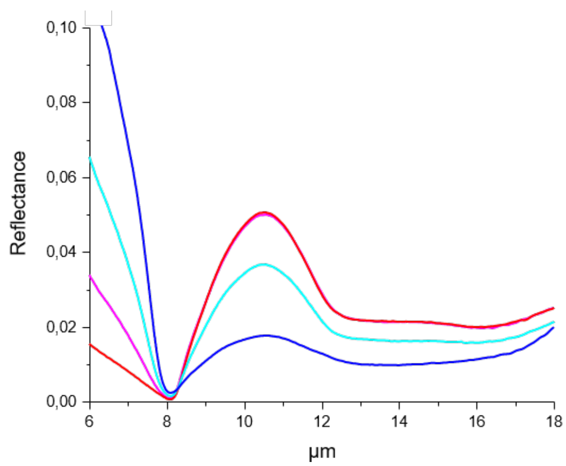

Fig. 1a: Reflectance mid-infrared spectra of surface of Venus, based on Lander data [9].

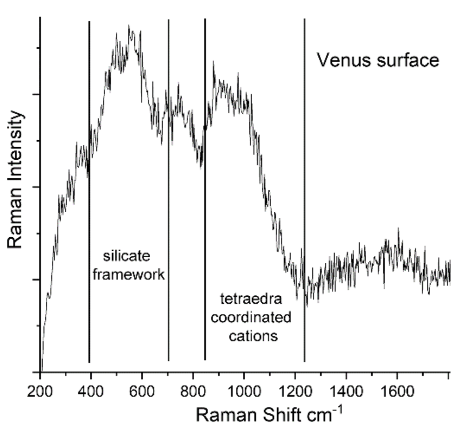

Fig. 1b: Raman spectra of glass in the Venus analog.

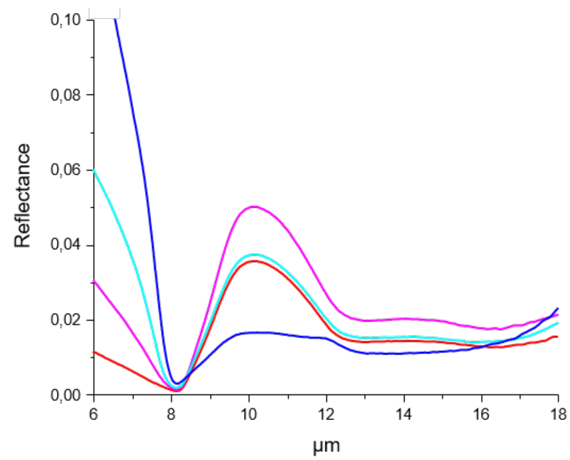

Fig. 2: Reflectance mid-infrared spectra of terrestrial MORB, based on average of several analyses [10].

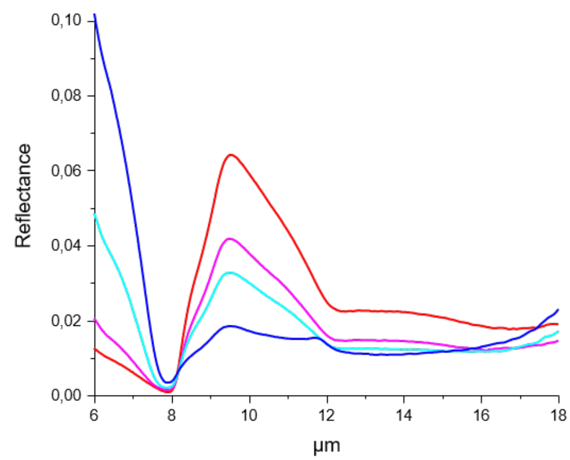

Fig. 3: Reflectance mid-infrared spectra of terrestrial continental crust [11].

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