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"Smoking Gun" Evidence That Liquid Water Has Flowed on Mars?

"The distributary fan's discovery provides clear, unequivocal evidence that some valleys on Mars experienced the same type of on-going, or *persistent*, flow over long periods of time as rivers do on Earth. ... and might be the strongest indicator yet that some craters and other depressions on Mars once held lakes."

Mike Malin, Ph.D., Planetary Geologist, Malin Space Science Systems

Hubble Telescope image of Mars and the largest canyon in the solar system, Valles Marineris, that stretches for 2,500 miles (4,000 km). Image courtesy Space Telescope Science Institute.

December 7, 2003 San Diego, California - Planetary geologist Mike Malin of Malin Space Science Systems (MSSS) in San Diego, California, is in charge of the Mars Global Surveyor Orbiter Camera and its images which began taking pictures in September 1997. Thousands of images have been captured for analysis, and yet as of November 2003, only about 3% of the Martian surface has been photographed. From the continual stream of images sent back to NASA, the Jet Propulsion Lab in Pasadena, California, and to MSSS, Dr. Malin places an image each day at his website, http://www.msss.com, that he thinks is important or visually interesting.

On November 13, 2003, he highlighted in a special MSSS report entitled, "'Smoking Gun' Evidence for Persistent Water Flow and Sediment Deposition on Ancient Mars" an article from the journal *Science* that featured analysis of Martian images that seem to confirm once and for all that liquid water has flowed across the Martian surface.

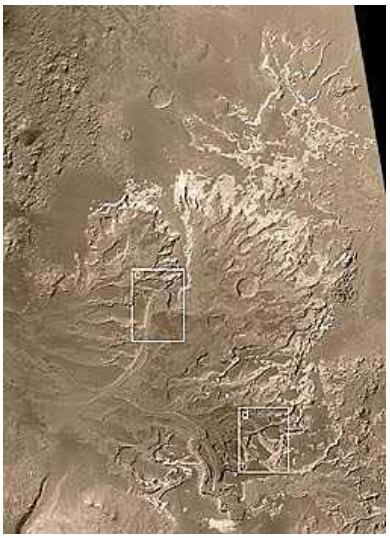
A "distributary fan," a geologist's term for deposits in river deltas and alluvial fans, photographed (MOC2-543a) inside a Martian crater not far from the Holden Crater at 24.3 degrees South/ 33.5 degrees West , between August 2000 and September 2003. Image courtesy NASA/JPL/MSSS.

Malin writes about the above image: "The picture is a mosaic of Mars Orbiter Camera (MOC) high resolution images acquired between August 2000 and September 2003. The area covered is 14 kilometers wide (8.7 miles) and 19.3 kilometers high (12 miles). North is up and the scene is illuminated by sunlight from the left. The MOC NA camera takes grayscale images; the color added to this and other images was derived from data collected nearby using the Thermal Emission Imaging System (THEMIS) Visible Imaging Subsystem, built by Malin Space Science Systems for Arizona State University which is on-board the Mars Odyssey spacecraft.

"The picture shows the entire distributary fan. The fan is a fossil landform, an eroded remnant of a somewhat larger, somewhat thicker deposit. The originally loose sediment has been turned to rock and then eroded over time to present the features seen today. The channels through which sediment was transported are no longer present. Instead, only their floors have remained and these have been elevated by erosion so that former channels now stand as ridges. The floors of former channels became inverted because they were more resistant to the forces of erosion either they were more strongly cemented than the surrounding materials or they have more coarse grains (which are harder to remove), or both."

The Distributary Fan's Significance

The fan's discovery "provides clear, unequivocal evidence that some valleys on Mars experienced the same type of on-going, or *persistent*, flow over long periods of time as rivers do on Earth. Second, because the fan is today a deposit of sedimentary rock, it demonstrates that some sedimentary rocks on Mars were deposited in a liquid (probably water) environment (suspected but never demonstrated). Third, the general shape of its channels and low topographic slopes provide circumstantial evidence that the feature was actually a delta. That is a deposit made when a river or stream enters a body of water. In other words, the landform discovered by the Mars Orbiter Camera (MOC) might be the strongest indicator yet that some craters and other depressions on Mars once held lakes. Although hundreds of other locations on Mars where valleys enter craters and basins have been imaged by MOC, this is the first to show landforms like these (that are so earthlike)."

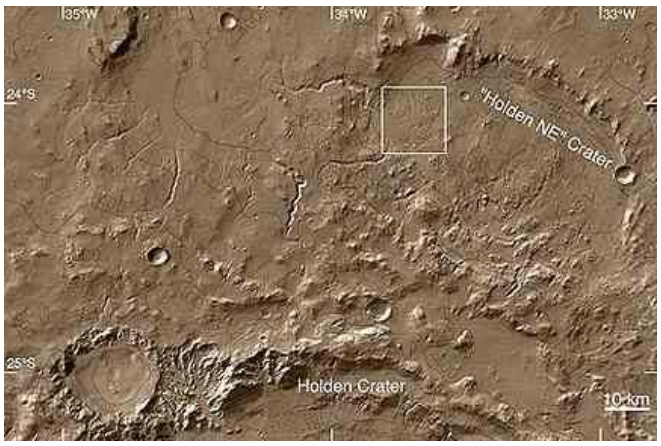


The areas in white rectangles are highlighted and shown in close-ups below. Image courtesy NASA/JPL/MSSS.

Close-up (MOC2-543c) of loop allegedly created by meandering water stream that was cut off as channel adjusted its course. Image courtesy NASA/JPL/MSSS.

Malin summarized: "In the above image, meanders and cut-off meanders are prime evidence for on-going, persistent flow of water through this area some time in the Martian past. Below are inverted channels at different levels within the sedimentary deposit, also indicating a long and complex history of water-related processes. One ridge crosses over another just left of the center of the frame. The top of the lower ridge is the former floor of a channel that was transporting water and sediment toward the lower right. The top of the upper ridge was once the floor of a channel that moved material toward the right/upper right. The lower ridge is the older channel. It was completely filled and buried beneath the surface when the upper channel formed."

Inverted channels (MOC2-543d) at different levels allegedly created by flowing water on Mars. Image courtesy NASA/JPL/MSSS.



White square (MOC2-543e) indicates location of the distributary fan at the west end of the Holden NE Crater which is northeast of the much larger Holden Crater. Image courtesy NASA/JPL/MSSS.

Michael Malin describes the map above as "showing the location of the distributary fan in the white box. It is at the west end of the Holden NE Crater (64 kilometers/40 miles diameter), which is northeast of the much larger Holden Crater. To the west of the fan are several valleys that fed water and sediment to the Holden NE Crater. This map is a mosaic of Mars Odyssey daytime thermal infrared images released by the THEMIS team. Sunlight illuminates the mosaic from the upper left."

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