

**Laboratory Spectral Measurements of Palagonite-Salt Mixtures In The Visible And Near Infrared - Implications for Mars:** Diana L. Blaney, Patti A. Walsh, Thomas B. McCord, Planetary Geosciences Division, Hawaii Institute of Geophysics, University of Hawaii, 2525 Correa Rd., Honolulu, Hawaii 96822.

Carbonates and other salts are proposed as constituents of the Mars surface based on theoretical and Viking results (1,2,3). Carbonates are especially important to the debates on the evolution of Mars's atmosphere (4,5). Determination of the carbonate abundance on Mars would enable a more accurate determination of the outgassed abundance of carbon dioxide and the extent to which any "green housing" occurred. Compositional information can be determined through reflectance spectroscopy. However, telescopic and spacecraft data interpretation is only as good as the laboratory data base available. This abstract presents results of a series of laboratory measurements that were made to determine the detectability of these salts in a Mars soil.

The samples were prepared by mixing palagonite from Mauna Kea, Hawaii, a Mars dust analog, with various weight percent calcium carbonate and magnesium sulfate. Palagonite is an amorphous weathering product of basaltic glass and is considered a good spectral analog for Mars dust (6). The palagonite used was collected from the 10,000 ft. elevation on Mauna Kea. The calcium carbonate and magnesium sulfate used were reagent grade powders from a chemical supply house. The materials were sieved to a grain size of less than 63  $\mu\text{m}$ . The amounts of the materials were measured and mixed together by shaking to produce mixture of 1,3, and 5 weight percent calcium carbonate and magnesium sulfate in palagonite. Surface adsorbed water was removed by heating the samples in an oven at 135° for four hours. The hot samples were immediately transferred into a dry nitrogen environment and allowed to cool. The samples were measured under nitrogen in specially designed sample holders.

Measurements were made using three different instruments which covered different spectral regions. The first instrument used a circular variable interference filter (CVF) with a cool silicon diode and covered the visible portion of the spectrum from 0.33 to 1.09  $\mu\text{m}$ . The other two instruments, also using CVFs, used cooled InSb detectors and covered the spectral ranges 0.62 to 2.6  $\mu\text{m}$  and 2.4 to 4.6  $\mu\text{m}$ . The measurements were made using a spectrophotometer set with an incidence angle of 10° and an emission angle of 20° for a phase angle of 30°. Halon was used as a reflectance standard. Halon is an almost perfect diffuse reflector between .33 and 2.6  $\mu\text{m}$ . A correction was made between 2.6 to 4.2  $\mu\text{m}$  for halon absorptions based on published work (7). The data collected for each sample were averaged and then divided by the halon reflectance to remove instrumental and light source effect and were finally corrected to absolute reflectance. Examples of the resultant spectra in the 2.6 to 4.2  $\mu\text{m}$  region appear in figure 1.

The spectra show that shortwards of about 3.5  $\mu\text{m}$  neither the calcium carbonate nor the magnesium sulfate are detectable in quantities under 10 wt%. However, in the 4  $\mu\text{m}$  region, the 3.9  $\mu\text{m}$  carbonate absorption feature is clearly present in the 5wt% measurement and is barely recognizable in the 3wt% sample. Sulfates are definitely seen in the 5 wt% sample and can also be observed in the 3wt% sample. We feel that with good spectral resolution 3-5wt% of either carbonate or sulfate can be detected in a Mars soil through reflectance spectroscopy.

**REFERENCES:** (1) Clark V.C. and Van Hart D.C. (1981) *Icarus* **45**, 370-378. (2) Gooding J.L. (1978) *Icarus* **33**, 483-513. (3) Baird A.K., Toulmin P., Clark B.C., Rose H.J., Keil K., Jr. Christian R.P., and Gooding J.L. (1976) *Science* **194**, 1288-1293. (4) Fanale F.P., Salvail J.R., Banerdt W.B., and Saunders R.S. (1982) *Icarus* **50**, 381-407. (5) Khan R. (1985) *Icarus* **62**, 175-190. (6) Singer R.B. (1982) *J. Geophys. Res.* **87**, 10159-10168. (7) Weidner V.R. and Hsia J.J. (1981) *Jour. Opt. Soc. Amer.* **71**, 856-861.

## PALAGONITE-SALT MIXTURES

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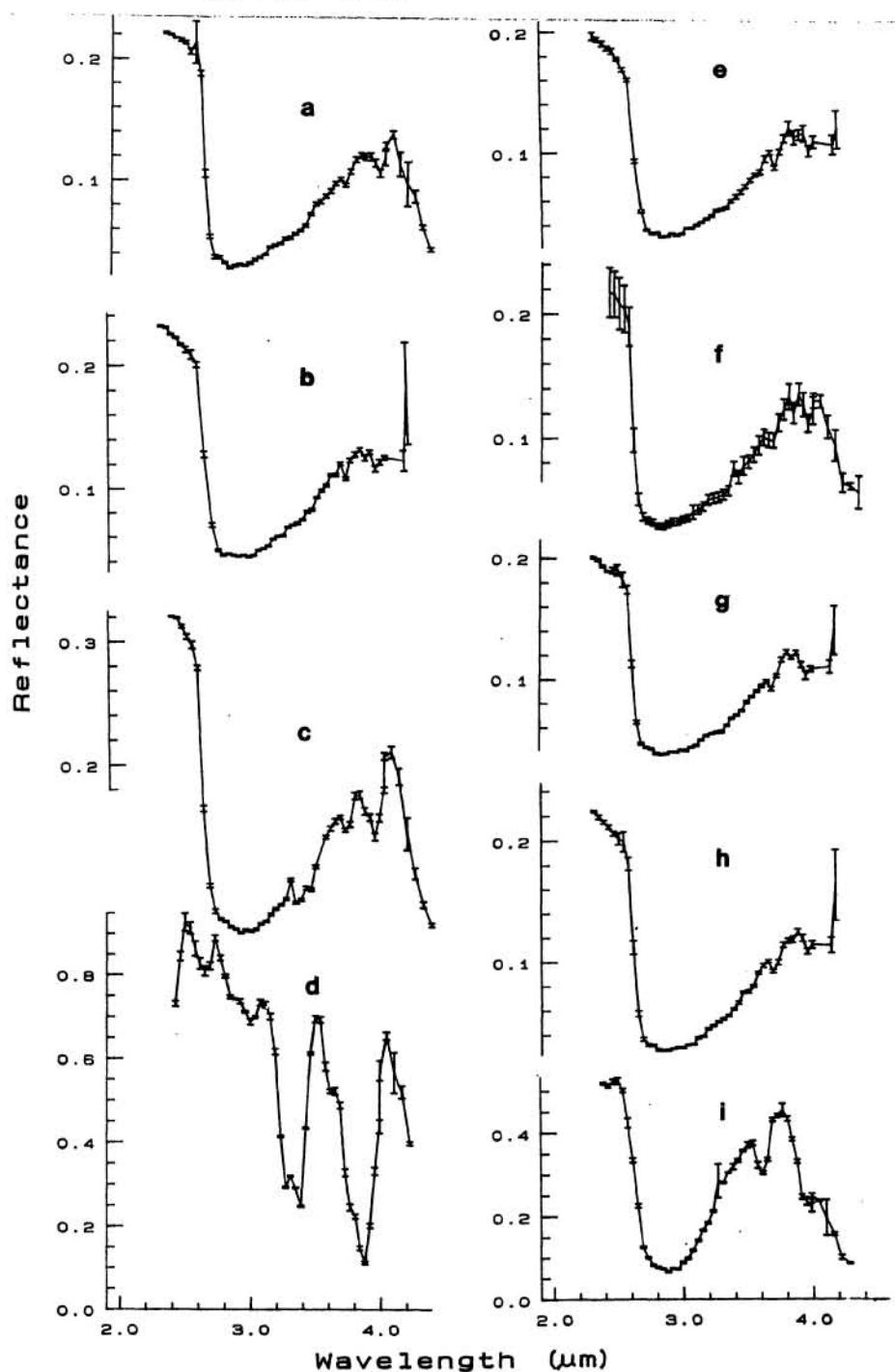


Figure 1. Reflectance Spectra of Salt-Palagonite Mixtures a) 1 wt% CaCO<sub>3</sub> in Palagonite, b) 3 wt% CaCO<sub>3</sub> in Palagonite, c) 5 wt% CaCO<sub>3</sub> in Palagonite, d) CaCO<sub>3</sub>, e) Palagonite, f) 1 wt% MgSO<sub>4</sub> in Palagonite, g) 3 wt% MgSO<sub>4</sub> in Palagonite, h) 5 wt% MgSO<sub>4</sub> in Palagonite, and i) MgSO<sub>4</sub>.