Buried Carbonates at Mars

- Infrared observations from spacecraft orbiting Mars are used to determine the composition of minerals on the surface
- Impacts expose material previously buried below the surface
- Observations from the center of one Martian crater show carbonate rocks (containing CO_3), which have been detected only in restricted areas elsewhere on Mars
- The most likely explanation implies the carbonates formed in an ancient body of water in contact with Mars' carbon dioxide (CO_2) atmosphere

False color image of the interior of a Martian crater from NASA's Mars Reconnaissance Orbiter, showing exposed raised light-colored regions containing carbonates

Martian Climate and Volcanism

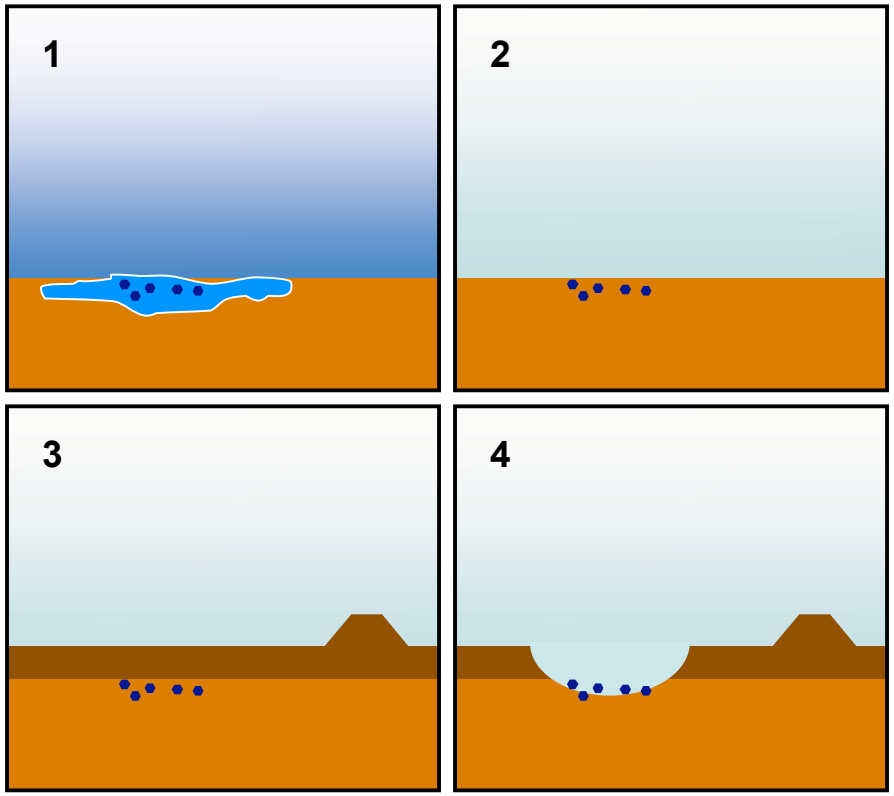
Carbonates require liquid water and CO_2 to form. The observations reveal the end of a multi-stage process:

1. Carbonates form at the surface in the presence of liquid water, possibly in a denser ancient atmosphere

2. The atmosphere changed and/or liquid surface water disappeared - surface carbonates stopped forming

3. Subsequent volcanic activity buried the carbonates, altering them

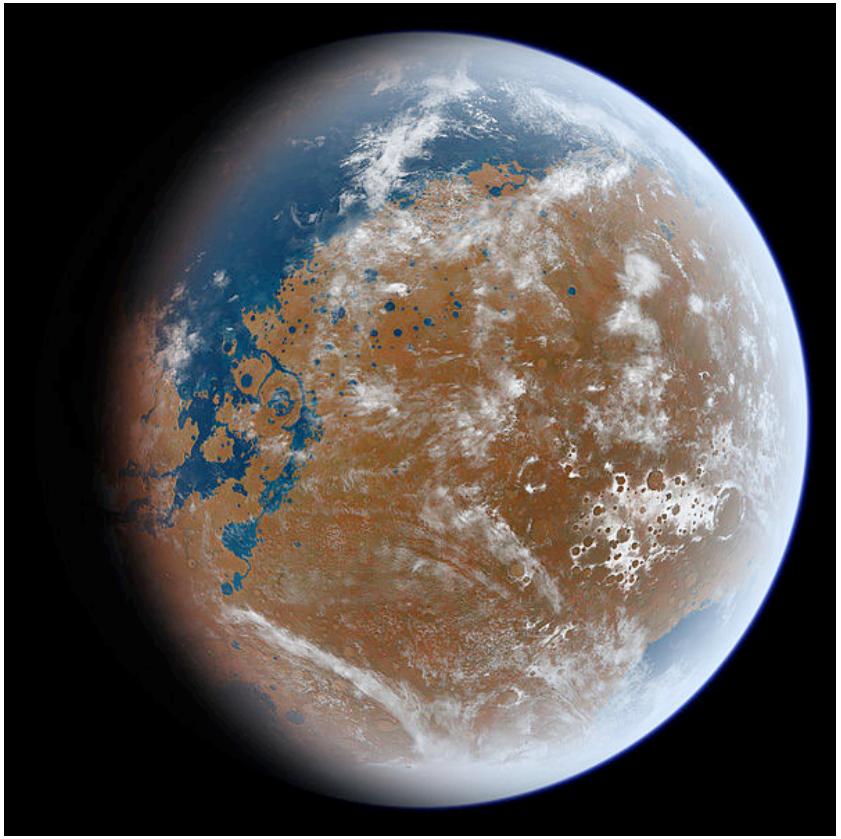
4. Impacts exposed the carbonates in some places, including tell-tale signatures of their alteration



Possible stages of carbonate formation, burial, and exposure in Martian craters. Note that other processes, such as rivers or tectonics, are also capable of exposing subsurface rocks.

The Big Picture

- We can find the past history of water on a planet by looking in craters or valleys at exposed rocks laid down over history
- The observations suggest that more carbonates could have formed on Mars than have been observed so far, but they may have been buried by volcanism
- On Earth, waters where carbonates form (like the oceans) provide ideal habitats for life. Carbonate areas may be a good place to look for evidence of life on Mars
- The observations of carbonates have scientists asking how widespread they are, how much Martian atmosphere they trapped,and whether they preserve evidence for life



An environment capable of supporting liquid water early in Martian history would have allowed the formation and subsequent burial of carbonates.

For More Information…

Press

- Universe Today - 10/11/10 - “Habitable Environments Could Exist Underground on Mars”
  http://www.universetoday.com/75511/habitable-environments-could-exist-underground-on-mars/
- MSNBC.com - 10/12/10 - “Deep hotspots on ancient Mars looked habitable”
  http://www.msnbc.msn.com/id/39639281/ns/technology_and_science-space/
- JHUAPL - 12/18/08 - “Scientists Find "Missing" Mineral and New Mars Mysteries”
  http://www.jhuapl.edu/newscenter/pressreleases/2008/081218.asp

Images

- Slide 1 image courtesy NASA / JPL / U. Arizona
  http://i.space.com/9306-deep-hotspots-ancient-mars-looked-habitable.html
- Slide 3 image courtesy Ittiz
  http://en.wikipedia.org/wiki/File:AncientMars.jpg

Source Articles (on-campus login may be required to access journals)

- Michalski and Niles, ‘Deep crustal carbonate rocks exposed by meteor impact on Mars’, *Nature Geoscience*, 3, doi:10.1038/ngeo971, 2010.
  http://www.nature.com/ngeo/journal/v3/n11/full/ngeo971.html
- Ehlmann et al., ‘Orbital identification of carbonate-bearing rocks on Mars’, *Science*, 208, doi:10.1126/science1164759, 2008.
  http://www.sciencemag.org/content/322/5909/1828

Prepared for the Division for Planetary Sciences of the American Astronomical Society by David Brain and Nick Schneider
dpsdisc@aas.org - http://dps.aas.org/education/dpsdisc/ - Released 15 April, 2011