

AMORPHOUS GELS AS POSSIBLE ANALOGS TO MARTIAN WEATHERING PRODUCTS, D.L. Evans and J.B. Adams, Department of Geological Sciences, University of Washington, Seattle, WA 98195; D.B. Wenner, Department of Geological Sciences, University of Georgia, Athens, GA 30602.

A weathered basaltic tephra from Hawaii was found by Evans and Adams (1) to have spectral characteristics similar to surficial deposits at the Viking 1 lander site, based on comparisons of laboratory spectral reflectance curves and Viking lander multispectral images. From laboratory IR spectroscopy (2.5 - 50 μm), X-ray diffraction, X-ray fluorescence (XRF) and microprobe data it can be shown that the weathered portion of the Hawaiian tephra consists of iron allophane, a solidified amorphous gel. The weathered portion of the Hawaiian sample, however, has over three times as much Al_2O_3 as the martian soils analyzed by the Viking XRF experiment. We have investigated the reflectance properties of synthetic samples and have found that iron- and silica-bearing synthetic gels, including those with no Al_2O_3 have generally similar optical properties, and reproduce the Hawaiian sample and V11 spectral curves.

The Viking lander cameras obtained images between 0.4 and 1.1 μm , and in this wavelength region the spectral reflectance curves are dominated by absorption features arising from ferric iron. The reflectance spectrum of a pure iron-hydroxide gel is shown in Figure 1, and is compared with spectra of hematite and of goethite. The Fe^{3+} charge-transition absorption band in hematite is at approximately 0.87 μm ; in the spectra of goethite and of the gel the band is broader and is shifted to longer wavelengths. The spectra of goethite and the iron-hydroxide gel differ in the 0.7 μm region, and OH and H_2O vibrational bands at 1.4 and 1.9 μm are present only in the gel spectrum.

In Figure 2 we show the spectrum of a synthetic gel consisting of silica and iron-hydroxide. The addition of silica increases the overall reflectance and subdues the Fe^{3+} band at 0.89 μm . Neither the goethite nor the amorphous iron-hydroxide gel provide a good match to the reflectance spectrum of the Hawaiian tephra sample (Fig. 2) in the wavelength region imaged by the Viking cameras. However, a good match to the Hawaiian sample and the V11 site is obtained from the solidified synthetic gel of silica and iron hydroxide. The main differences between the composition of the Hawaiian tephra sample and the martian soils analyzed by the Viking XRF experiment is that the Al_2O_3 content of the tephra is 18.1 wt% compared with 5.7 wt% for martian soil (2). From Figure 2, however, it appears that the V11 site spectra can be modeled by materials having no Al_2O_3 , and, we expect that the optical effects of Al_2O_3 are minor in the 0.4 - 1.1 μm region for Fe^{3+} -bearing gels.

Although the Fe^{3+} -bearing siliceous gels satisfactorily model certain parts of the V11 surface we have not yet completed our comparisons with other areas and with telescopic spectra. We note however, that Singer (3) found that a fresh Hawaiian basalt coated with material that is apparently identical to the weathered

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tephra sample has a reflectance spectrum very similar to telescopic spectra of martian dark areas.

Chemical models of the martian surface materials based on Viking XRF and biology experiment data, and evidence based on surface morphology, indicate that liquid water may have been important for weathering on Mars at some time in the past (e.g. 4, 5) or possibly at the present (6). Given the presence of liquid water at some time, our data imply that the surface of Mars may have abundant terrestrial-type amorphous weathering products. Since amorphous ferric-iron-bearing gels can satisfy the constraints provided by spectral reflectance data, mixtures of crystalline phases, where clay is a principal component (e.g. 2, 4), although not excluded, may not be required to explain Viking XRF data.

References

(1) Evans, D.L. and Adams, J.B. (1979) *Proc. Lunar Planet. Sci.* 10th, 1829-1834; (2) A.K. Baird, et al. (1976) *Science* 194, 1288-1293; (3) Singer, R.B. (1980) (submitted to JGR); (4) P. Toulmin, et al. (1977) *JGR* 28, 4625-4634; (5) Soderblom, L.A. and Wenner, D.B. (1978) *Icarus* 34, 622-637; (6) Huguenin, R.L. (1974) *JGR* 79, 3895-3905.

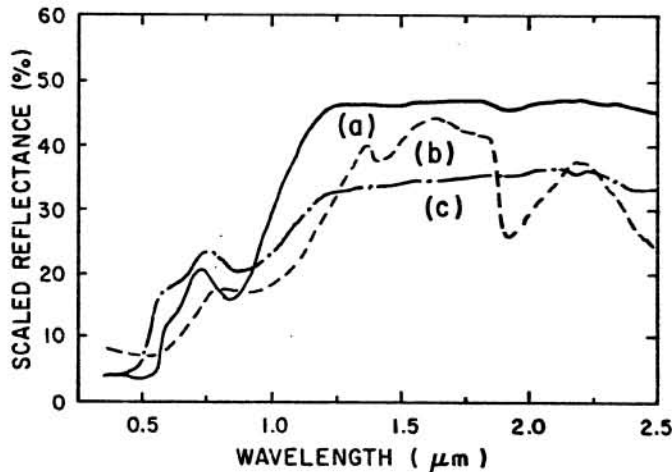


Figure 1. Reflectance spectra of (a) hematite, (b) a solidified amorphous gel of iron hydroxide, and (c) goethite.

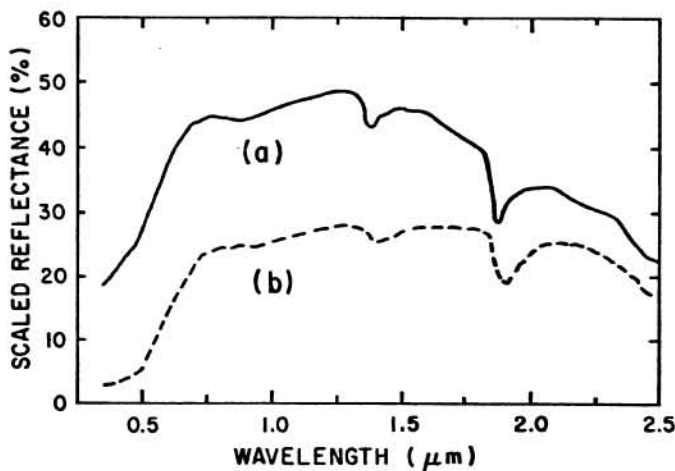


Figure 2. Reflectance spectra of (a) a solidified amorphous gel of silica and iron hydroxide, and (b) a weathered basaltic tephra from Hawaii that has spectral characteristics similar to a deposit at the VL1 site (1).