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MARS, CLAYS, AND THE ORIGINS OF LIFE

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An outstanding problem that the scientists and engineers of NASA faced in designing the Viking mission to Mars could be phrased in simple terms: How to detect life in the Martian soil? The tests that were decided upon were designed to look for respiration and photosynthesis. The respiration experiment or labeled release (LR) experiment consisted of adding organic molecules such as formate to the Martian soil and measuring the carbon dioxide released. The results of this experiment were positive. The photosynthetic experiment or pyrolytic release (PR) experiment consisted of adding water to a Martian soil sample in a Martian atmosphere of carbon dioxide and nitrogen and shining light on it and measuring the organic molecules formed. The results of this experiment were also positive. Thus both tests for life in the Martian soils were positive. However, when the measurement for organic molecules in the soil of Mars was made, none were found. The interpretation given is that the inorganic constituents of the soil of Mars were responsible for these observations. The inorganic analysis of the soil was best fitted by a mixture of minerals: 60–80% clay minerals, iron oxide, quartz and soluble salts such as halite (NaCl). The minerals most successful here on Earth in simulating the PR and LR experiments are iron-rich clays (Banin and Margulies, 1983).

There is a theory that considers clays as the first organisms capable of replication, mutation and catalysis and hence of evolving (Cairns-Smith and Hartman, 1986). Clays are made up of various ions imbedded in a "two-dimensional" silicate lattice. The ions are mainly silicon, aluminum, iron and magnesium. Clays are formed when liquid water causes the chemical weathering of rocks. The concentration of ions in clays, e.g., iron and magnesium, is extremely variable and thus clays can be considered solid solutions. In 1966, Cairns-Smith (1966) proposed that the original genes were clays. The distribution of ions such as aluminum, magnesium and iron played the role of bases in the DNA. The information was stored in the distribution of ions in the octahedral and tetrahedral layers. The major idea is that clays could not only adsorb and catalyze reactions between organic molecules, but that they could, like DNA or RNA, replicate. Thus, two sheets of clay would be like the two complementary strands of a DNA molecule. When they replicated, each sheet of clay would be a template for a new sheet. The ion substitutions in one clay sheet would give rise to a complementary or similar pattern on the clay synthesized on its surface. If we now suppose that, as with DNA, an error of replication or mutation is possible, then replicating clays could evolve. It has been theorized that it was on the surface of replicating iron-rich clays that carbon dioxide would be fixed in the light into organic acids such as formic or oxalic acid (Hartman 1975).

If Mars had liquid water during a warm period in its past, clay formation would have been abundant. These clays would have replicated and evolved until the liquid water was removed due to the cooling of Mars. It is entirely possible that the Viking mission detected life on Mars, but it was clay life that awaits the return of water to continue its evolution into life based on organic molecules.

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