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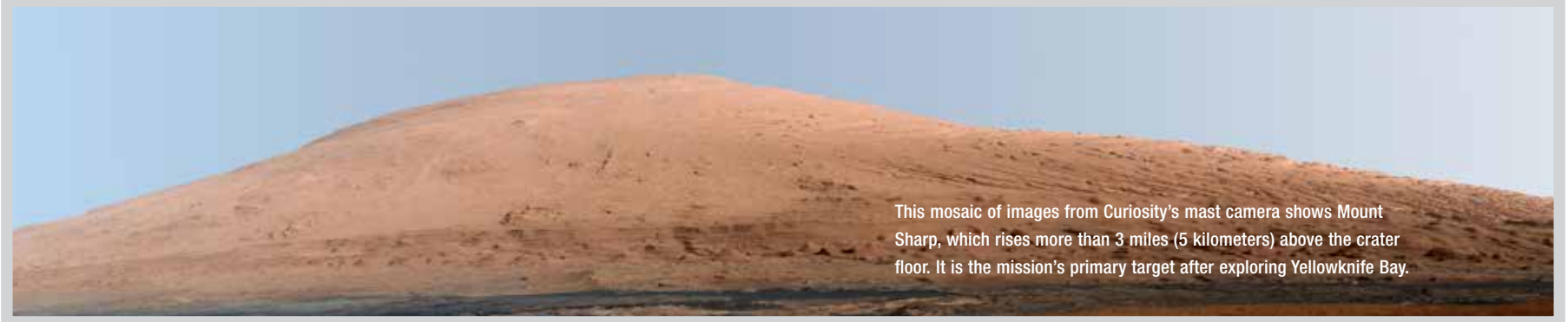
Curiosity assesses conditions favorable for life

Chemical analysis of rock shows key ingredients for development of microbes on Mars

By Mark Whalen



This mosaic of images from Curiosity's mast camera shows Mount Sharp, which rises more than 3 miles (5 kilometers) above the crater floor. It is the mission's primary target after exploring Yellowknife Bay.

Through its analysis of powder from a drilled rock, JPL's Curiosity rover has officially fulfilled its objective to assess whether past environmental conditions at Gale Crater were favorable for the development of microbial life on Mars.

Data returned by Curiosity's Sample Analysis at Mars and Chemistry and Mineralogy instruments showed that the Yellowknife Bay area was the end of an ancient river system or an intermittently wet lakebed that could have provided chemical energy and other favorable conditions for microbes. The science team identified sulfur, nitrogen, hydrogen, oxygen, phosphorus and carbon—some of the key chemical ingredients for life—in the powder Curiosity drilled out of a sedimentary rock.

Also, in mid-March the science team revealed that Curiosity found evidence of water-bearing minerals in rocks near where it had also found clay minerals inside a drilled rock. With the rover's mast camera, "we see elevated hydration signals in the narrow veins that cut many of the rocks in this area," said Melissa Rice of Caltech, a science team collaborator. "These bright veins contain hydrated minerals that are different from the clay minerals in the surrounding rock matrix."

Curiosity resumed science investigations after recovery from a computer glitch that prompted engineers to switch the rover to a redundant main computer on Feb. 28. The rover had been monitoring the weather since March 21 and delivered a new portion of powdered-rock sample for laboratory analysis two days later.

There is so much more ahead for the science team, which is anxious to continue on to Curiosity's landing-site target, Mount Sharp. But not so fast. For Curiosity, seven months into its two-year prime mission, there's still a lot to see at Yellowknife Bay.

Deputy Project Scientist Joy Crisp said the near-term emphasis will be on completing the analyses of the drilling of the rocks in the "John Klein" area—named in honor of the former Mars Science Lab deputy project manager—and a more complete characterization of the concretions and veins in the rock. And there's no hurry. "We have no specific period of time scheduled for how long we will remain at Yellowknife Bay," she said. "It depends on what we discover."

The initial drilling has given the science and engineering teams a lot of confidence, said Deputy Project Scientist Ashwin Vasavada. "Curiosity was built to survey, inspect, sample and analyze, all while monitoring the present environment. It's wonderful that we've now exercised all these capabilities. But the scientific mission is just beginning."

One reason for the extended stay is an upcoming solar conjunction, in which Mars will be passing almost directly behind the sun from Earth's perspective. This alignment occurs about once every 26 months and can disrupt radio transmissions between the two planets. Therefore, to prevent an impaired command from reaching the rover, mission controllers will suspend sending any commands to Curiosity from April 4 to May 1. The rover will continue to monitor weather and high-energy radiation during that time.

Curiosity can continue making science observations from Yellowknife Bay, however. The region has proved to be a goldmine of fascinating finds.

"We have characterized a very ancient, but strangely new 'gray Mars' where conditions once were favorable for life," said Project Scientist John Grotzinger. "Curiosity is on a mission of discovery and exploration, and as a team we feel there are many more exciting discoveries ahead of us in the months and years to come."

Crisp said the geology in Yellowknife Bay was even more intriguing than expected, with water-lain sedimentary rocks, abundant clay minerals and different signatures of water alteration. "The gray interior of the rock we drilled into was a welcome surprise—if future rock drilling reveals similarly low oxidation levels, that should improve the likelihood of preserving organic compounds if any were there when the rocks were formed."

Curiosity's been making other surprising discoveries in addition to the primary goal of habitable environments, noted Vasavada. "I was pretty surprised by the very low levels of atmospheric methane, essentially consistent with zero," he said. "The capability to measure methane was a relatively late addition to the mission based on the exciting hints of it from Mars Express and ground-based observations. We'll continue to monitor the atmospheric composition for diurnal and seasonal changes, including methane."

Investigating the stack of layers exposed on Mount Sharp, where clay minerals and sulfate minerals have been identified from orbit, may add information about the duration and diversity of habitable conditions.

"The thought was that by having a thick and diverse sequence of rocks to explore, we'd give ourselves the best shot at finding evidence of ancient habitable environments and conditions conducive to preserving evidence for us to study today," added Vasavada. "As it turns out, that exploration is well underway even on the crater floor. Continuing on to locations where additional environments can be assessed remains key to accomplishing our mission."

Crisp said she's most looking forward to "seeing the beautiful Mount Sharp scenery and finding out which textures, minerals and chemistry are revealed in the Mount Sharp rock layers—and seeing the beautiful Mount Sharp scenery up close!"

For more information on the mission, visit *http://www.jpl.nasa.gov/msl.*

Sequestration affects conference travel, outreach

By Mark Whalen

New guidelines for conference travel are in effect at JPL following a March announcement by NASA implementing cost-saving measures in response to federal spending cuts resulting from the Budget Control Act of 2011, also known as sequestration.

Effective March 25, all JPL travel must be determined to be essential rather than discretionary, and to contribute to NASA's core mission. In addition, travel will only be permitted when alternative collaboration methods such as videoconferencing aren't available.

Domestic travel will be approved under existing procedures after these criteria have been met. Stricter tests will be applied to travel beyond the continental United States (including travel to Hawaii and Alaska), travel to launches, and travel to speaking engagements not hosted at a NASA center. These must also be approved by JPL Deputy Director Eugene Tattini.

According to Randy Friedl, deputy director for research for JPL's Engineering & Science Directorate, the Lab will be carefully screening travel requests to meet NASA's cost-saving objectives while preserving travel that is important to JPL objectives. "I believe technical conferences provide important opportunities for our staff to interact with their professional peers and share their key results," said Friedl.

The new NASA policy says no more than 50 people from across NASA agencywide will be permitted to attend a domestic conference. Friedl expects this will still allow strong JPL participation in most conferences

Some conferences attract a large number of NASA and JPL attendees, such as the annual American Geophysical Union conference, traditionally JPL's most heavily attended meeting. In cases like this, Friedl's office will assess waiver

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requests and work with NASA to permit justifiable attendance beyond the specified ceiling.

All JPLers who wish to go to conferences will now use the domestic heavily attended conference travel forecasting web tool *(http://dhac.jpl.nasa.gov)*. Foreign conference attendance is prohibited according to NASA Administrator Charles Bolden's March 13 memo. NASA has a waiver process for foreign conferences, but such waivers will be very rare, said Friedl.

But JPL travelers are encouraged to forecast foreign conference travel in case a waiver request appears in NASA's best interest. The foreign conference forecast tool will continue to be available on the current quarterly schedule *(http://foreigntravel)*.

When there is uncertainty about the appropriate classification of a foreign meeting (conference vs. nonconference/programmatic), Friedl said travelers may submit a non-conference travel request following the process described in the March 18 memo from JPL Deputy Director Gene Tattini.

For sequestration travel guidelines and more information, visit *http://travel.jpl.nasa.gov/.*

In another impact of NASA cost-saving efforts as a result of federal budget sequestration, the agency in late March announced plans to suspend and review all education and public outreach activities. The stated goal is to assess the activities' effectiveness, with the highest priority on preserving mission-critical activities.

"The initial communiqué was very broad in scope but since then messages from different directorates have been refining their intentions," said Blaine Baggett, director for JPL's Communications & Education Directorate.

In another impact of NASA cost-saving efforts as a result of federal budget sequestration, the agency in late March announced plans to suspend and review all education and public outreach activities.

Critical areas in education, media relations and public outreach will be permitted to proceed normally, Baggett said.

"There's nothing wrong with doing a fresh evaluation of the agency's communications programs," said Baggett. He added that the value of JPL's educational and communications programs is clear enough that he expects most activities to continue.

For more information, call the Communications & Education Directorate, ext. 4-7007.

Ready resources for researchers

A number of online resources save time and make life easier for JPL researchers. Some, like the JPL Library's Beacon site, are well known to JPLers, but other resources are surprisingly not as familiar.

The NASA Aeronautics and Space Database contains more than 4 million records, including citations and abstracts of NASA technical reports, videos, journal articles and conference proceedings. More than half a million records directly link to full-text documents in PDF, and all other documents can be ordered via the JPL Library. NASA historical data dating back to early National Advisory Committee for Aeronautics reports (the early precursor to NASA) are also available.

Altogether, this makes up the biggest collection of aerospace technical information in the world, said Robert Powers, supervisor of the Library and Archives Group. Free desktop access for JPL employees is available by registering with the NASA Science and Technical Information service at *http://www.sti.nasa.gov* or via the JPL Library site at *http://beacon.jpl.nasa.gov.*

Another useful resource is the JPL Technical Report Server *(http://trs-new.jpl.nasa.gov/dspace/)*, a repository for digital copies of technical publications authored by JPL employees and cleared for external distribution. The server includes about 24,000 preprints, meeting papers, journal articles and other publications from 1992 to the present.

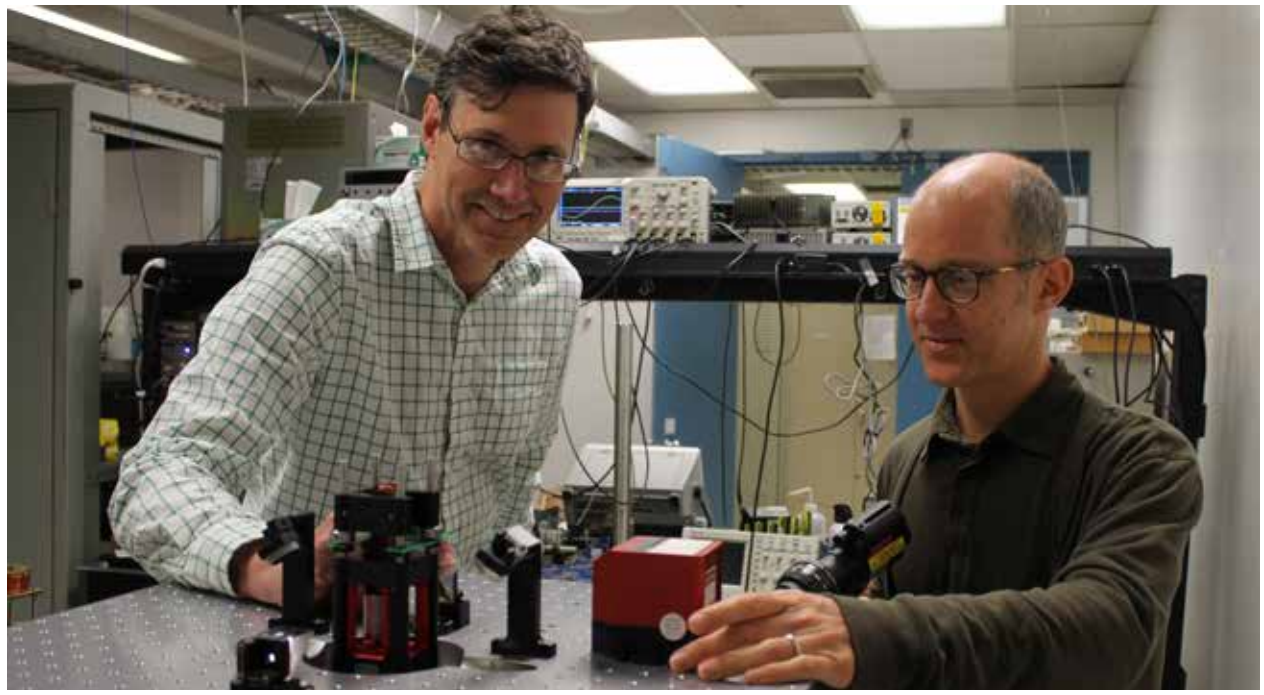
In addition to the online resources, the Logistics and Technical Information Division offers a range of services for JPL researchers and authors. The Library *(library@jpl.nasa.gov)* can assist with pre-publication research. For information on research services, see *https://beacon.jpl.nasa.gov/jpl-authors.* In addition, the Technical Information Section *(http://sec274.jpl.nasa.gov/)* provides technical writing and editing, document formatting, meeting support, graphic design, technical illustration, photography/imaging, website development and document review/clearance.

For more information, contact Powers at ext. 4-9263 or Scott Bowdan (Technical Information Section) at 4-3006.

THINKING SMALL

Many JPLers are gaining valuable experience by working with CubeSats and space station payloads

By Mark Whalen



Project Scientist Robert Thompson (left) with engineer James Kohel setting up lasers in the Cold Atom Laboratory ground testbed.

A major part of the Laboratory's future will lie in smaller projects than JPLers have been accustomed to. The future is now, with a dozen small missions in the works.

Four projects are in development for flight to the International Space Station, including JPL's next launch, the Optical Payload for Lasercomm Science, or OPALS, a technology demonstration set for liftoff in November of this year. Other missions to the space station are being prepared for launches in 2014 and 2016.

OPALS' objective will be to deliver video via an optical link from the space station to a telescope at JPL's Table Mountain facility. The experiment will test connectivity via high-bandwidth networks to benefit Earth science via high-resolution remote sensing and imaging instruments, as well as high-definition video for public access. The project manager is Michael Kokorowski; Baris Erkmen is principal investigator.

Also working toward space station launches are ISS-RapidScat (early 2014 launch), Cold Atom Laboratory (April 2016) and Orbiting Carbon Observatory 3 (fall 2016).

ISS-RapidScat will measure ocean-surface wind speed and direction by using the spare engineering model for QuikScat to provide a low-cost mission to mitigate the loss of the scatterometer's measurement capability in 2009. A new antenna and other elements are being developed at JPL for space station adaptation. The payload will be integrated to its Dragon launch vehicle at Kennedy Space Center this December.

"Because RapidScat will cross the orbits of QuikScat and other scatterometers, it will be uniquely positioned to allow cross-calibration between these instruments," said Project Manager Howard Eisen.

By studying ultra-cold gases in the space station's microgravity environment, one of the Cold Atom Laboratory's primary goals will be to explore a previously inaccessible regime where "interesting and novel quantum phenomena can be expected," noted Project Manager Anita Sengupta. "The lab will cool atoms to the lowest temperature ever achieved; hence we call it 'the coldest spot in the universe,'" she said.

Laser-cooling tests are underway, with a system-requirement review set for mid-April. Launch will be in early 2016.

Using the spare OCO 2 flight instrument with elements added to accommodate operation on the space station, OCO 3's three high-resolution grating spectrometers will measure atmospheric carbon dioxide to assess the spatial and temporal variability of carbon dioxide over an annual cycle.

Project Manager Ralph Basilio said the team is on track to conduct a system-requirements review this summer and is preparing for launch in fall 2016.

OPALS was developed as part of JPL's Phaeton Program, which provides opportunities for early-career hires to gain hands-on experience with small, flight-qualified payloads.

Two Phaeton-initiated projects are headed in a different direction, an area of continuing strategic importance for JPL—CubeSats, the low-cost, small satellite payloads where one unit measures about 10 centimeters on a side and weighs no more than 1.33 kilograms.

These CubeSats are the Radiometer Atmospheric CubeSat Experiment, or RACE, due for launch in April 2014; and the CubeSat VHF Transmitter to Study Dispersion of Radio Pulses, or CHIRP, one of three JPL CubeSats among 24 recently selected by NASA for flight in the next three years.

RACE, a four-channel instrument for water-path and water-vapor measurements, is led by principal investigator Boon Lim and Project Manager Alex Kadesch. CHIRP's measurements will be essential to the development of a future Explorer-class, charged-particle astronomical observatory. Principal investigator is Andrew Romero-Wolf.

The other two JPL CubeSats selected for launch with CHIRP in February:

- The Integrated Solar Array and Reflectarray Antenna, or ISARA, a demonstration of a Ka-band high-gain antenna that will substantially increase downlink data rates with minimal impact on spacecraft mass, volume, cost and power requirements. Principal investigator is Richard Hughes.
- The Interplanetary NanoSpacecraft Pathfinder In Relevant Environment, or INSPIRE, which will enable deep-space heliophysics and planetary science by demonstrating functionality, communication, navigation and payload-hosting in interplanetary space on dual CubeSats. Principal investigator is Andrew Klesh.

JPL is currently partnering to develop nine CubeSats overall. Activity on CubeSats has grown to include a broad cross-section of JPL, noted Charles Norton of the Instrument Software and Science Data Systems Section and NASA's Earth Science Technology Office, who oversees the projects for the Engineering and Science Directorate.

"CubeSats are very quickly becoming a serious platform for technology flight validation and targeted science observations," said Norton. "We are very interested in them not only as an educational tool and a way of strengthening relationships with universities and industry, but also to provide significant opportunistic science in regimes where we would not normally consider using a traditional large spacecraft."

A major part of the Laboratory's future will lie in smaller projects than JPLers have been accustomed to. The future is now, with a dozen small missions in the works.

Payload development for many of JPL's CubeSats is led by the Flight Instrument Electronics & Smallsat Technology Group, supervised by Paula Pingree. JPL has launched one CubeSat thus far, a University of Michigan partnership for an onboard processing validation experiment that went to space in fall 2011. Pingree will repeat as principal investigator for a reflight, targeted for December of this year. That launch will also include a second CubeSat, partnered with Cal Poly San Luis Obispo, carrying the JPL CubeSat Intelligent Payload Flight Experiment payload, or IPEX, which will validate Hyperspectral Infrared Imager–type onboard data processing and autonomous science. Steve Chien is the principal investigator.

JPL CubeSats in the hopper for the near future are GEO-CAPE Read out Integrated Circuit In-Flight Experiment, or GRIFEX, led by principal investigator David Rider and due for launch in 2014; and the Low Mass Radio Science Transponder Satellite, led by Courtney Duncan. Launch date is to be determined.

The prominence of the mini-missions prompted the formation of the "CubeSat Kitchen Cabinet," which considers JPL's investments and plans. The group includes technical-division and program-office representatives as well as Tony Freeman, manager of the Innovation Foundry. Ongoing studies through the Foundry and the A-team are looking at the role CubeSats could have for Europa, for Mars, and for observations in astrophysics and planetary science.

"This is an area that is maturing very quickly," said Norton. "These are smaller-scale missions, but still fully end-to-end development efforts. JPL is taking steps to ensure that we can have a significant role in determining and leading how CubeSats can be useful for beyond low-Earth orbit missions both as standalone science flights and complementary to future missions."

News Briefs

Assembly honors Trosper

Mars Curiosity Mission Manager Jennifer Trosper was honored March 4 by the California Legislative Women's Caucus as part of their "Breaking the Glass Ceiling" event.

The ceremony commemorates women who have made great contributions to the state and who have inspired women and girls in California and beyond.

Trosper was one of 12 women who were chosen for being pioneers in the sciences, civil rights, the arts, education, U.S. armed forces, courts and government. The women were honored as a part of the Assembly's celebration of Women's History Month.

For more information, visit *http://www.calchannel.com/california-women-of-the-year-ceremony-2.*

Jennifer Trosper

Soderstrom, Holm named to Federal 100

Tomas Soderstrom and Jeanne Holm, both in the Office of the CIO, have been named recipients of the 2013 Federal 100 Award. The two were honored March 20 in Washington, DC.

The award recognizes government and industry leaders who have made significant contributions toward the efficiency, innovation and progress that transformed information technology in their agency and playing a pivotal role in the federal information technology community.

Tom Soderstrom

Soderstrom, JPL's IT chief technology officer, is the champion of the office's Innovating Together strategy. By acting like a startup rather than an enterprise organization, JPL IT has successfully partnered with NASA, industry and academia to help shape the course of JPL's IT future, an approach has enabled the early adoption of emerging technologies into the JPL computing environment. Examples include JPL's cloud-computing strategy, the ability to search the spoken word in JPL Tube, and the Technology Petting Zoo.

Jeanne Holm

Holm, currently on a long-term assignment to the General Services Administration, supports the U.S. Chief Information Officer and Chief Technology Officer in the White House Executive Office of the President, leading collaboration with the public, educators, developers, businesses, innovators and international and state governments in using open government data. The data.gov team works with 180 government agencies to bring data to the public and make it accessible, machine readable and discoverable.

New book for Lopes

Rosaly Lopes, a senior research scientist and manager of the Planetary Sciences Section, is co-author of a new book on volcanoes.

"Modeling Volcanic Processes: The Physics and Mathematics of Volcanism" covers a wide variety of material on volcanism. Experts in each subdiscipline of quantitative physical volcanology—including field dynamics, thermodynamics, solid mechanics ballistics and acoustics—contributed to the work.

A JPLer since 2002, Lopes has authored five other books, including "Volcanic Worlds: Exploring the Solar System Volcanoes" and "The Volcano Adventure Guide." Co-authors for the new book are Sarah Fagents, a researcher in the Hawaii Institute of Geophysics and Paleontology at the University of Hawaii, and Tracy Gregg, associate professor of geology at the University of Buffalo. The publisher is Cambridge University Press.

Rosaly Lopes

Fellow honor to Ramesham

Rajeshuni Ramesham of the Mission Environments Group (5132) has been named a Fellow of the Society of Photo Optical Instrumentation Engineers.

A JPL employee since 1997, Ramesham's expertise is in extreme-temperature qualification for Mars and other deep-space missions. He has established an extreme-temperature thermal qualification laboratory (+500 C to –195 C) at JPL to support a wide variety of JPL/NASA projects.

Society fellows have made significant scientific and technical contributions in the multidisciplinary fields of optics, photonics and imaging, and are honored for technical achievement, service to the general optics community, and to the society in particular.

Rajeshuni Ramesham, right, receives his honor at a Photonics West symposium in San Francisco in February.

Small-business award goes to Honeybee

JPL has named the New York-based Honeybee Robotics Spacecraft Mechanisms Corporation the 2012 Small Business Subcontractor of the Year, one of 10 awards presented by each of NASA's 10 field centers.

The honor recognizes companies that provide "value-added and outstanding support—on schedule and within cost—and innovative solutions to problems/issues that arise in the execution of the contract."

Honeybee Robotics focuses on developing tough, reliable automated systems for extreme environments. The company was nominated for its contribution to the design and development of the Dust Removal Tool component of the Mars Curiosity Rover, designed to remove Martian dust from rocks to help with scientific analysis. For Curiosity, Honeybee also provided the Sample Manipulation System, the core mechanism inside the Sample Analysis on Mars suite of instruments.

Previously, Honeybee developed the Mars Exploration Rovers' Rock Abrasion Tools and the Mars Phoenix lander's Icy Soil Acquisition Device (the scoop).

Honeybee is currently developing next-generation space drills that could peer deep inside Mars, Europa or other targets in the solar system.

Honeybee Robotics team members accept their award at the JPL High-Tech Conference for Small Business March 5. From left: JPL Deputy Director Gene Tattini, Gale Paulsen, Ola Rzepiejewska and Kris Zacny.

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Passings

Edwin Dobkowski, a retired mission-assurance engineer, died Feb. 11.

Dobkowski joined JPL in 1983. He served as JPL project manager for the Federal Aviation Administration's Traffic Simulator Unit and the update to the entire U.S. air traffic control system. He subsequently worked as a mission assurance manager on Microwave Limb Sounder and the Atmospheric Infrared Sounder. He also supported Galileo's launch safety program, developing an atmospheric wind flow measurement system for the Kennedy Space Center to support radioisotope launch safety criteria.

Ed Dobkowski

Dobkowski retired in 2005. He is survived by his wife, Jean; daughters Natalie and Renee; son-in-law Ron; and grandchildren Selena and Rachel. A funeral mass will be held at Our Lady of Perpetual Help Catholic Church, 23045 Lyons Ave, Santa Clarita, April 8 at 10:30 a.m. Interment will be April 9 at 1 p.m. at Holy Cross Cemetery, 5835 Slauson Ave., Culver City. The family requests that in lieu of flowers donations be considered for the St. Vincent De Paul Society, 23936 Avenida Crescenta, Valencia, CA, 91355.

Retirees

The following employees retired in March: **Marc Adams**, 39 years, Section 353E; **Donnalee Campbell**, 35 years, Section 1000; **Keith English**, 34 years, Section 352S; **Russell Sugimura**, 34 years, Section 385H; **Anna Tavormina**, 26 years, Section 1610; **Carlos Carrion**, 25 years, Section 318L; **Nancy Walizer**, 22 years, Section 2662; **Philip Varghese**, 21 years, Section 6200; **Gaylon McSmith**, 19 years, Section 6800; **Mae Hawk**, 14 years, Section 1141; **Elisa Garcia**, 12 years, Section 356A.