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Phoenix says its goodbyes

Cold, clouds do in mission to Mars arctic

By Mark Whalen

The visit was relatively short, but it was oh, so sweet.

JPL's Phoenix lander had only a brief lifetime on the surface of Mars, finally succumbing to the harsh elements of the Red Planet's arctic north. But by all accounts it was well worth the trip.

"We knew that the environment was stacked up against us and there was no way to win," said Phoenix Mission Manager Chris Lewicki. "So we just had to make the best use of our time as possible."

After landing on Mars on May 25, Phoenix had a successful run of 151 sols, or Martian days, far exceeding its planned 90-day mission to conduct and return science data. Engineers last received a signal from the lander on Nov. 2 (sol 157). In addition to shorter daylight, the spacecraft encountered a dustier sky, more clouds and colder temperatures as the northern Mars summer approached autumn.

Lewicki noted that in the extended mission water-ice clouds became an increasing wildcard, especially when combined with dust storms. While this was not a surprise, the engineering team had not anticipated the clouds' effect. "The clouds get fairly dense, so they have just about the same effect as a dust storm. They block out the sun and diffuse it in a similar way that dust in the atmosphere does. None of our models showed how to survive through that. The clouds were a lot thicker and stayed around a lot longer than any of the clouds that Spirit or Opportunity had seen, for example."

Still in all, Phoenix has been considered a success from its first day on Mars.

"There was a sigh of relief when we landed—it was a bull's-eye from our standpoint," said Robert Bonitz, who developed and operated Phoenix's robotic arm. "It was reasonably flat, not overly rocky, nothing we couldn't handle. It worked out really well."

In the end, he said, the team didn't have to do as much digging as planned, since the ice table was only 2 to 7 centimeters down. "We designed the arm to dig a half-meter trench but we didn't have to excavate that much; although we dug many smaller trenches all over the workspace," he said.

"I was pleased it performed as well as it did. It accomplished what it was supposed to in terms of digging trenches and delivering samples."

Bonitz noted fundamental differences between the arms for Phoenix and the Mars Exploration Rovers —which he also developed. "The rovers, for the most part, deploy instruments on the end of their arms; but when they do that, there is not a lot of arm motion. Phoenix has had to do a lot of digging, and sometimes ran for hours.

"The Phoenix arm's life requirements were actually more extensive than those of MER," he said. "By the time we were coming up with the requirements for Phoenix, the motors on the MER arm had not yet accumulated that same amount of life.

"Getting samples from the surface of a planetary body into an in-situ instrument is a tricky operation," he added. "You really need to deal with a lot of uncertainties and unknowns and design a system that is robust to that uncertainty. We designed Phoenix for a 90-day mission, and there's some margin built into that. It's not too surprising that it lasted a lot longer."

"Phoenix has been a delightful challenge," said Michael Hecht, principal investigator for the Microscopy, Electrochemistry and Conductivity Analyzer (MECA), one of two soil instruments on the spacecraft, which used a suite of four tools to examine Martian soil. "The data we've acquired really changes the landscape of our understanding of the planet. Certainly, it was technically very successful and it accomplished everything it set out to do scientifically.

"My greatest excitement came from the wet chemistry experiment," Hecht said. "Wet chemistry tells us about processes that would affect any life on Mars and might even affect geology if rocks were ever exposed to water. When you explore the role water plays in microbial life and geology, you're interested in the chemistry of what would dissolve in water, even if the water isn't there now."

"Our approach is like making tea, then seeing what it tastes like," Hecht said. "That gives us the most direct answer to the question of whether something that needs water could live on Mars."

"There's always a discovery where you say, 'my instrument must be broken, this can't be right,'" he added. "For us, that was the discovery of perchlorate. This is fairly innocuous-looking stuff that contains a tremendous amount of energy. On Earth, we use it for rocket fuel, fireworks and for making breathing oxygen. Under Mars conditions it won't explode, but it dissolves readily in water and can control the humidity around it, much like the salt in a cigar humidor. That could be a big issue for life. While perchlorate can cause hypothyroidism in humans, it isn't much of a chemical hazard for microbes—unless we're dealing with microbes with thyroid glands."

"But in terms of the eventual human exploration of Mars," he said, "you couldn't have asked for anything more exciting than a source of fuel and oxygen. This is huge."

The wet chemistry lab also discovered "garden-variety calcium carbonate" at the level of a few percent. Its presence implies that water on Mars would have a similar pH to that of Earth's oceans, which is controlled by calcium carbonate. "This is terribly important," Hecht said. "We've been looking for it, but no one has found it before."

Hecht also noted that MECA included both optical microscopy and atomic force microscopy, which offers a level of resolution "no one has ever achieved before in space. We found a population of small, sand-size, glassy particles, in all colors—they're less than the thickness of a human hair, but under a microscope they're beautiful to look at. These colorful particles are embedded in

Continued on page 2

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Robert Bonitz

Carol Lachata / JPL Photo Lab

Phoenix *Continued from page 1*

the fine, red dust we see everywhere on Mars. With the atomic force microscope we can see that the fine dust particles are angular, sharp and flat. That tells us a great deal about how they came to be there, how they're going to behave, and why they stick together so tenaciously."

Other unprecedented measurements came from the "conductivity" portion of the instrument—using a probe at the end of the robotic arm that measured the electrical and thermal properties of the soil to help understand the amount of water in the soil in the solid, liquid and vapor phases.

"I tremendously enjoyed running this out of the University of Arizona," Hecht added. "I know it's a long way from home, and I joked that it was like summer camp. For some, the remote location was a challenge. But it let us get away from all the other distractions and let us focus entirely on making those 150 days as fully successful as possible."

Being on Mars time, and in Tucson, in different ways affected Katie Dunn, a science plan integrator responsible for building the primary sequence that coordinated all of the payload sequences each sol.

"Part of it is that we were working really long hours—12 to 14 hours a day—and you would end up starting at the end of one day, then you might work what seemed like through the whole next day, and then come back the following day. Time passed really quickly," Dunn said.

"I definitely knew what sol it was but I didn't know what day it was on Earth, which was kind of a strange situation," she said. "I would be out driving in Tucson and wonder why there was so much traffic in the middle of the morning, then I realize, oh, it's Saturday, that's why people are out and about. Or I would wonder why there wasn't traffic at rush hour, then realize it was a Saturday night. It was like living in a Martian bubble."

Dunn, who has worked for the Lab for 3½ years, will soon move to the Juno mission's flight system engineering team, when she will relocate to Denver, at least until launch in August 2011. But she doesn't mind the travel.

"JPL as an institution was really supportive while we were working in Tucson, always wondering how we were doing and attempting to make our relocation to Tucson as short as possible," Dunn said. "Living in Tucson and working on Mars time allowed many of us on the operations team to get to know each other well. That was really fun."

Although in an extended mission at its demise, time ran out on Phoenix for some data collection and analysis.

"In the last several weeks of operations it became very clear that the science goals pushed out to future sols wouldn't all fit into the remainder of the mission," noted Robert Denise, who served several roles on Phoenix, culminating as tactical mission manager.

"When we first touched down, we didn't know how deep the ice was. We had built the arm to be able to excavate to nearly half a meter deep, hoping we'd be able to capture ice in the first half meter. And the fact that we encountered it 7 to 10 centimeters below the surface was amazing. So then it became how much can we dig, how much can we expose? It would have been utterly unrealistic to expose the ice across the entire work area, but it would have been fun to try."

Denise is a veteran of the Mars Polar Lander mission in 1999, which was lost during descent and landing. The experience showed him to not get emotionally attached to the spacecraft. "It was like stepping off a curb when you don't expect it—the fact that it was suddenly not there and didn't have an opportunity to reach its science goals."

There's no doubt, however, that Phoenix was a positive experience.

"Phoenix is far more satisfying in that it had a good surface mission; we accomplished basically what we set out to do," he said.

"I love all my children the same even though they're all different. I was there for landing day for both MERs. They had a 90-day mission in front of them as well; now the rovers have lasted five years. When Phoenix landed we knew that we wouldn't be able to do that.

But, "Absolutely, it was no less rewarding," he said. "It's been a good run."

"Being able to operate 151 sols on Mars, with the exception of three of those days —the only days we didn't do science—I'm proud that we were able to keep the system running smoothly enough to give 148 sols of operations to the science community," Lewicki said. "I certainly feel very good about that.

"There's a little regret on the team that we couldn't get just a few more weeks out of it," Lewicki said. "Given the design of the spacecraft and the environment that it was in, it didn't take much of a dust storm to just really knock the wind out of us, and that's what happened.

"We oftentimes compare Phoenix to Ranger, where we knew our fate before we launched," he added. "We knew it was going to end this way, figuring that sometime around sol 90 or later, we're just going to run out of juice, and we're going to have unfinished plans, and it's going to be over. With Ranger, of course, they launched on a terminal mission, and the whole point was to smash into the moon, and get that one picture a quarter-second before impact.

"It's been different for everyone, knowing that Phoenix died of natural causes. You know, we shouldn't really be sad about it. We're of course sad to see it go, but we should be happy with the life that it lived."

Smooth deployment tests for Aquarius

By Brian Frank

When Aquarius begins measuring sea surface salinity from orbit in mid-2010, it will collect more data in two months than has been amassed by ships and in-water sensors in 100 years. Housed on an Argentine satellite, it will map Earth's surface once every seven days, providing 150-kilometer resolution and returning measurements that will be off by no more than a pinch of salt to a gallon of water.

Aquarius/SAC-D [Satelite Aplicaciones Cientificas-D], a three-year joint mission with Argentina, will mark the first time salinity has been measured from space, and it will help further our understanding of climate change by helping scientists answer questions about how fresh water input and output affects the ocean and the global water cycle.

Of course, to collect data the instrument must deploy properly once in orbit. Aquarius contains a microwave radiometer and scatterometer, which are about an order of magnitude more accurate than any previously flown. They send and receive signals by bouncing them off a reflector poised 2 meters away on the end of a boom. Like a sleeping spider, the instrument will be folded up during its journey in the fairing of a Delta-II rocket, its reflector nestled up against the primary structure. Once the spacecraft has been released and successfully inserted into orbit, Aquarius will unfold and stretch its single mechanical limb.

It's a one-time, mission-critical event, said Simon Collins, the instrument manager for Aquarius. "We need to ensure a full deployment."

A JPL team led by Collins has been integrating and testing Aquarius since its radiometer arrived from Goddard Space Flight Center early this year, and on Nov. 12 they successfully proved the instrument can deploy on its own. Testing went smoothly and marked a major milestone for Aquarius on its path to launch, capping a year of significant achievements by the integration team.

For testing under Earth's gravity, the boom and reflector are supported by an off-load fixture. The boom is spring-loaded and temperature-controlled to manage the speed at which it unfolds. A handful of pins and bolts keep the reflector and boom locked into place. Once in orbit, tiny explosives will cut the bolts in half and push the pins aside, allowing the springs to force the instrument open. After several manual deployments, the team did a live test using the pyrotechnics.

"Not an everyday operation right beside flight hardware!" Collins said.

Fortunately, all went according to plan, Aquarius passed, and the team is looking ahead to the next round of tests. For these dynamics tests, Aquarius will have to endure vibrations and a barrage of sound waves more violent than those created inside the nosecone of a rocket during launch.

Tom Wynne / JPL Photo Lab

Jon Dalshaug, left, and Charlie Fisher prepare to stow the Aquarius boom after a successful deployment in JPL's high bay.

"We've designed deliberately to higher levels (than what it will receive during launch)," Collins said. "The system is designed to be able to handle this, but it's once again another nerve-wracking activity."

In June, following a few other rounds of testing (predominantly repeats of earlier tests for good measure), Aquarius will head to Argentina, where it will be mounted on the SAC-D spacecraft, shipped to Brazil for even more tests, and finally sent to Vandenberg Air Force Base, where it will hitch a ride on a Delta-II rocket to space, bound for its first-of-a-kind mission and three years of service.

'ShakeOut' exercise tests Lab's readiness

JPL participated in what is considered to be the largest earthquake drill in United States history, the "Great Southern California ShakeOut" on Nov. 13. The exercise simulated the aftermath of a 7.8 earthquake.

Shortly after 10 a.m. JPLers performed a "drop, cover and hold," followed by the evacuation of more than 4,000 employees and contractors, who were moved to assembly areas. About 200 construction workers were evacuated from the Flight Project Center.

The activity included the deployment of Urban Search and Rescue, Fire Department and Security personnel for damage assessments. More than 100 people participated in the exercise as first responders, emergency managers, executive managers and evaluators.

In a memo to personnel, JPL Deputy Director Gene Tattini noted that overall the exercise was a success, pointing to orderly building evacuations and the seriousness with which personnel participated. Areas identified for improvement included enhancement of the public address system and improvements in devices such as hand-held radios and satellite telephones.

Tom Wynne / JPL Photo Lab

During the ShakeOut exercise, JPL physician Dr. Robert Estrada attends to a mock victim as Lab firefighters look on.

News Briefs

Fellow grade for Yueh

For his contributions to polarimetric radar and radiometer remote sensing, Simon Yueh of the Climate, Ocean and Solid Earth Science Group has been elevated to the Fellow grade of the Institute of Electrical and Electronics Engineers, a leading professional association for the advancement of technology.

The award, one of the institute's most prestigious honors, is effective Jan. 1.

Pecora award to QuikScat

The JPL-managed Quick Scatterometer, an Earth-observing satellite that has provided early detection of ocean storms and advanced the scientific exploration of global ocean wind patterns, has been recognized for helping scientists better understand Earth with the presentation of the William T. Pecora Award to the QuikScat mission team.

Since 1999, QuikScat has advanced Earth science research and contributed to improved environmental predictions. The mission was conceived, developed and launched less than two years after the unexpected loss of the Japan Aerospace Exploration Agency's Advanced Earth Observing Satellite-1 spacecraft, which carried the NASA scatterometer. QuikScat measurements have had enormous impact on marine forecasts by enabling early detection of the location, direction, structure and strength of ocean storms. QuikScat data also help monitor changes in Arctic sea ice and icebergs, as well as snow and soil moisture changes on land.

The QuikScat team includes personnel from JPL; Goddard Space Flight Center; Ball Aerospace and Technology Corp. of Boulder, Colo.; the University of Colorado's Laboratory for Atmospheric and Space Physics; and principal investigators funded by NASA's Ocean Vector Winds science team.

NASA and the U.S. Department of the Interior present individual and group Pecora Awards annually to honor outstanding contributions in the field of remote sensing and its application to understanding Earth. The award was established in 1974 to honor the memory of Pecora, former director of the U.S. Geological Survey and under secretary of the Department of the Interior.

For more information about the award, visit *http://remotesensing.usgs.gov/pecora.php.*

Lab veterans' stories sought

JPL is looking for a few good veterans—current staff and retirees who served on missions in the 1960s and 1970s, that is.

Following on the success of the Explorer 1 activities that commemorated the 50th anniversary of the first U.S. launch earlier this year, the Office of Communications and Education (1800) has begun to collect oral histories from the people who served on the Ranger, Mariner and Lunar Surveyor missions.

"We want to make sure that we capture for history the memories of the men and women who explored the solar system for the first time," said Blaine Baggett, JPL's executive manager of communications and education. "We're looking not only for science and engineering stories, but also interesting human anecdotes, heartfelt personal stories, photographs, 8-millimeter film, and other materials."

Several veterans of the Ranger and Surveyor programs have already been interviewed. Production staff set up one-on-one appointments with participants and use audio and videotaping to capture their stories. The interviews typically take an hour to an hour and a half and include general questions about interviewees' role in their respective missions, what their contributions were, how they viewed their mission in the context of the moon program.

Those interested in sharing their stories should e-mail *blaine.a.baggett@jpl.nasa.gov* or send mail to Blaine Baggett, JPL mail stop 186-131, 4800 Oak Grove Drive, Pasadena, CA 91109.

Photo by Office of Communications and Education

Twittering from Mars

Veronica McGregor, manager of JPL's Media Relations Office, conveys Phoenix mission news to the public via twitter.com. Bloggers and Web surfers alike by the thousands have taken to the fresh mode of communication, which will also be explored for Cassini and JPL's rover missions. For the full story, visit *http://dailyplanet/onlab/twitter-veronica.php.*

Disney contest for rover name

NASA, in cooperation with Walt Disney Studios Motion Pictures' movie WALL-E from Pixar Animation Studios, has launched a naming contest for the Mars Science Laboratory rover that is now under construction at JPL for launch in 2009.

The contest is open to students 5 to 18 years old who attend a U.S. school and are enrolled in the current academic year. To enter the contest, students will submit essays explaining why their suggested name for the rover should be chosen. Essays must be received by Jan. 25, 2009. Next March, the public will have an opportunity to rank nine finalist names via the Internet as additional input for judges to consider during the selection process. NASA will announce the winning rover name in April.

Since JPL and Caltech are event co-sponsors, employees and their immediate family members and/or those living in the same household of each are not eligible to enter the contest or win a prize.

Disney will provide prizes to students submitting winning essays, including a trip to JPL. The grand-prize winner will have an opportunity to place a signature on the spacecraft.

NASA said Disney will make it possible for WALL-E, the name of its animated robotic hero and summer 2008 movie to appear in online content inviting students to participate in the naming contest. The naming contest partnership is part of a Space Act Agreement between NASA and Disney designed to use the appeal of WALL-E in educational and public outreach efforts.

For more information, visit *http://marsrovername.jpl.nasa.gov.*

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Letters

I was blessed through the support shown to me by my JPL and NASA-wide colleagues and friends regarding the passing of my Grandmother Hines. Thank you for the plant sent in her memory and the encouragement you shared. It means a lot to me and my Missouri family.

Erisa K. Hines

My family and I want to convey our heartfelt thanks for the many kind words and expressions of sympathy during the illness and recent passing of my beloved father, Joe Arrigo. The support and love shown by my manager and co-workers in Travel Accounting, and my friends in Travel Reservations and Van Pool #6, made this tough time a little easier to bear. The flowers and plants sent to my mother's home in Wisconsin were a great comfort to her and will always be cherished. Thank you, JPL, for the lovely plant that will help to keep his memory alive in my home.

Cathy Marte and family

Passings

Marjorie Meinel, 86, a retired Distinguished Visiting Scientist who along with her husband helped to develop many next-generation space-telescope concepts, died June 25.

Meinel and her husband, Aden, left the University of Arizona after a distinguished career to join JPL as Distinguished Visiting Scientists between 1982 and 1993. The pair created systems designs for the Large Deployable Reflector, some of which eventually evolved into the James Webb Space Telescope.

She supported Aden's work to develop advanced architectures, and to define and develop technology programs in adaptive optics, interferometry and materials engineering, all in support of NASA and JPL's reimbursable programs.

Besides her husband, Meinel is survived by children Carolyn, Walter, Barbara, Elaine, Edward, Mary and David. Memorial services were held in Henderson, Nev.

Retiree **Ralph West,** 81, died Sept. 16. He worked at the Lab from 1970 to 1989.

Former JPL employee **Maribelle Leflang,** 82, died Sept. 20.

Leflang worked at JPL during the 1950s and 1960s. She also was an active volunteer of many service organizations, including serving as a long-time docent for the Caltech Architectural Tour Service and others.

She is survived by her husband and son, daughter-in-law and granddaughter.