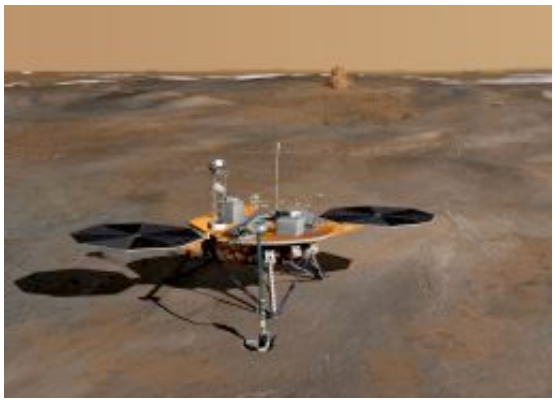
Planetary News: Phoenix (2008)

Phoenix Confirms Water-Ice on Mars, But Finds Evidence of Soil Habitability Inconclusive – and No It Hasn't Found Life

By A.J.S. Rayl
August 4, 2008

Remember back to late June and that Earth-like soil scientists announced that Phoenix had found in the north polar region of Mars? Turns out, it may not be so Earth-like at all. Turns out it might just choke the life right out of the asparagus and green beans and broccoli one might try to plant there – or not.



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Phoenix
Credit: NASA / UA / art by C. Waste

On further analysis, the mission's scientists have found that the data they've collected is inconclusive, at least for the moment. It may be the soil that the lander has sampled is more Martian than Earth-like, and the scientists at this stage are still trying to sort it all out.

During the past several weeks, two samples of Martian soil have been analyzed by the wet chemistry lab, part of the spacecraft's Microscopy, Electrochemistry, and Conductivity Analyzer, more simply known by its acronym, MECA. Those samples seemed to indicate that one of the ingredients in the soil may be "perchlorate, a highly oxidizing substance," according to an official statement.

This could be telling, because if perchlorate is present in any signficant quantity and in a highly oxidizing state, it would in all likelihood make it extremely difficult for life – as we know it on Earth – from taking hold in the Martian soil in this area of the Red Planet.

NASA rushed out a press release announcing the results from Sunday's TEGA experiment just this afternoon, informing that the sample of Martian soil taken from directly above the ice layer that TEGA baked and "sniffed" showed *no* evidence of perchlorate.

"This is surprising since an earlier TEGA measurement of surface materials was consistent with but not conclusive of the presence of perchlorate," Peter Smith, Phoenix principal investigator, of the University of Arizona, stated in the press release. Back to the laboratory, so to speak.

Meanwhile, a press conference is slated for Tuesday, August 5, at 11 a.m. Pacific / 2 p.m. Eastern.

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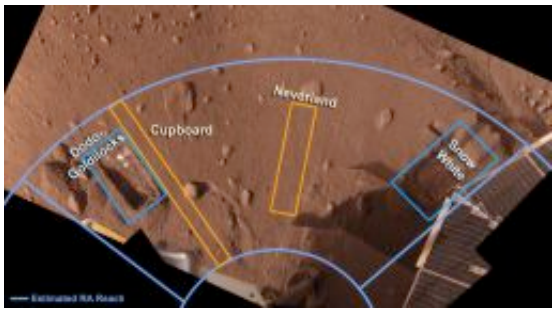

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Phoenix work volume
This map of Phoenix's robotic arm work volume

Scientists at the Phoenix Science Operations Center at the UA, which is running the mission for NASA, are looking at the data from the MECA's wet chemistry laboratory and from TEGA to provide detailed information on the composition of the Martian soil in this north polar region.

"We have not completed our process on these soil samples," Smith noted. "Initial MECA analyses suggested Earth-like soil. Further analysis has revealed un-Earthlike aspects of the soil chemistry," added Smith, who noted that the team is "committed to following a rigorous scientific process."

Perchlorates are salts derived from perchloric acid. Both potassium perchlorate and ammonium perchlorate are used extensively within the pyrotechnics industry. Ammonium perchlorate is a component of solid rocket fuel.

delineates the trenches made up to Sol 64, Dodo-Goldilocks and Snow White, and the areas identified for future trenching, Cupboard and Neverland.
Credit: NASA / JPL / UA / Texas A & M

Since spacecraft use pyrotechnics to release the ties and straps that hold delicate, movable parts down during launch, cruise and landing, and since rocket fuel is used as fuel by spacecraft, the team is also working now to rule out any possibility of the perchlorate readings being influenced by any of those Earthly sources, which, according to the press release "may have migrated from the spacecraft, either into samples or into the instrumentation."

"When surprising results are found, we want to review and assure our extensive pre-launch contamination control processes covered this potential," said Barry Goldstein, Phoenix project manager, of Jet Propulsion Laboratory (JPL), the NASA center responsible for MECA and project management of the mission.

It would help to know, of course, what kind of perchlorate was detected. But that level of detail is not yet known, according to Michael Hecht, a Phoenix co-investigator and MECA's lead scientist.

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Peter Smith
Phoenix principal investigator, Peter H. Smith, of the University of Arizona, the first public university to run a NASA planetary exploration mission.
Credit: The Planetary Society / A.J.S. Rayl

"The way [the wet chemistry lab] works is we measure in the solution anions and cations, and that's what we've done," Hecht told The Planetary Society today. "Piecing them together and saying which goes with which is a tough job," Hecht said Monday evening. "And we're just not prepared at this point to say what that is."

Anions are negatively charged ions that have more electrons in their electron shells than they have protons in their nuclei; conversely, cations are positively charged ions that have fewer electrons than protons.

"I think we have some guesses," Hecht added. "There are some particularly interesting properties of magnesium perchlorate – and I'm not suggesting in any way that's what we have – but we are looking at the properties of all of these and the answer is we still don't know. The things we can measure are magnesium, potassium, sodium and indirectly calicum and there may be others. They're all interesting and fascinating in their own right."

MECA's robotic wet chemistry lab studies soluble chemicals in the soil by mixing a soil sample with a water-based solution with several reagents brought from Earth. The inner surface of each cell's beaker has 26 sensors that give information about the acidity or alkalinity and concentrations of elements such as chloride or perchlorate, and of magnesium, potassium, and calcium, which form salts that are soluble in water.

NASA and the Phoenix team had been waiting to compare the wet chemistry lab results with those of the Thermal and Evolved-Gas Analyzer, or TEGA, which also is capable of detecting perchlorate, before making any announcement. When rumors started flying this past weekend and then quickly began to take on a life of their own, that plan changed.

The backstory

The rumors, it seems, can be tracked back to about a week ago as word began to spread around the scientific and NASA communities involved with or interested in Phoenix that the scientists working with the wet chemistry lab, which is a part of the had found "something really interesting." The rumors grew and gained momentum following a press conference emanating from the Phoenix Science Operations Center in Tucson last Thursday, July 31.

At that press conference, agency and mission officials, including Michael Meyer, the chief scientist for the Mars Exploration Program at NASA headquarters, Smith, and Bill Boynton, a Phoenix co-investigator and lead scientist for TEGA, announced that two-thirds of the way through its three-month primary mission, Phoenix had delivered samples that

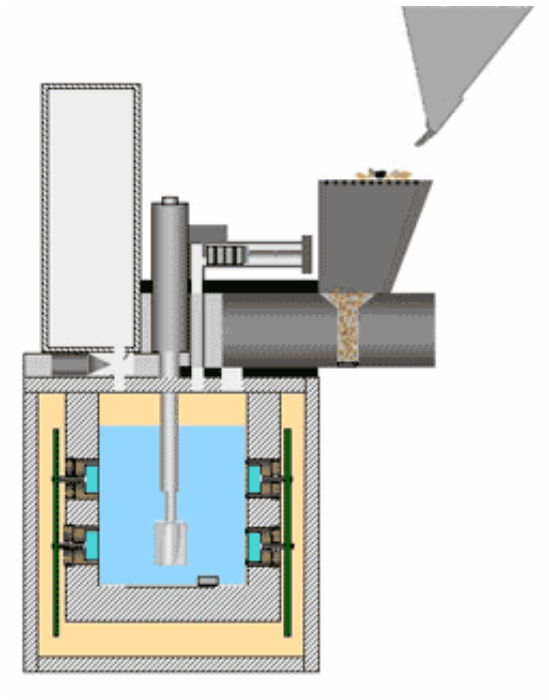
reconfirm the presence of water-ice at the north polar region of Mars, solved various little glitches with equipment and experimental protocols, and garnered a mission extension from the agency.

With continuing results and the spacecraft in good condition, Meyer announced that NASA was extending the mission through the end of the agency's fiscal year, or September 30. The original prime mission of three months ends in late August; therefore, the extension adds five weeks of additional research for the Phoenix researchers at a cost of $2 million.

The MECA scientists, though, were not represented at that press conference and their absence made their finding, apparently, conspicuous to some reporters, even though Smith did report that the Phoenix scientists had "seen salts inside of the MECA wet chemistry cells" and that "there are some signatures that have not been interpreted yet." He also very specifically said: "We have yet to discover organic materials."

"The soil is turning out to be different than what was expected – it's alkaline and has these salts in it, so it's a substance that we're not familiar with and it's different than what MERs have found," Meyer noted, adding that "there is a lot more work that needs to be done before we have any real conclusion about what's in the soil."

Delivery to first MECA wet chemistry cell
Two images captured by the robotic arm camera document the first delivery of a Martian soil sample into a MECA wet chemistry laboratory cell. The image taken at 12:29 shows the soil sitting in the funnel, which is covered by a grille whose wires are spaced 2 millimeters apart. At 12:35 the drawer underneath the hopper had closed, allowing a tiny amount of dark dirt to fall to the lander deck below. However, most of the sample remained stuck inside the funnel. Fortunately, plenty of sample did fall through the funnel into the waiting drawer of the wet chemistry laboratory cell. (For comparison, look at the next funnel, located at the top of the image; you can see right through it to the deck of the lander below.) Credit: NASA / JPL / UA / MPI / animation by E. Lakdawalla



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Analyzing sample in MECA wet chemistry lab
Phoenix's Microscopy, Electrochemistry, and Conductivity (MECA) features includes four "wet chemistry" cells, in which a sample of Martian soil is dropped into water carried from Earth as ice. MECA then stirs up the cell and analyzes the chemistry of the species that dissolve into the water.
Credit: NASA / JPL / University of Arizona

The following day, August 1, *Aviation Week & Space Technology* ran a webstory quoting a source that described the new MECA data as "provocative." The story, however, also stated: "Sources say the new data do not indicate the discovery of existing or past life on Mars. Rather the data relate to habitability--the 'potential' for Mars to support life--at the Phoenix arctic landing site." The news article was authored by veteran space science journalist Craig Covault, a longtime and respected senior editor at the magazine.

Over the weekend that "something really interesting," that "provocative" finding was redefined six ways to Sunday and seemed to snowball into something completely, well – alien to the Phoenix team, as widely disparate headlines hit the Internet.

Depending on which story you read, NASA was either about to announce that it had found life on Mars or that it found that the conditions proved life was impossible. And at least one story from overseas actually completely misreported that *Aviation Week & Space Technology* revealed that NASA has "ruled out the possibility of life on Red Planet at this point of time, but it will brief the White House regarding potential of life on Mars." The same report further misinformed: "The spacecraft has, however, found the presence of bacteria on the surface of Red planet."

Bacteria is, of course, life. All the misinformation and confused hoopla in a story that was growing by the hour caused NASA to rush out a press release today and move forward with the press conference sooner rather than later.

Unraveling Martian mysteries: a work in progress

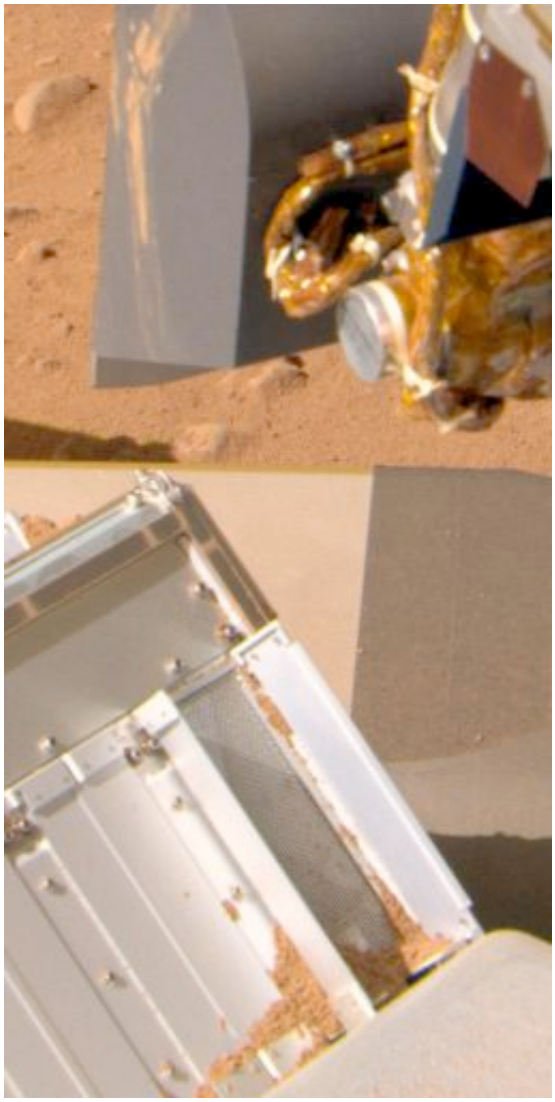
Unraveling Martian mysteries is a work that has long been in progress and one that it is pretty safe to say won't end when the lights go out on Phoenix.

Since landing on May 25, Phoenix has been studying the unusually cohesive and clumpy Martian soil, which is unlike any of the simulants or pseudo Martian soils made of Earth compounds that researchers historically have used as analogues. The stuff has been a source of frustration, adhering to the lander's scoop in a way that was never expected. "It has really been a science experiment just learning how to interact with the icy soil on Mars -- how it reacts with the scoop, its stickiness, whether it's better to have it in the shade or the sunlight," as Smith put it.

The mission scientists have looked at the confounding Martian soil with an optical microscope and two cameras, checked out how well it conducts electricity and heat with a fork-like probe, as well as analyzed it with the wet chemistry lab and TEGA's ovens. Investigations with the atomic force microscope are now ramping up.

Through their analyses of all the Phoenix data, the team scientists "hope to answer the question -- is this a habitable zone on Mars – meaning that we have periodic liquid water over time and the materials that are the basic ingredients for life forms," Smith reiterated at lat Thursday's press conference. "It will be for future missions to find if anybody's home in this environment, but we will be finding out if this is a place to search for life forms throughout next two months of approved mission," he added, underscoring a point he's made dozens of times since the spacecraft landed in May, a point that seems to have been lost on no end of reporters.

The question of life on Mars aside for the moment, Smith reviewed the "rather dramatic" progress Phoenix has made to date. "We have finished complete panorama in full color and in stereoscopic view so we actually have a topography now of the landscape around us," he said. "We are following the NASA guidelines of looking for water on Mars. We expected to find water at this landing site and that's why we came here. Mars Odyssey discovered regional water supplies in 2006. But we are very pleased to see that we landed right on top of ice and the thrusters spread the soil away and revealed ice right underneath our lander. This was not expected. The water could have been all around us and not within reach. We had no way of knowing on the local scale of how the ice is distributed," he pointed out.



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Sample dumped on TEGA on Sol 64
On Phoenix's Sol 64 -- or 64th Martian day --the lander dumped a sample TEGA lead scientist Bill Boynton dubbed Wicked Witch, which was taken from the floor of the Snow White trench, onto the open doors of TEGA oven #0. This time, enough sample was delivered for the oven doors to shut. To everyone's surprise, there was one to two percent water-ice present in the sample. What it didn't find was any signature of perchlorate, which was detected by MECA's wet chemistry lab.
Credit: NASA / JPL / UA / Texas A & M / color composite by D. Crotty

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Wicked Witch?

"We've been looking with microscopic at samples of soil," Smith continued. "We see these clay-like components, very small particles that have unexpected properties as we found when we tried to scoop some up and deliver to one of our prime instruments. We just getting to point where we can apply another tool that takes resolution down by a factor of 40 over the microscopic pictures we have shown, the atomic force microscope and we'll be using the extended mission to do that science."

TEGA lead scientist Bill Boynton donned a hat resmbling the one worn by Margaret Hamilton in the 1939 movie classic, *The Wizard of Oz*, to celebrate the tiny sample of water-ice that was made it into the instrument. He initially named it for the wicked witch who starred in *Hansel and Gretle* , because "that witch saw her final demise by being pushed into an oven." But when TEGA detected H2O, Boynton switched the witch to *Oz*'s antagonist who met her end from a bucket of water, wailing, "I'm meeellting . . ."
Credit: NASA TV

In addition, Phoenix has been successfully churning out daily weather reports from the Red Planet and in late July began the first systematic search for the dust devils that are ubiquitous on Mars. Although no dust devils have yet been recorded, the weather has been relatively mild, with winds traveling at an average speed of about 7 meters per second or 15 miles per hour.

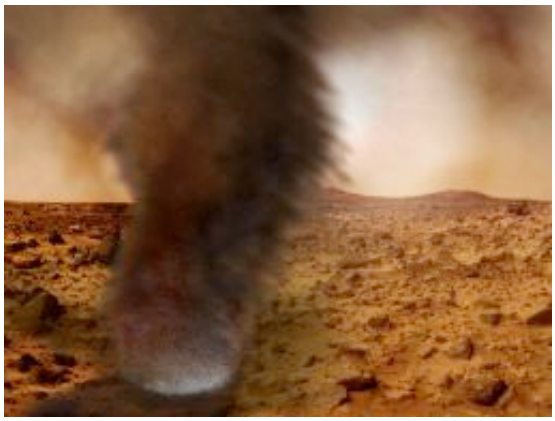
"We expected summer period to be fairly calm and have not seen any major weather system pass by," informed Victoria Hipkin, the mission scientist for the Meteorological Station, of the Canadian Space Agency. "We have not been seeing significant changes day to day, apart from pressure," she added. "We're seeing a slow daily decrease in pressure related to condensation of a significant part of CO2 [carbon dioxide]on southern pole, which is to be expected."

Harsh theories

The notion that there may be some sort of oxidizing material antagonistic to life on the surface of Mars isn't new. Two papers published during the summer 2006 in the journal *Astrobiology*, suggested that the reason there is no life on the surface of Mars is because the dust devils and the regional and planet-wide dust storms that cloak the Red Planet in a rusty red veil may be generating a toxic mix of hydrogen peroxide and other corrosive chemicals. Through a combination of field studies on Earth, laboratory experiments, and theoretical modeling that Gregory T. Delory, Sushil K. Atreya, and colleagues arrived at the hypothesis that oxidizing chemicals could be produced by static electricity generated in the swirling dust clouds that often obscure the surface of Mars for months.

If these chemicals have been produced regularly over the last 3 billion years, the length of time that Mars is believed to have been dry and dusty, the accumulated peroxide in the surface soil could have built to levels that simply, "would kill life as we know it," said University of California, Berkeley, physicist Delory.

Even so, that would not necessarily mean there is no life on Mars. The presence of life *below* the surface of the planet now or in the past cannot be ruled out, the papers authors say. "The hydrogen peroxide or new oxidants that get produced from the electrical storms will be in the regolith, but if there is any life below the surface it will not be affected by this antiseptic that's there," said Atreya, a University of Michigan professor in the Department of Atmospheric Oceanic and Space Sciences.



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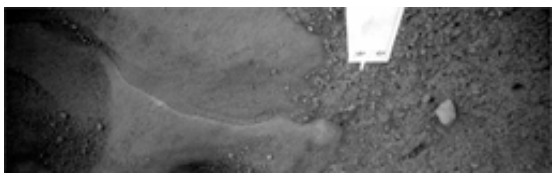
Martian dust devil imagined
University of Michigan researcher Nilton Renno, a co-investigator on Phoenix's meteorological team, drew this concept of what a dust devil might look like up close on Mars.
Credit: University of Michigan / N. Renno

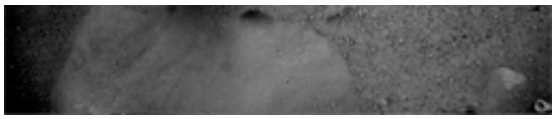
Could there be life on Mars?

"Might it be possible for some microbial life to be up there?" asked Hecht, rephrasing the question. "Yes," he answered. "Would finding life surprise me? Finding it would astonish me. Because it would not be easy to find, even with the experiments we're doing now," he said.

"I'm not even sure if we took a sample of dirt from outside this building here in Tucson we'd find it," Hecht continued. "We could probably find some organics with TEGA, but even that would not mean there's life. Most of the time, if I took a sample of dry soil and put it in a microscope, I probably wouldn't see things crawling around," he said.



"The likelihood of life on Mars is that it's not sitting up there on the surface waiting for us to scoop it up. That's probably not a hospitable habitat for life with all the ultraviolet radiation and the wild temperature swings at the surface," Hecht expounded. "You can have some interesting speculation about where life might hide on Mars," he agreed. "But I don't think it's just out there waiting for Phoenix to scoop it up and detect it."



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Ch-ch-changes at Snow Queen

When Phoenix landed, its thrusters blew soil away from its landing site, exposing these platy structures named Snow Queen. This animation cycles between two images taken on Sols 21 and 44. In that time, cracks appeared on the surface of the layers; a pebble seems to have been extruded from one crack; and the surface has "subtly roughened." These changes support the notion that the plates are icy material that is sublimating. It's possible there is also some re-deposition of ice at times.
Credit: NASA / JPL / UA / MPI

the Finnish Meteorological Institute.

"I ask for a little patience here," Smith said, demonstrating an admirable brand of patience all his own. "As we get to the part of the mission where we do the scientific analysis of the soil and contact with ice, this does take some time and we still have not collected all our data," he said. "We are looking to understand the history of the ice by trying to figure out if this ice had ever melted and through melting has created the liquid environment that modifies soils, changes chemistry, and the microscopic appearance of these soils. We're just getting the data back."

"This *is* Mars," Hecht summed up. "It really is a matter of everyone being patient. This isn't going to be solved in one mission. We're not going to see a little Martian. We're trying to study a whole planet from a teaspoon of soil and we've got to be a little humble about that. If we keep just trying to hit a home run, we're never going to score. "

The Phoenix mission is led by Smith at the University of Arizona, with project management at JPL and development partnership at Lockheed Martin, Denver. International contributions come from the Canadian Space Agency; the University of Neuchatel; the universities of Copenhagen and Aarhus, Denmark; Max Planck Institute, Germany; and

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