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## Part 1: Silicas - and Hot Springs? - Could Mean Ancient Life On Mars



*"On Earth, hydrothermal deposits [hot springs] teem with life and the associated silica deposits typically contain fossil remains of microbes."*
- Jack Farmer, Ph.D., Astrobiology, Arizona State Univ.


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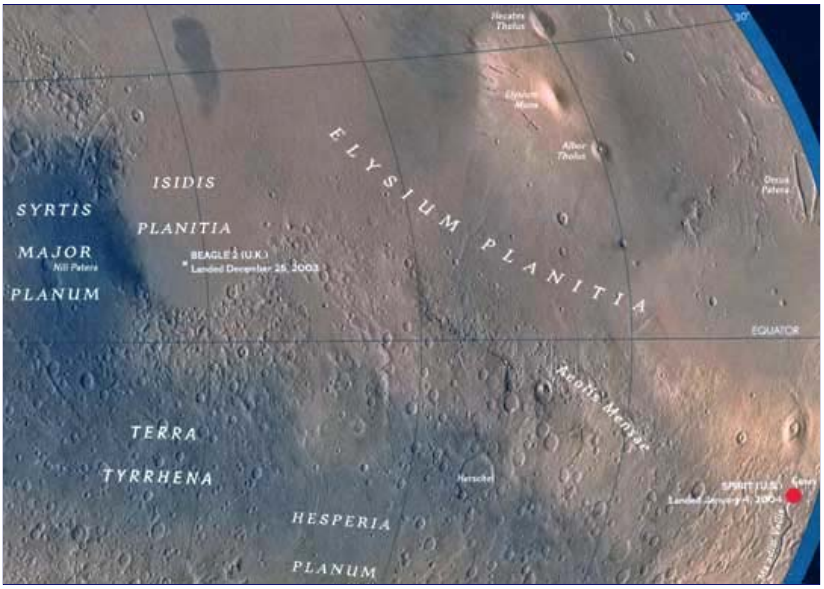
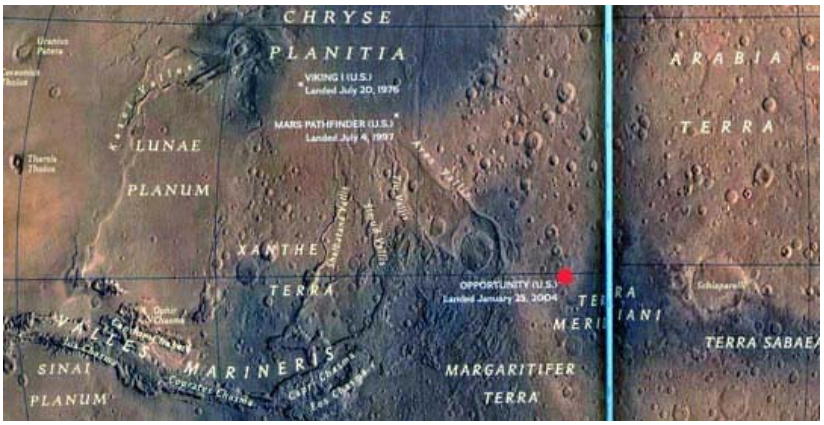
Dark "horse head" of Syrtis Major Planum rises at center of this Hubble telescope image of Mars. On the right side of that darkness is Elysium Planitia; on the left is Arabia Terra. Image courtesy Hubble.

**February 21, 2009 Albuquerque, New Mexico -** NASA landed the two Mars rovers, Spirit and Opportunity, near the Martian equator on opposite sides of the red planet in January 2004. The goal was to look for evidence of water. Spirit and Opportunity recently came out of 2008 winter hibernation and started their fifth Martian spring of exploring.

Artist illustration of Spirit rover on edge of Martian Gusev crater. Graphic courtesy NASA.

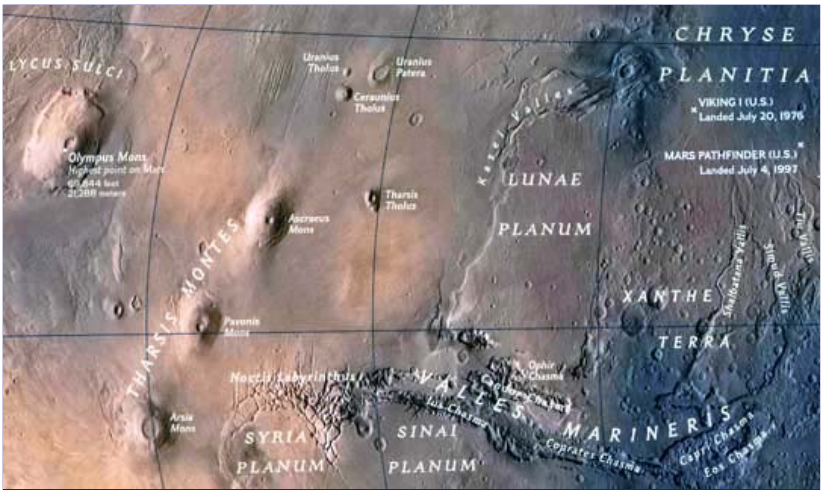



Spirit rover landed near Gusev crater (red circle in map above) on January 4, 2004, a little south of the equator at the southeastern edge of Elysium Planitia. Map © 2009 by National Geographic Society.




Opportunity rover landed January 25, 2004, on the other side of Mars southwest of Arabia Terra near the equator (red circle in map above). Map © 2009 by National Geographic Society.

The tallest volcano in our solar system is Olympus Mons on Mars. From a 373-mile-diameter base, Olympus Mons rises 14 miles (23 kilometers) – which is about three times the elevation of Earth's tallest Mount Everest. For comparison, the largest volcano on Earth is Mauna Loa 6 miles high (9 kilometers) and 75 miles across (120 kilometers).




Solar system's tallest volcano is Olympus Mons (upper left) rising 14 miles (23 kilometers), about three times taller than Earth's 5.5-miles-high Mount Everest, from a base that is 373 miles in diameter (600 kilometers). East of Olympus Mons is a straight line of volcanoes named Arsia Mons, Pavonis Mons (crossed by 0 degrees equator latitude), Ascraeus Mons, Ceraunius Tholus, Uranius Patera, Uranius Tholus. Opportunity Rover has been exploring near the equator southeast of Tiu Vallis, a channel at far center right. Map © 2009 by National Geographic Society.

Scientists think that Olympus Mons was actively spouting hot lava as recently as 2 million

years ago. With all that subterranean magma heat, it is assumed that water ice in some Martian sites might have melted and perhaps even risen to the surface as hot springs or warm artesian outwellings. Warm water on Earth usually means life and for a long time, scientists have been searching Mars for evidence of hot springs from an older time when Mars was much wetter.

A year ago in May 2008, the Spirit rover on Mars churned one of its wheels into so much white silica that scientists were stunned. The Spirit rover's spectrometer showed the white substance was more than 90% silica. To make such nearly pure silica requires a lot of water. On Earth, the only way to have so much silica is to have hot water running over rocks.

The Martian location of that silica is a place called Home Plate in the Gusev Crater near the Martian equator where Spirit has been exploring since it landed in January 2004. On the other side of Mars near the equator is Spirit's rover side kick, Opportunity. So, this begins the rovers' fifth year of work on Mars and both rovers woke up from long winters' naps about a month ago. The exciting goal for Spirit is to go south toward a feature that looks like a volcanic cone and explore for evidence of lava and hot springs residues.

Strangely, in the last week of January, Spirit stopped cooperating with NASA managers for about ten hours. Spirit didn't send back any record of what it was doing and when signals were sent from Earth for Spirit to move, the rover didn't move.

This week I talked with a planetary geologist who follows Spirit in order to produce detailed maps of that rover's every move. He is Larry Crumpler, Ph.D., Science Team Member and Long Term Planning Lead for the Mars Exploration Rover Program and Research Curator of Volcanology and Space Sciences, at the New Mexico Museum of Natural History and Science in Albuquerque. Dr. Crumpler described the puzzling frustration of sending signals to Spirit during Sol 1800 the last week of January 2009, and for the first time since January 2004 in the rover's work on Mars, Spirit didn't respond.

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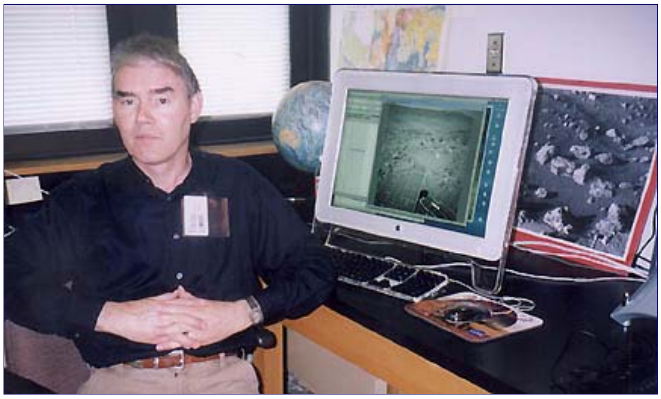
## Interview:



Larry Crumpler, Ph.D., Research Curator for Volcanology and Space Science at the New Mexico Museum of Natural History and Science in Albuquerque, New Mexico, and NASA Science Team Member and Long Term Planning Lead, Mars Exploration Rover Program. Photograph © by Linda Moulton Howe.

**Larry Crumpler, Ph.D., NASA Science Team Member and Long Term Planning Lead, Mars Exploration Rover Program and Research Curator, Volcanology and Space Sciences, New Mexico Museum of Natural History and Science, Albuquerque, New Mexico:** "Yeah, we could could communicate with it (Spirit rover). It just was not telling us what it did – which is unusual! It always tells us what it did, leaving us a record of what it did (in its work).

SO, SPIRIT CLAMMED UP IN A KIND OF MYSTERY.

Yeah. One idea was that something went wrong with the gyroscope that tells it what its position is. So, we did a diagnostic on that and that came out just fine.

SO, YOU DON'T EVEN HAVE AN ANSWER FOR WHY SPIRIT DIDN'T TALK BACK WITH YOU GUYS?

Yeah, we don't. One idea that was bandied about was that maybe there was a stray cosmic ray hit and confused a sequence. Something like that.

IN ALL OF SPIRIT'S WORK, IT HAS NEVER DONE ANYTHING LIKE THIS BEFORE WHERE IT DIDN'T COMMUNICATE BACK WHAT IT WAS DOING OR MOVE WHEN YOU TOLD IT TO MOVE?

Yeah, not that I'm aware of. In this case, it was just like missing time! (laughs) It just didn't record anything and didn't tell us what was going on.

HOW LONG DID THAT RECALCITRANCE ON THE PART OF SPIRIT GO ON?

Looks like it was between 5 AM and 2:48 PM (nearly 10 hours) on Sol 1800 in last week of January 2009. It's like the number one thing it (Spirit rover) does is record everything that it does … and it didn't! (laughs)

HOURS ARE MISSING AND IT IS STILL A MYSTERY ABOUT WHAT ACTUALLY HAPPENED TO SPIRIT.

Well, as of the last time I heard anything about it, it was a mystery.

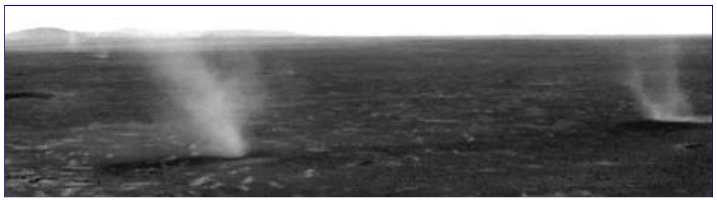
COULD IT BE THAT THESE ARE SIGNALS THAT THESE TWO ROVERS ARE BEGINNING TO DETERIORATE AND MIGHT BE ON THEIR LAST LEGS, SO TO SPEAK?

Well, none of the analyses indicated that. I mean, there is no indication of the degradation in the ability to communicate or for the antennas to point or to be able to determine their positions carefully. That all seems to be better than specifications.

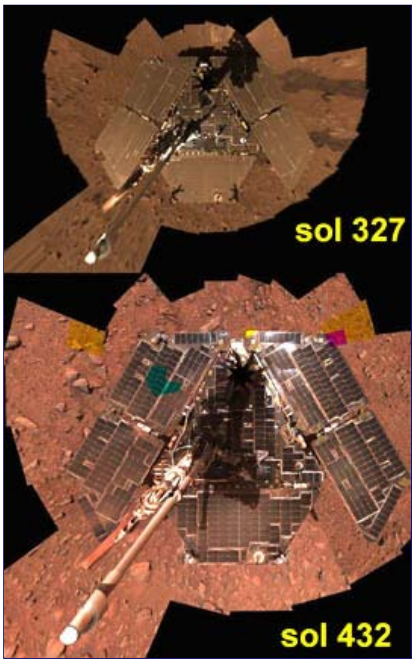
YOU ARE STILL EXPECTING THAT SPIRIT AND OPPORTUNITY ARE GOING TO BE ABLE TO DO WORK ON MARS FOR ANOTHER YEAR?

Right now, they are no different than they were last year, other than having dusty solar panels. But even Spirit has gotten a couple of panel cleaning events in the past month or so. (laughs)

## Martian Dust Devils Keep Rovers Going



Several dust devils photographed by NASA's Mars Exploration Rover, Spirit, on July 13, 2005, during its exploration of the Gusev Crater. Image courtesy NASA.




Spirit rover cleaned by Martian dust devil between Sol 327 and Sol 432. These Martian wind-blown cleanings of the rovers and their solar panels are keeping the machines powered. Images courtesy NASA.

SO, THOSE WHIRLY WINDS HAVE COME OVER THE ROVERS AND CLEANED OFF THE DUST, AS YOU HOPED WOULD HAPPEN?

Yeah, we don't know specifically if it is a dust devil or if it's just general winds blowing across the terrain. We must be getting gusts now because it is early spring on that (equator) part of Mars, so we're getting some dust-cleaning events.

IF YOU DIDN'T GET THESE DUST CLEANING EVENTS, SPIRIT AND OPPORTUNITY MIGHT ACTUALLY STOP WORKING BECAUSE THEY COULDN'T GET ENOUGH ENERGY FROM THE SUN?

Absolutely! Spirit was so dusty it was only generating like 25% of the power it's supposed to. It's gotten a couple of solar panel cleaning events and its power has jumped up to 25 to 30 watt-hours.

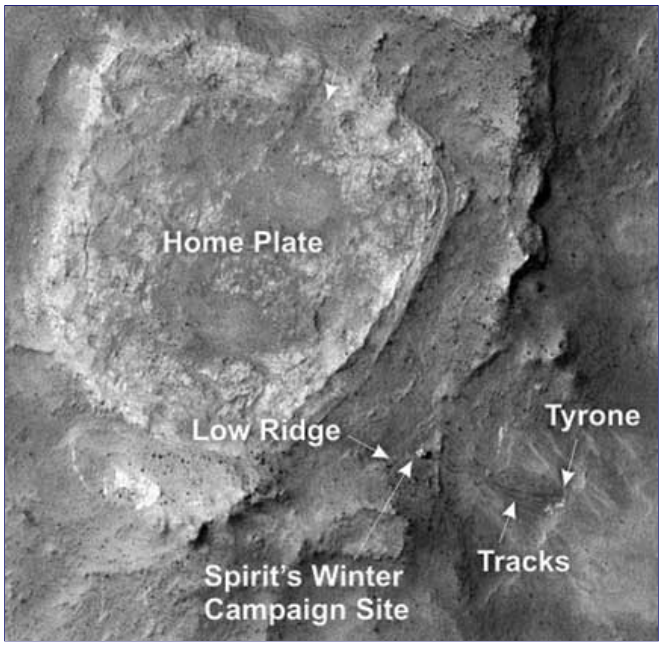
HOW FASCINATING THAT YOU SCIENTISTS ON EARTH ARE DEPENDING UPON WHIRLY WINDS ON MARS TO KEEP CLEANING OUR ROVER MACHINES TO KEEP THEM GOING!

Yeah! The one thing that we have no control over is when the panels get cleaned. Initially, we assumed they would never get cleaned, so that's why the missions were planned for 90 sols or certainly no more than a year. But we learned that can happen, so now we kind of rely on it! We've discovered it happens often enough – several times a year.

BUT WITHOUT THAT WIND BLOW-OFF, BOTH ROVERS PROBABLY WOULD HAVE CEASED FUNCTIONING LONG AGO.

Absolutely! They have been getting really dusty! Even the first year, we were starting to creep downwards and then the next day (after whirly wind blew off dust), we were back up to the same power levels as when we landed. A big gust came along. And that helped us last summer, too. Spirit was getting pretty low on power and then we had this big panel-cleaning event, so we shot up to 800 watt-hours or something like that.

## Silica Discovered by Spirit At Home Plate




Mars Reconnaissance Orbiter's High Resolution Imaging Science Experiment image shows the Spirit rover parked at its winter site on September 29, 2006, south of the Martian equator at the southeastern edge of the Elysium Planitia. The Low Ridge feature is where Spirit was parked with an 11-degree northerly tilt to maximize sunlight on the solar panels during the Martian southern hemisphere winter season. Tracks made by Spirit on the way to Home Plate (possible volcanic feature) and to and from Tyrone, an area of light-toned soils exposed by rover wheel motions, are also evident. In May 2008, one of Spirit's wheels churned up a white substance, which the rover's spectrometer confirmed was more than 90% silica. On Earth, silica is associated with lots of hot springs water. Image courtesy NASA.

What is really interesting are the deposits that Spirit discovered during its last field season at Home Plate are some of the best evidence we've seen yet for the types of environments that are habitable. Those deposits are just the spitting image of salicious center, which is only produced in thermal hot spring deposits. (laughs) So, there were hot springs, hot water, flowing somewhere there to generate these silica deposits that we discovered last summer.

In May 2008, as the Spirit rover drove away from Tyrone near Home Plate, its jammed right front wheel dug this trench. The Mini-TES instrument confirmed the white material is more than 90% silica. Image courtesy NASA.

That's one of the Holy Grail environments for potential early life and microbial communities. In short, a habitable situation, that would generate life. So, that was probably one of the most significant results of either rover to date. I don't get the sense that people understand the significance of it yet! (laughs)

## Spirit Rover Headed South of Home Plate
## Silica to Possible Volcanic Feature

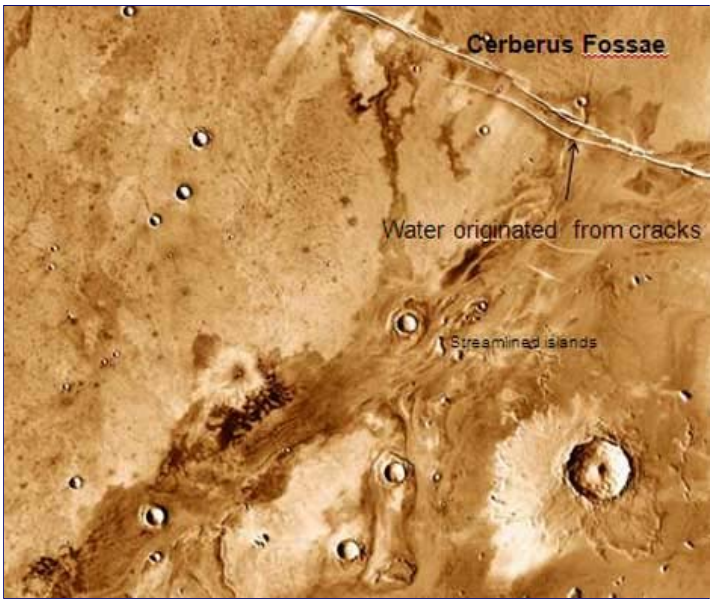
WHAT ARE YOU LOOKING FORWARD TO THE MOST AS SPIRIT CONTINUES ITS EXPLORATION THIS YEAR?

The idea is to get south of the area we've been in for a year or two and go to a new feature that looks like some sort of explosive center, maybe a volcano. It's kind of eroded and looks like a volcano you might see in the New Mexico landscape where you have some erosion going on, but you still can see the original feature. So, that's probably a good site for determining where the thermal energy came from for some of the possible spring-like features we have seen. We want to get down there real fast.

COULD THERE STILL BE ACTIVE VOLCANOES ON MARS?

Ah, it's entirely possible. The problem is the thermal energy on Mars is much more limited than it is on Earth. We know that volcanism is quite young for the largest volcanoes in the Tharsis region (Olympus Mons and others). There are some volcanoes that look quite young in the Athabasca region, maybe a million years old or less.

> [ Editor's Note: The recent geologic history of Athabasca Valles on Mars, the youngest known lava-draped channel, is controversial. Some studies report ice-rich sediment in its channels, whereas others report only lava. Data from the High-Resolution Imaging Science Experiment (HiRISE) camera now confirm that, although certain features exhibit a superficial similarity to ice-related landforms, solidified lava coats the entire channel system. Both the water and the lava erupted from a few discrete sites (vents?) along the Cerberus Fossae, a 1600-kilometer (1000-mile) long network of faults.




Water channels flowing from Cerberus Fossae in the Athabasca Valles of Elysium Planitia. Athabasca is the youngest known volcanic feature on Mars. Location is 9.6 degrees north latitudeand 155.8 degrees east longitude. Picture taken with Mars Odyssey's THEMIS. Credit: NASA/JPL/University of Arizona.

I WAS READING THAT OLYMPUS MONS MIGHT HAVE BEEN ERUPTING AS RECENTLY AS 2 MILLION YEARS AGO. [ 115 million to 2 million years ago. ]

Yes. And the stuff in Athabasca is so fresh, it's just like yesterday. The real question is what are the small features we see here and there around Mars?

COULD THEY BE VOLCANIC VENTS?

Maybe some could be some sort of strange spring deposit. All springs don't have to be thermal.

ARTESIAN?

Yes. They aren't hot springs. They are just regular ambient temperature springs.

OSMOSIS BRINGING THE WATER UP THROUGH THE SOIL AT THAT PARTICULAR PLACE?

Yes, they make these nice little mounds with a crater on top.

IF SPIRIT CAN GET TO THE VOLCANIC FEATURE THIS YEAR, DOES THE ROVER HAVE ANY WAY TO DETERMINE THE AGE OF THE SOILS THERE?

Nothing about the age, but it can assess the chemistry. For age, you really have to bring a sample back to determine that.

BUT, WE ARE STILL OPERATING UNDER THE IDEA THAT THERE HAS BEEN VOLCANISM ON MARS, PERHAPS AS RECENTLY AS A MILLION YEARS AGO IN ATHABASCA VALLES AND THERE MIGHT BE SOME MECHANISM THAT IS HEATING UNDERGROUND AND CAUSING PERIODIC SPRINGS OF LIQUID WATER TO COME OUT ON THE SURFACE?

Perhaps in some places.

WARMTH AND WATER ARE ASSOCIATED WITH LIFE.

That's right."

Continued in **Part 2:** Hot Springs in Arabia Terra?

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**More Information:**

[ Editor's Note: *Wikipedia* - "Olympus Mons is a shield volcano that is the tallest known volcano in the Solar System, located in the Tharsis bulge, a huge swelling in the Martian surface that bears numerous other large volcanic features. Among them are a chain of lesser shield volcanoes including Arsia Mons, Pavonis Mons and Ascraeus Mons. The volcanoes in the Tharsis region are 10 to 100 times larger than those on Earth. They were

built from large magma chambers deep within the Martian crust. The Martian flows are also much longer. This is probably due to larger eruption rates and to lower gravity. One of the reasons volcanoes of such magnitude were able to form on Mars is because the hot volcanic regions in the mantle remained fixed relative to the surface for hundreds of millions of years.

The land immediately surrounding Olympus Mons is depressed 2 kilometers deep. Based on crater size and frequency counts, the surface of this western scarp has been dated from 115 million years old down to a region that is only 2 million years old. This is very recent in geological terms, suggesting that the mountain may yet have some ongoing volcanic activity.

Elysium Planitia is the second largest volcanic region on Mars. Elysium Planitia is centered on a broad dome that is 1,700 by 2,400 kilometers (1,060 by 1,490 miles) in size. It has smaller volcanoes than the Tharsis region, but a more diverse volcanic history. Three significant volcanoes include Hecates Tholus, Elysium Mons and Albor Tholus.

Not all Martian volcanoes are classified as shields with effusive lava eruption styles. North of the Tharsis region lays Alba Patera. This volcano is comparable to Olympus Mons in its horizontal extent but not in height. Its base diameter is 1,500 kilometers (930 miles) but is less than 7 kilometers (4.3 miles) high. Ceraunius Tholus is one of the smaller volcanoes. It is about the size of the Big Island of Hawaii and exhibits explosive eruption characteristics and probably consists of ashdeposits. Tyrrhena Patera and Hadriaca Patera both have deeply eroded features, which indicate explosive ash eruptions Mt. St. Helens is an example of an Earth ash eruption.”]

For further reports about Mars, please see **Earthfiles Archive:**

- 12/07/2003 — "Smoking Gun" Evidence That Liquid Water Has Flowed on Mars?
- 08/27/2003 — No Ancient Oceans On Mars? Only Glaciers?
- 08/26/2003 — Mars At Its Closest August 27, 2003, At 2:51 a.m. PDT / 5:51 a.m. EDT.
- 06/02/2003 — Mars Express Radar Will "See" 3 Miles Into Red Planet's Crust
- 01/05/2003 — What Are the Grooves in the Martian South Pole?
- 06/01/2002 — Scientists Surprised by Abundance of Water On Mars
- 06/06/2001 — Another Unusual "Face" On Mars
- 04/08/2001 — A Martian Southern Hemisphere Mystery - What are these?
- 03/18/2001 — Can Earth Plants and Bacteria Grow On Mars?
- 03/11/2001 — Are the "Tubes" On Mars from Lava, Water, or Wind?
- 02/25/2001 — A New Martian Mystery
- 01/14/2001 — An Australian Zircon Crystal is 4.4 Billion Years Old
- 12/24/2000 — Martian Bacteria?
- 06/26/2000 — 250 Photographs of Mars Show Signs of Water
- 12/02/1999 — Is There Water - And Life - On Mars?
- 08/28/1999 — Oddball Quasar and Salt Water Inside Meteorite
- 06/27/1999 — Microbes Two Miles Below Earth Surface in South Africa

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## Websites:

Mars Exploration Rover Mission: **http://marsrovers.jpl.nasa.gov/home/index.html**

Athabasca Valles HiRISE: **http://hirise.lpl.arizona.edu/PSP_008779_1905**

Athabasca Valles THEMIS: **http://en.wikipedia.org/wiki/File:Athabasca_Valles.JPG**

*Science* Journal, Athabasca Valles, Mars Volcano: **http://www.sciencemag.org /cgi/content/full/320/5883/1588c**

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