N91-27058

**THE CHEMISTRY AND MINERALOGY OF MARS SOIL AND DUST.** A. Banin, NRC/NASA Ames Research Center (MS 239-12), Moffett Field, CA 94305, and Hebrew University, Rehovot 76100, Israel.

A single "geological unit" consisting of fine, apparently weathered soil material is covering large portions of the surface of Mars. This soil material has been thoroughly homogenized by global dust storms and it is plausible to assume that Mars dust is strongly correlated with it.

The chemical-elemental composition of the soil has been directly measured by the Viking Landers. Positive detection of Si, Al, Fe, Mg, Ca, Ti, S, Cl and Br was achieved. Compared to most basalts, Fe is high and the $MgO/Al_2O_3$ ratio is uncommonly close to one. Potassium concentration is relatively low. Analyses of the SNC meteorites, a group of metorites that has been suggested to be ejected martian rocks, supply additional elemental-concentration data, broadening considerably our chemical data-base on the surface materials. A compositional model for Mars soil, giving selected average elemental concentrations of major and trace elements, was recently suggested (Table 1). It was constructed by combining the Viking Lander data, the SNC meteorite analyses, and other related analyses.

The mineralogy of the surface materials on Mars has not been directly measured yet. By use of various indirect approaches, including chemical correspondence to the surface anlayses, spectral analogies, simulations of Viking Lander experiments, analyses of the SNC meteorites and various modelling efforts, the mineralogical composition has been constrained to some extent. It is suggested that the fine surface materials on Mars are a multicomponent mixture of weathered and non-weathered minerals. Smectite clays, silicate mineraloids similar to palagonite, and scapolite, have been suggested as possible major candidate components among the weathered minerals. Iron is present as amorphous iron oxyhydroxides mixed with small amounts of crystallized iron oxides and oxyhydroxides, having extremely small particle sizes ("nanophases"). Specific candidate minerals that

have been proposed include nanophase hematite, lepidocrocite, goethite, and jarosite. As accessory minerals, it is likely that the soil contains various sulfate minerals, most probably calcium and magnesium sulfate, and chloride salts. If present, carbonates are likely to be at very low concentrations, although siderite ($FeCO_3$) may be present at somewhat higher concentrations. Organic matter is totally lacking.

No direct analyses of soil reactivity have been done yet. Indirect evidence, mostly from the Viking biology experimental results, suggests that the soil probably has a slightly acidic reaction (pH<7) and is generally oxidized. Upon humidification during the Viking biology experiments, the soil released oxygen and various other atmospheric gases. The amount of oxygen released was 70-770 nM/g. Whether the oxygen was physi-sorbed, present in peroxide or superoxide compounds, or both is not clear at present. Small particle size (nanophases) of both the silicate and the iron oxide minerals in the soil, may lead to high specific surface area and suggest potentially high catalytic reacitivty and high adsorption capacity of the soil.

Unambiguous identification of the Mars soil minerals by direct mineralogical analyses, and non-disturbed or *in situ* measurements of the soil's reactivity, are of primary importance in future Mars research.

**Table 1**

**AVERAGE CHEMICAL COMPOSITION MODEL OF THE FINE MARTIAN SOIL**

| Constituent | Selected Average Concentration % | Constituent | Selected Average Concentration % | Constituent | Selected Average Concentration % |
|---|---|---|---|---|---|
| $SiO_2$ | 43.4* | $K_2O$ | 0.10** | $SO_3$ | 7.2* |
| $Al_2O_3$ | 7.2* | $P_2O_5$ | 0.68** | Cl | 0.8* |
| $Fe_2O_3$ | 18.2* | MnO | 0.45** | | |
| MgO | 6.0* | $Na_2O$ | 1.34** | $CO_3$ | <2*** |
| CaO | 5.8* | $Cr_2O$ | 0.29** | $NO_3$ | ? |
| $TiO_2$ | 0.6* | | | $H_2O$ | 0-1+ |

* Based on direct soil analyses by Viking XRF.

** Based on SNC meteorite analyses.

*** Estimated from LR simulation.

\+ Varying content.