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IN SITU MINERALOGICAL-CHEMICAL ANALYSIS OF MARTIAN MATERIALS AT LANDING/ROVING SITES BY ACTIVE AND PASSIVE REMOTE SENSING METHODS; G. Neukum, F. Lehmann, P. Regner, and R. Jaumann, DFVLR Oberpfaffenhofen, Institute for Opto-electronics, Planetary Remote Sensing Section, 8031 Wessling, FRG

Remote sensing of the martian surface from the ground and from orbiting spacecraft has provided some first-order insight into the mineralogical-chemical composition and the weathering state of martian surface materials (1,2,3,4). Much more detailed information can be gathered from carrying out such measurements in situ at the landing sites or from a rover in combination with analogous measurements from orbit (or making use of previous orbital data). Measurements in the wavelength range of ~ 0.3 µm to ~ 12.0 µm appear to be suitable to characterize much of the physical, mineralogical petrological and chemical properties of martian surface materials and the weathering and other alteration processes that have acted on them. It is of particular importance to carry out measurements at the same time (or near-simultaneously) over a broad wavelength range since the reflectance signatures are caused by different effects and hence give different and complementing information. (Electronic transitions, charge transfer lands of iron oxides: UV to near infrared; OH overtones, layered silicates: near to mid infrared; restrahlenbands, molecular composition of minerals: thermal infrared (5)). It appears particularly useful to employ a combination of active and passive methods because the use of active laser spectroscopy (laser diodes or CO_2-laser) allows to obtain specific information on thermal infrared reflectance of surface materials. Compared to passive optical thermal-infrared sensors, the active sensing method is little affected by parameters like grain size and roughness of surface materials (6,7), does not depend on temperature effects and can be used during day and night time. In the past decade the impact of active laser systems on terrestrial surface materials mapping (7-10) could be clearly demonstrated by ground based and airborne measurements. Earth orbiting space missions are planned for the end of the eighties.

It seems to be evident that a spectrometric survey of martian materials has to be focused on the analysis of altered and fresh mafic minerals and rocks, water-bearing silicates and possibly carbonates. Examples for such materials are given in Figure 1, displaying the potential of combined passive visible/near infrared and active laser thermal infrared spectroscopy. Graph 1 of Fig. 1 displays the spectrum of montmorillonite, a typical weathering product of mafic rocks. This mineral has characteristic spectral features in the near and thermal infrared (around 2.2 µm and 9.4 µm). Due to the fact, that other layered silicates show comparable spectral signatures in the near infrared, only the combination of NIR and TIR spectral data enables to detect the mineral (10).

Graph 2 and 3 of Fig. 1 give the reflectance spectra of fresh rock samples of granite and dunite. Those samples display characteristic spectral features in the thermal infrared, due to the restrahlenbands of olivine, serpentine, quartz and feldspars. Graph 4 of Fig. 1 shows the carbonate (limestone) signature at 2.35 µm and the typical increase of reflection intensity from 9.6 µm to longer wavelengths..

On-site (lander, rover) measurements of martian surface materials by application of the proposed remote sensing methods will achieve the following goals:

a) characterising the landing/roving sites and surroundings by photometrically and spectroscopically mapping martian soils and rocks;

b) gathering photometric/spectroscopic data of landing/roving site materials for orbital data evaluation and separation of surface and atmospheric (aerosol) spectral signatures;

c) pre-selecting samples for further analysis by other instruments of a lander or rover (X-ray, γ-ray, mass spectrometer);

d) selecting materials (soils and rocks) for sample return purposes and further analyses back on earth, including lab analyses of the spectral reflectance properties for obtaining "ground truth" data from martian samples in the lab in combination with the in situ measurements at the landing/roving sites for the interpretaion of orbital remote sensing data.

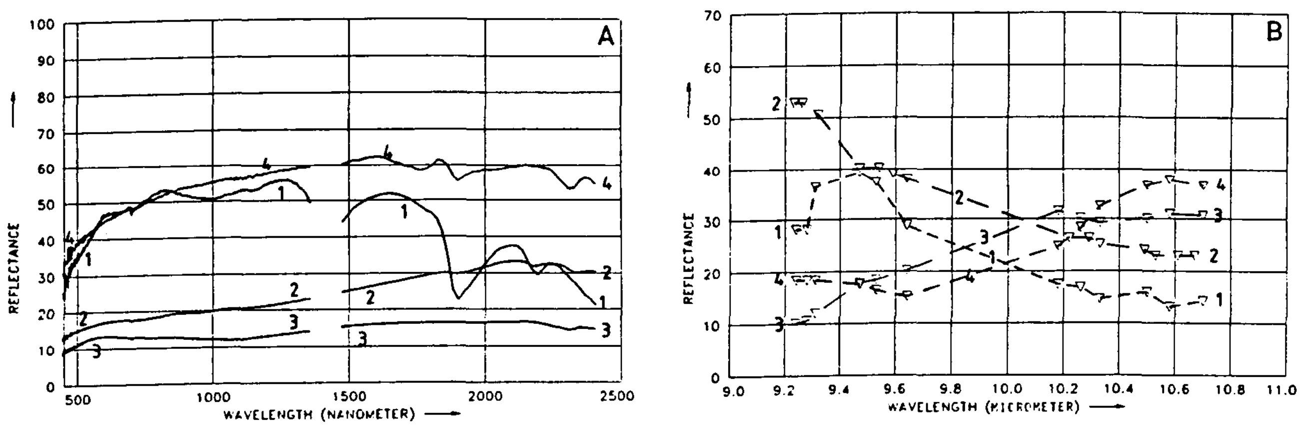

Fig. 1. Reflectance spectra of montmorillonite (1), granite (2), dunite (3), and limestone (4), in the visible/near-infrared (left) and thermal-infrared (right, CO_2-laser spectrometer).

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