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Experimental photometric characterization of natural granular surface samples: implications for planetary regoliths

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Orbital photometric measurements are today the only way to characterize the physical surface properties of planetary regoliths relevant to understand their optical behaviour, that is, the diffusion mode of particles (forward-scattering or backscattering), grain sizes, surface roughness, or compaction state. These surface state characteristics are crucial to better understand geologic processes such as the different types of volcanism (explosive, effusive), cratering effects, or the interaction between the surface and the interplanetary environment (formation and evolution of the surface state). Besides, such knowledge about the texture of a surface would help refine the spectroscopic models and radiometric calibrations, all the more today when very high image resolution are reached (e.g., LROC). However, there is still a lack of appropriate multiangular measurements from orbit, which makes experimental photometric studies on controlled materials necessary to better analyze orbital results.
Multiangular experimental measurements have been carried out with ISEP facility (Imaging Spectrogoniometer for Planetary Exploration) operating at the Midi-Pyrénées Observatory, Toulouse, France (see Daydou et al., this workshop). The present study is centred on volcanic materials and amorphous phases (or glasses), because of their significance in processes leading to the formation and evolution of regoliths. Using Hapke's photometric model, whose parameters, once inverted, lead to the physical surface properties, different natural granular volcanic materials with various compositions, grain sizes, and contents of glass and monocrystals have been photometrically characterized: basalts, volcanic sand, pyroclastics, olivine, and glass from the controlled melt of basalt. According to their compositions, shapes, and textures, an evolution of the samples photometric behaviour with grain size is found. Materials which are rich in fresh glass and/or monocrystals display a specific forward-scattering behaviour seldom observed so far, which enables their distinction from glass-free materials or with more mature glass. Mixtures of basalt and basaltic glass have also been studied, with varied fraction of glass. It shows that the optical influence of fresh glass is very strong and highly non linear, so that if present in a regolith, it could be detected by photometry, even if it is present in minor quantity.