

29:52 Exploration of the Solar System
Class Notes for April 2, 2008
What Spirit and Opportunity Found

The Mars Exploration Rovers contributed in a major way to our knowledge of Mars and its geological past. Both of these Rovers landed on Mars in January, 2004. Both sites were chosen because they indicated possible presence of water in the past. *Spirit* landed in *Gusev Crater*, an impact crater that has a dry river flowing into it. *Opportunity* landed on *Meridiani Planum*, a region on Mars chosen because orbit pictures showed evidence for *Hematite* on the surface. Hematite is an oxide of iron, Fe_2O_3 which on Earth formed in the presence of water.

Principal Findings of Spirit and Opportunity

- From the very first, Opportunity found evidence of sedimentary rocks. See Figure 11.28 of the text.
- Opportunity also found abundant hematite at the landing location in the form of “blueberries”, little sphere of hematite. Geologists concluded that the blueberries are due to mineral condensation in water. For this to be the case, the region where the hematite was found would have been submerged for long periods of time. As MER scientist Steven Squyres said “this area was soaking wet”.
- To quote from the textbook “the evidence conclusively shows that water at least several inches deep (and probably much deeper) covered Meridiani planum for a considerable period of time.”

Water on Mars at the Present Time

The question arises as to what happened to the water that was standing and flowing on the surface of Mars billions of years ago. Either it evaporated into space, or it is locked below the surface of the planet. Both possibilities probably occurred.

The Mars Odyssey spacecraft had instruments which could form images of neutrons reflecting from the surface of Mars, as well as gamma rays produced when these neutrons reacted with protons in water molecules. The map of the subsurface water, shown in Figure 11.41, shows that there is apparently substantial stores of subsurface ice in the north and south polar regions. It may exist at other regions as well, but would have to lie deeper. This finding is why the Mars Phoenix lander will be landing at the south pole.

Summary

The following summarizes what we have learned from spacecraft exploration of Mars, both orbiters and landers.

1. The present day Martian climate is inhospitable for more advanced life, because water is not stable in liquid form.
2. The results of the Viking lander experiments indicate that microbial life is not present either, but due to ambiguities, these experiments should (and will be) repeated in the future.
3. The MERs have conclusively shown that there was water standing on the surface of Mars for long enough for minerals to form. This happened very early in the history of the solar system.
4. The water that was on Mars may have been highly acidic, so it is unclear what the implications were for the early development of life.
5. There appears to be subsurface ice under the north and south poles of Mars. It is not known if this ice liquifies at greater depths.
6. The situation will be clarified by future missions.

Future Missions

The two principal planned missions for the future are as follows. *Mars Science Laboratory* will be launched in 2009, and arrive at Mars in 2010. It will be a lander and rover, and will conduct biological experiments. The ultimate goal is for *Mars Sample Return Mission*, which will collect Martian rock samples from carefully chosen locations and return them to Earth for analysis. This mission may answer the question as to whether life ever existed on Mars.