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Laboratory spectral analyses of enstatite, feldspar, oldhamite mixtures and aubrites: Implications for the Rosetta VIRTIS data evaluation of asteroid Šteins flyby

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Laboratory reflectance spectra of enstatite, albite, oldhamite, their mixtures, Ti-bearing pyroxenes and aubrites have been measured in the wavelength range from 0.45 to 5 μm. The work focuses on the comparison of the spectral results with actual observations of the asteroid Šteins by the VIRTIS-M/ ROSETTA experiment and with former Earth-based observations.
Mixtures of enstatite and oldhamite varying in enstatite content from 55 to 90 vol% and 10 to 45 vol% of synthetic oldhamite. Additionally, mixtures with accessory amounts of 10-15 vol% of albite are completing the measurements. Effects of grain sizes were investigated and thermal contributions at wavelengths above 3.5 μm were considered. Grain size influence often dominates the spectral variations compared to the effects of mineral abundance variations in the mixtures. The mixture spectra show shallow absorption bands near to 0.5 and 0.9 μm knowing to be characteristic for E-Type asteroids. Temperatures above 210 K contribute essentially to the observed signal and must be considered in the spectral analysis.
Aubrites as enstatite achondrites are highly probable linked to the E-type asteroids. They are nearly monomineralic enstatite meteorites, consisting of nearly FeO-free enstatite with minor amounts of plagioclase, diopside, and forsterite. Sulfides like oldhamite occur as accessory phases. For this work spectra of the aubrites Peña Blanca Spring and Norton County were analyzed. The Peña Blanca Spring sample is brecciated and consists of up to 1 cm large enstatite grains in a fine grained matrix composed of mainly enstatite. The matrix also consists of diopside, forsterite and albitic plagioclase. Sulfides, including oldhamite, and metals occur as accessory phases. The Norton County sample consists only of enstatite grains with segregated diopside. Sulfides and metals occur as accessory phases. All silicates in both samples are virtually FeO-free. Both aubrites show a flat and featureless spectrum between 1 and 2.5 μm. At wavelengths shorter than 1 μm a steep drop in reflectance is observed. Several weaker absorption bands are located between 4.5 and 5 μm, which are also visible in enstatite spectra.
Basing on the laboratory measurements of terrestrial analogues and aubrites the implications for the recent Šteins observations and information on surface and bulk composition are discussed.