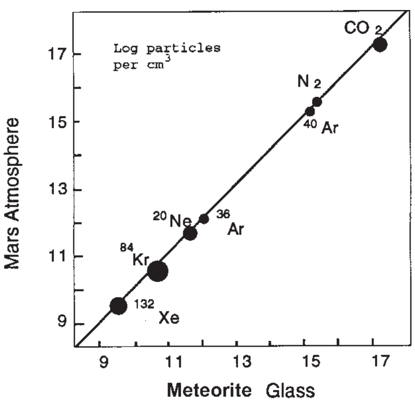
Meteorites from Mars!

Robotic exploration of Mars has provided much of our information about the geology and weather of the red planet. The Viking mission in the 1970s had two orbiters which mapped the surface and two landers which analyzed rocks and soils. The Mars Surveyor Program plans to send a series of orbiters and landers every two years. The first missions were the Pathfinder lander/rover in 1997 and its companion Global Surveyor orbiter which is now mapping Mars. The Polar Lander and Climate Orbiter are expected to arrive at Mars in the Fall of 1999. However, none of these missions has returned a Mars sample to Earth. Further crucial information about Mars comes from an unexpected source—**meteorites** that arrived on Earth unaided by technology.



Why Are They From Mars?

The fourteen martian meteorites are igneous rocks of five different varieties. They crystallized from molten lava near Mars' surface. The group is unusual compared to typical igneous meteorites from asteroids. All but one are younger (1.3 billions years old or less) and have higher contents of water and gases than meteorites from asteroids. The conclusive evidence that these meteorites originated on Mars came from the measurement of gases trapped in one meteorite's interior. These trapped gases, now confirmed in other meteorites, match those that the Viking lander measured in the martian atmosphere.

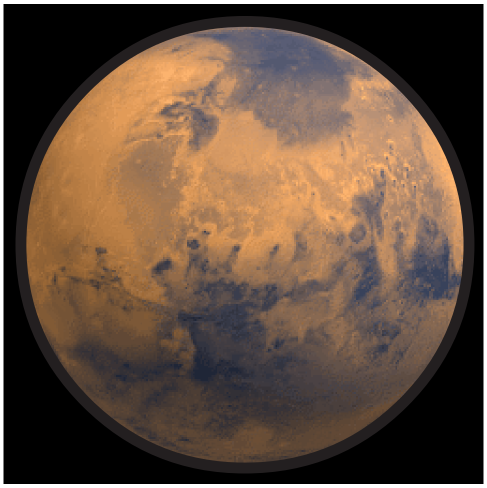
Martian Meteorites. (falls are indicated by *. Year is date of discovery or classification as martian)

Name	Find Location	Year	Classification	Mass (kg)
Shergotty*	Bihar, India	1865	basalt	5.00
Zagami*	Katsina, Nigeria	1962	basalt	18.00
EETA79001	Elephant Moraine, Antarctica	1980	basalt	7.90
QUE94201	Queen Alexandra R, Antarctica	1995	basalt	0.012
Dar al Gani 476/489	Sahara, Libya	1998	basalt	2.02/2.15
ALHA77005	Allan Hills, Antarctica	1978	lherzolite	0.48
LEW88516	Lewis Cliffs, Antarctica	1991	lherzolite	0.013
Y793605	Yamato Mts, Antarctica	1995	lherzolite	0.018
Nakhla*	Alexandria, Egypt	1911	clinopyroxenite	10.00
Lafayette	Indiana, USA	1931	clinopyroxenite	0.80
Gov. Valadares	Min. Gerais, Brazil	1958	clinopyroxenite	0.16
Chassigny*	Hau. Marne, France	1815	dunite	4.00
ALH84001	Allan Hills, Antarctica	1993	orthopyroxenite	1.90

How Did They Get Here?

The only natural process capable of launching martian rocks to Earth is meteorite impact. Mars' surface has numerous impact craters of various sizes and ages. To be ejected from Mars, a rock must reach the escape velocity of 5.4 km/sec, which is more than five times the muzzle velocity of a hunting rifle. An impact capable of ejecting the martian meteorites would have left a crater 10-100 km across. The meteorites spent several million years in space before landing at various sites on Earth.

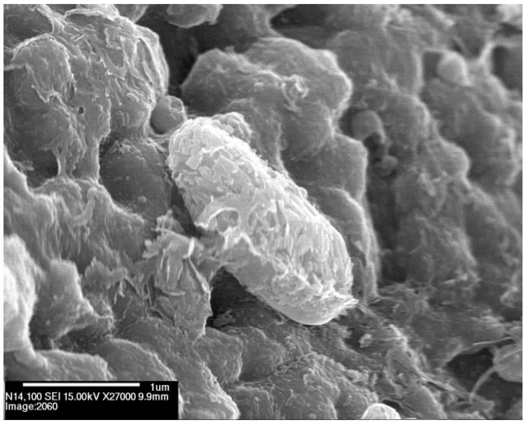
For more information write to: Antarctic Meteorites, Mail Code SN2, NASA Johnson Space Center, Houston, Texas 77058.
http://www-curator.jsc.nasa.gov/curator/antmet/marsmets/contents.htm



What Do They Tell Us About Mars?

Martian meteorites tell us about processes occurring throughout Mars' history. The story begins 4.5 billion years ago with the formation of Mars' core, mantle and crust. The oldest martian meteorite crystallized from a magma soon thereafter. The youngest martian meteorites show that volcanism continued until about 180 million years ago. Impacts occurred on the surface throughout Mars' history.

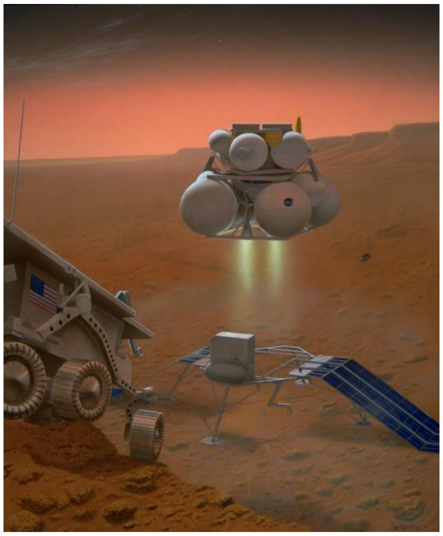
The martian meteorites are gray rocks which show none of the red color of the oxidized Mars soil. However, many of the meteorites show some evidence of interaction with water. Some have igneous minerals containing water, while others have salts and clays caused by weathering. Studies of gases show that Mars' atmosphere evolved very differently from that of Earth, losing its lightest gases to space over time.



What About Life on Mars?

Mars is the most likely of the other planets to be a home for life. Liquid water and volcanic heat were available to support life at least early in Mars' history. In the 1970s the Viking landers analyzed Mars rocks and soil but could find no evidence of life on Mars. In 1996 a team of JSC scientists reported finding possible fossil life in martian meteorite ALH84001. Their evidence included minerals formed at low temperatures which contained small amounts of organic compounds, and oxide minerals which could be biogenic, and tiny structures which look like miniature Earth bacteria. After three years of intense study and debate, with new data supporting both sides, the issue is still not resolved. The meteorite has had such a complex history that it may never provide a simple answer to the question of life on Mars.

Why Do We Need Sample Returns?



Mars sample return may be the best way to evaluate life on Mars and study the geology and climate of the planet. Martian meteorites have several disadvantages as martian probes. Most have been on Earth a long time and are contaminated by its environment. Moreover, they are all igneous rocks and not as likely to contain evidence of life as sedimentary rocks or soils. Finally, we don't know the locations on Mars that the meteorites came from so it is difficult to tie them to local geology.

The Mars Surveyor Program is using its early missions to search for sites for sample return. These might be volcanic hot springs or sedimentary lake beds. The Mars Sample Return mission is planned to launch in 2003-2005 and return to Earth in 2008. Perhaps these samples will solve the question of life on Mars.