WHAT WE KNOW ABOUT MARS (BUT OTHERWISE WOULDN'T) IF IT IS THE SHERGOTTITE PARENT BODY.

Harry Y. McSween, Jr., Department of Geological Sciences, University of Tennessee, Knoxville, TN 37996.

One of the major scientific triumpns of the last several Lunar and Planetary Science Conferences has been the presentati·· of evidence that some meteorites may actually be samples of fairly large solar system bodies, specifically the moon and the planet Mars. The proposed martian meteorites, called shergottites after the first example which fell in Shergotty, India in 1865, are igneous rocks that crystallized from molten magmas. Their crystallization ages are much too young to have formed by internal melting within small asteroids, and the unusual chemical composition of gases trapped when these rocks were severely shocked matches that of the martin atmosphere measured by Viking. These meteorites were presumably ejected from Mars by some catastrophic impact.

In a paper presented to the 16th Lunar and Planetary Science Conference, Harry Y. McSween, Jr. of the University of Tennessee discussed the implications of these samples for martian evolution. In a nutshell, his conclusion is that if Mars is the shergottite parent body, the martian interior is much more like that of the earth than has been previously thought.

The compositions of magmas produced by partial melting of rocks in the interior varies depending on the depth. It is possible to estimate the depth of melting from the height of martian volcanoes, assuming that magmas are forced upward by the weight of the overlying material. This information can be used to constrain the mineralogic and chemical composition of the martian mantle. McSween argued that shergottite magma compositions could only be produced at the inferred depth of martian melting if the mantle is more earth-like in composition that previously published estimates. Certain assemblages of minerals in shergottites also indicate that the martian mantle is oxidized like that of the earth, rather than reduced like the moon.

The evolution of a planet is driven by the heat it can generate internally. One of the great problems in constructing martian thermal models is uncertainty in the amounts of radioactive heat sources in the planetary interior. However, data from shergottites indicate that the abundances of the radioactive isotopes of potassium, thorium, and uranium are similar to terrestrial values.

The most important event in planetary evolution is the separation of a core, a process called differentiation. At present, the time of martian core formation is constrained only by rather uncertain thermal models to have occurred anywhere from 4.5 to 0.9 billion years ago. Data in shergottites indicate that their parent planet suffered differentiation very early, at approximately 4.5 billion years ago. We know very little about the martian core, other than the fact that it is probably small. Many models predict that it should consist of iron-nickel sulfides, rather than iron-nickel metal as in the earth's core. An estimated composition of the shergottite parent body mantle by Heinrich Wanke and coworkers at the Max Planck Institut fur Chemie in Mainz, Germany, is similar to that of the earth's mantle, except for the proportions of a few elements that were extracted to form the core. Those elements which have strong affinities for sulfur, such as cobalt and copper, are significantly depleted in the shergottite parent body mantle, but elements like tungsten that have affinity for metal are not. The inference that Mars has a sulfide core is apparently correct. The estimated mass fraction of the shergottite parent body that is core is about 22 percent.

The magnetic field of Mars is the least understood of all the planets visited by spacecraft, and a major question remains about whether Mars even has a magnetic field. Shergottites apparently record the presence of a small magnetic field at the time they were shocked. Similar unshocked meteorites have not been analyzed, but may offer the potential for determining the presence of even more ancient magnetic fields.

The proportion of highly volatile elements in Mars is an important characteristic, because escape of volatiles as the planet heats up produces an atmosphere. Some earlier interpretations of Soviet data, as well as the present thin atmosphere, suggested that Mars is a volatile-poor planet. However, measurements in shergottites indicate that volatile element concentrations in Mars should be similar to the earth. Some of the early martian atmosphere has apparently been lost, and the planet may have been outgassed less efficiently than the earth.

Shergottites may also provide an explanation for the grest lengths (up to 800 kilometers) of volcanic flows on the martian surface. McSween's calculations of the physical properties of shergottite magmas suggest that they would be dense and highly fluid, just the kind of characteristics that would allow long flows. The compositions of shergottites also provide a good comparison for martian soil analyses by Viking. The similarity in compositions suggests that soils may be derived directly from volcanic bedrock, and that no drastic chemical changes occur during weathering. This is very different from weathering on the earth and implies that the ratios of water to rock were low on Mars.

The return of lunar samples by Apollo missions revolutionized scientific thinking about the moon. Although we have learned a great deal about our other planetary neighbors since the Apollo program, the absence of returned samples has hampered progress in understanding their geologic evolutions. Shergottites may be the Apollo samples of Mars.