

PALAGONITES VS. SMECTITES AS POSSIBLE MARS SOIL ANALOGS, A. Banin* and L. Margulies, Seagram Centre for Soil and Water Sciences, Hebrew University of Jerusalem, Rehovot, Israel (*now at the Extraterrestrial Research Division, NASA-Ames Research Center, Moffett Field, CA 94035).

The identification of the prevailing mineral(s) in Mars soils studied by the Viking Landers remains an open and somewhat enigmatic question. Since no direct mineralogical measurement has been performed by Viking, the evidence at hand is indirect and consists mainly of (a) the elemental chemical analyses(1), (b) spectroscopic measurements (2-6). In addition, the results of the Viking biology experiments can, and did supply information regarding the physico-chemical nature of the soil material (7-11). Based on the elemental composition of the soil it was originally proposed (1) that smectite clay minerals, mainly nontronite and montmorillonite, are the major minerals present, and that they are mixed with various soluble salts. We have used the Viking biology results as a reference to study experimentally these smectite minerals in simulation experiments and obtained faithful simulations of the ^{14}C release kinetics in the Viking Biology Labeled Release (LR) experiments and of the labeled carbon fixation in the Pyrolytic Release (PR) experiments (7-9, 12). This work established the technique of LR simulation as a useful tool for the physicochemical characterization of Mars soil analog materials.

Recently, several reports in the literature have suggested that volcanic glass and especially its weathering product, the amorphous aluminosilicate called palagonite, may be the major components of the Mars soil. The experimental basis for this suggestion was the IR reflectance spectra of the martian dust and martian surface as measured from Earth (2,3,13-15). A geological scenario was developed (16) to account for the presence of these minerals in the Mars soil. According to these findings the smectite minerals and particularly nontronite do not fit well the average Mars IR reflectance spectrum, due apparently to the high crystallinity of their iron sites. It was suggested that the amorphous, short-range ordered palagonite gives a more neutral spectrum (15), coupled with the high absorption at the near IR, that better fits the Mars spectral curve.

To test further this hypothesis we compared palagonites and smectites in LR simulations. In the simulation a solution of labeled (^{14}C) formate was added to the minerals at Viking-Lander conditions. The release of ^{14}C to the atmosphere, was followed with time (8). In Figure 1 we compare the Viking IR results with the active iron- and hydrogen-montmorillonite clays and with a palagonite from British Columbia. Whereas the clays show high decomposition activity resulting in release of ^{14}C , the palagonite is non-active. Similar results were obtained for several other palagonites, for an Hawaii volcanic soil and for allophane soil. We believe that the major reason for these observations is the relatively high pH of the palagonites, which prevented formate decomposition and/or $^{14}\text{CO}_2$ release. However, leaching of the British Columbia palagonite with acid did not change its pH considerably, nor increased its activity in formate decomposition. The decomposition reaction kinetics obtained with the iron clay is the most similar to that measured on Mars and this led us in the past (7-9) to suggest that iron-rich clays, particularly montmorillonite, are major components of the Mars soil. We now conclude that, in their natural form, many of the palagonites found on Earth may not have the surface-chemical properties that the fine components of the Mars soil have. The question of how to reconcile the spectroscopic observations on Mars with the chemical findings still remains open and requires further study.

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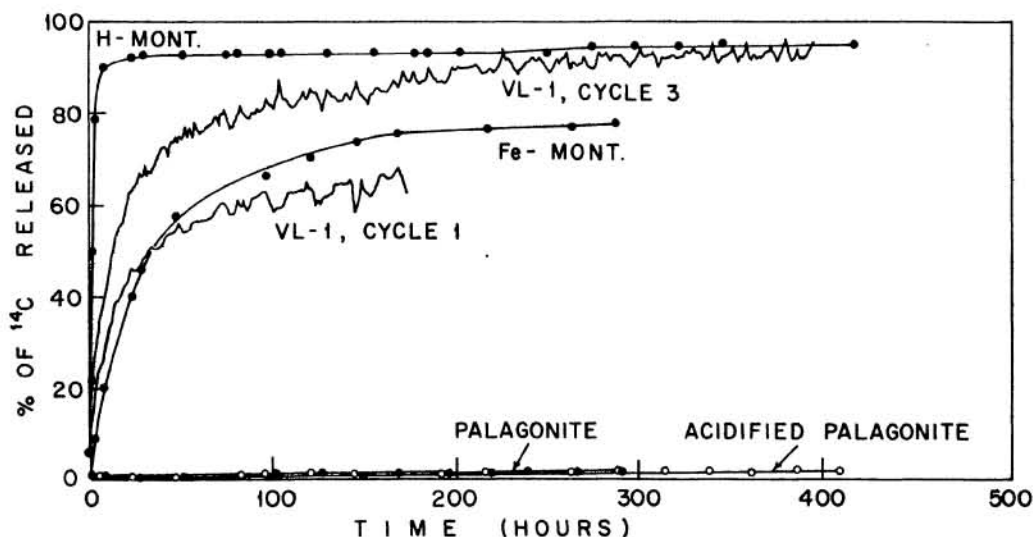


Fig. 1. Kinetics of ^{14}C release caused by Mars soil in two cycles of the Viking Labeled Release Experiment (VL-1), compared with simulations using iron and hydrogen montmorillonite (H- and Fe-Mont.), and a palagonite from British Columbia.

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