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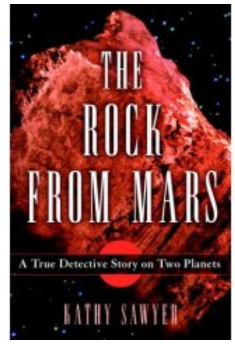
The Rock from Mars—A Detective Story on Two Planets, by Kathy Sawyer, 2006. Random House, New York. Hardback, XII + 395 pages. Price USD 25.95. JSBN 1-4000-6010-9.



Each atom of that stone, each mineral flake of that night—filled mountain, in itself forms a world. The struggle itself toward the heights is enough to fill a man's heart. One must imagine Sisyphus happy.
—Albert Camus, 1955; End of *The Myth of Sisyphus*: also quoted by Sawyer

A mystery fan, I have read this entire book twice, including the 87 pages of Notes, and parts of the book half a dozen times. It is a most enjoyable account of politics and science, and of postulated microscopic life on Earth and Mars—riveting, suspenseful, and astonishing.

No matter how much some of us may wish it, we are far from knowing whether there is or ever was life on Mars. The search and speculation go on and will likely continue for years. However, when you finish the narrative that is presented here, you will have a good background on the most compelling hypothesis so far formulated for extraterrestrial life.

For a few months in the last quarter of 1996 the most famous rock on Earth was a snick (SNC), a grayish-green meteorite from Mars that long ago crystallized from a volcanic flow. Absolute age dating indicated that it originated about 4.5 bya, the oldest known rock from any planet. Blasted from Mars by a comet or asteroid 16 mya, it fell about13,000 years ago onto an Antarctic ice field, one of 30,000 or so meteorites the size of a fist or larger that fall to Earth each year. To escape Martian gravity it must have departed at around 11,000 mph.

For the petrologically sophisticated, the meteorite was called a "diogenite," a coarse-grained achondrite mainly of low-Ca pyroxene. At the time, only eight other SNCs were known. Roberta (Robbie) Score, a geology graduate of UCLA working for NASA, picked up the 4.25 pound rock on a balmy summer day, 27 December 1984, from the Far Western Icefield in Antarctica. It was Score's first journey to the "ice." In color, it was a vivid green, in size, a grapefruit. Because of its fiery descent it was covered with a black fusion crust. It became ALH84001 (ALH for the locality—Alan Hills—84 for the year Score found it, and 001 because she intended it to be first of the rocks collected by her group that field season to be recorded and analyzed. Like many other dust-gathering specimens, it lay in storage for nine years.

In 1996, a group of nine researchers (D. S. McKay, E. K. Gibson, K. L. Thomas-Keprta, Hojatollah Vali, C. S. Romanek, S.J. Clemett, D.F.Chillier, C.R. Maechling, and R.N. Zane) offered evidence that the meteorite from Mars contained fossil-like forms and had other possible signs of life (**Science 273**, 16 August, p. 924-930). Reaction to the article was immediate and in some instances apoplectic. The tubular "fossil-like" structures that the scientists saw are similar in size and shape to exceptionally small structures (nannobacteria) found in some Earth rocks. (Disclosure: McKay and colleagues cite for comparison structures illustrated in a 1994 article by McBride, Picard and Folk, 1994, on Italian concretions, published in the *Journal of Sedimentary*

Research.) Because of their tiny size (about 1/100 the volume of typical Earth bacteria) and for other reasons, researchers, notably J. William Schopf—but many others as well—quickly challenged the idea that the tubelike structures were evidence of primitive life on Mars or of life at all. According to Kathy Sawyer, Schopf initially was reluctant to become involved in the controversy.

Carbonate globules (moons), also variously called rosettes, orange spheroids, disk-shaped concretions, pancakes and so on, occur in ALH84001. That the carbonate actually formed on Mars is indicated by cracks that could not be the result of collision with Earth. Chris Romanek, a low-temperature geochemist working with NASA, thought that perhaps water saturated with carbon dioxide flowing on Mars during a wet interval lead to the conditions necessary for deposition of the carbonates. Early on, Romanek was excited by what he thought were "bacterial forms all over the place" in the carbonates. This was the first recognition of the tubular structures. Later, he learned about and was struck by the University of Texas petrologist R. L. Folk's reports on nannobacteria, purported dwarf bacteria occurring in many rocks on Earth, and identical to the structures in ALH84001.

A less controversial line of evidence, but one questioned nevertheless, was the McKay group's report of extremely tiny (a billion of them could rest on the head of a pin) magnetic crystals (magnetite) embedded within the carbonates. After extensive study, Kathie Thomas-Keprta and nine co-authors suggested that a biogenic process on Mars likely produced these truncated hexa-octahedral magnetites. Similar magnetites evolve from bacteria on Earth. Bacteria on Mars had made, said the geobiologist Joseph L. Kirschvink, one of the co-authors, little bar magnets that differ strikingly from anything found outside of biology. If so, this would be the oldest indication of life yet found in the universe.

The Mars meteorite also contains polycyclic aromatic hydrocarbons (PAHs), hydrocarbons of a type associated with life. According to some proponents of Martian life, when the supposed organisms on Mars expired, their decomposition yielded greasy organic remnants, products of "cellular" decay, as happens on Earth. Perhaps, they were sculpted into provocative mineral shapes, similar—so the McKay team suggested—to the fossilized remains of Earth bacteria. The small size of the purported organic remains is about the same size as that of Folk's nannofossils.

As in every major hypothesis, the critics of the hypothetical Martian life far outthundered on television those who looked favorably on or were open to claims of the McKay group. The PAHs, probably the weakest link in the evidence, were especially attacked by researchers who claimed that the organic compounds were the result of contamination during transit to Earth or after the meteorite fell on Antarctica. The "fossil-like forms" also attracted vitriolic dissent from those who claimed they were much too small, far below the lower limit in size of "life." McKay considered these structures the most controversial of four lines of evidence of Martian life that his group advanced. But the carbonates and the magnetic crystals with the carbonates also did not escape the fury of naysayers. At the time the research appeared, a volume equivalent to a sphere of 200 to 250 nm was generally considered to be the lower limit of life.

In a paper presented at the Geological Society of America's meeting eighteen months ago in Denver (October 2007), the sedimentary petrologists R. L. Folk and Brenda Kirkland reported that TEM (transmission electron microscope) data on algal/ bacterial slime collected from sulfurous springs near Viterbo in west-central Italy show a continuous gradation from "normal" cells in the 1 micron range with cell walls and ribosomes, down to spherical cells with ribosomes measuring 150 nm or less. Below that size, objects visible in section have cell walls and electron-clear interiors that range continuously down to 50 nm or even smaller. Folk and Kirkland said that there was no break in such sequences at the 200 nm boundary. If substantiated, the Viterbo slime extends the size limit of "life" well below 200 nm. It also supports the evidence advanced by McKay and others (1996) for life on Mars.

Ms Sawyer, a journalist who covered space science and technology for the *Washington Post* for seventeen years, has done a fine job, writing a balanced work, which humanizes a very large cast of characters. Apparently this is her first book. It is especially notable for its even treatment of the many points of view, prejudices, jealousies, and the professional positions of the principal players in this wonderful drama. *The Rock from Mars* is a moderate-size book that reads like a short one. I wanted more.

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