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Analysis of roughness of lava flow by optical remote sensing data : example of the Etna volcano imaged by ASTER

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Roughness of planetary surfaces is an important parameter to measure, both for remote sensing applications and understanding of dynamics of rock emplacement. Indeed, roughness modifies the spectral signature of rocks, and roughness reflects the physical and chemical conditions that prevailed at its development. Various theories have been proposed to measure roughness from remote sensing data by the exploitation of multi-angular views. Actually, no satellite in orbit around the Earth is able to provide such data. Only Mars is observed through a multiangular sensor that permits to estimate roughness but without direct measurements at the surface. We have undertaken a study of the basaltic lava flows of Etna as observed by the ASTER radiometer on board on the Terra satellite. We have 19 multispectral images of the Etna surface, acquired at various seasons and thus under lightly various angles of solar incidence. Moreover, each lava flow, whose chemistry can be considered as relatively homogeneous, has various surface orientations from the vent to the front. Thus each lava flow is observed with various angles of emergence. We computed a 15m resolution Digital Elevation model for the Etna surface from the ASTER data and have orthorectified each image. Then we reported the response of surface for each wavelength, according to angle of incidence and emergence. The response of the various surfaces were compared to the macroscopic roughness of the lava flow. Consequently, a model of reflectance including the macroscopic roughness was built. This model will be applied to multiangular observed planetary surfaces to estimate their roughness.