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Features

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Martian Organic Matter in ALH84001?

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A recent paper by Luann Becker, Brian Popp, Terri Rust (all at the University of Hawai'i), and Jeffrey Bada (University of California, San Diego) claims to have the first definitive evidence for the presence of martian organic compounds in martian meteorite ALH84001, the famous meteorite that may or may not have fossils in it. They do not think that these organic compounds reflect biological processes on Mars. There is plenty of organic matter in this meteorite, but many investigators have claimed that most of it entered the rock after it fell to Earth. Tim Jull and his associates, for example, estimated that 80% of the organic carbon in the meteorite was from the Earth (see **PSR Discoveries** article Organic Compounds in Martian Meteorites May be Terrestrial Contaminants). Although Jull's work emphasized the importance of the contamination problem, it also left room for the presence of organic matter that came from Mars.

Becker and her colleagues wanted to investigate the nature of that potentially-martian material. Using only 0.46 grams of ALH84001, they carried out a series of experiments in which they dissolved the carbonates, a main carrier of organic compounds, and measured the carbon isotopic compositions of the solutions and the left over, undissolved rock. The carbon associated with the carbonate globules had carbon-12/carbon-13 ratios like terrestrial organic carbon, and they consider it to be terrestrial contamination. They support this interpretation by pointing out Jull's work and previous work reported by Jeff Bada (see **PSR Discoveries** article Life on Mars -- The Debate Continues) which also suggest contamination.

The samples from which carbonate minerals had been removed, however, had carbon-12/carbon-13 ratios less than the standard terrestrial value, and Becker believes that this organic matter is probably indigenous to the rock, hence is from Mars.

Becker also made more direct measurements of the organic compounds in ALH84001. Using Laser Desorption Mass Spectrometer (LDMS), she fired a finely-focused laser at acid-treated carbonate globules and silicate mineral grains. Besides the usual polycyclic aromatic hydrocarbons (also known as PAHs), she found very heavy carbon compounds, with masses like that of heavy organic compounds called kerogens. Similar kerogen-like material in the Murchison carbonaceous chondrite has similar characteristics, including the same carbon-12/carbon-13 ratio. This similarity leads Becker and coworkers to suggest that the indigenous organic compounds in ALH84001 may be from meteorite bombardment of the surface of Mars. They do not think that the organic compounds in ALH84001 reflect biological processes on Mars.

An extra-Martian source of the organic compounds would overcome a problem: the surface of Mars is too oxidizing to allow synthesis of organic compounds, according to Becker and co-wokers. They cite recent studies by J. Farquhar and others (University of California, San Diego), which indicate that the surface of Mars is highly oxidizing. A rain of organic-rich debris, however, would be buried over time by being incorporated into sedimentary deposits, which would protect them from the oxidizing conditions at the surface. This may be how the raw ingredients for life were deposited on Mars, and perhaps on Earth as well.

Whether the organic compounds in ALH 84001 are biological or not, this work, coupled with Jull's observation that 20% of the organic compounds in ALH84001 could be extraterrestrial, shows that organic compounds are

present on Mars. Whether their presence led to life or not remains to be seen.

Additional Resources

Becker, L., B. Popp, T. Rust, and J. L. Bada, 1999, The Origin of Organic Matter in the Martian Meteorite ALH84001. *Earth and Planetary Science Letters,* vol. 167, p. 71-79.

Farquhar, J., M. H. Thiemens, T. Jackson, 1998, Atmosphere-Surface Interactions on Mars: Delta O^{17} Measurements of Carbonate from ALH84001. *Science,* v. 280, p.1580-1582.

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