PSI NEWSLETTER

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Mars Exploration Rovers are on their way *by Catherine Weitz*

Twin Mars Exploration Rovers were launched by NASA this summer on these Boeing Delta II rockets.

It was three years ago that NASA selected the Mars Exploration Rovers (MER) to be launched in 2003 and it has been a very difficult, stressful but rewarding three years getting the two identical rovers ready for launch. Finally, those long hours and heroic efforts were rewarded when both rovers successfully launched from Florida: the first rover, called Spirit, launched on June 10, the second rover, Opportunity, launched on July 7 (shown above). It took longer than hoped to launch each rover, mostly due to problems associated with the launch vehicle. The rovers were launched on Boeing Delta II rockets; the second rocket was slightly bigger and referred to as "heavy" compared to the first, since the second launch occurred later in the window of time required to get a spacecraft to Mars and more propellant was needed.
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In any case, the problems with the launch vehicles were fixed and both rovers are now on their way. Spirit will land on Mars January 3, 2004; then, only 21 days later, Opportunity lands January 24. It will certainly be a busy time for all of us on the MER mission next year!

The MER mission seeks to determine the history of climate and water at two sites on Mars where there is strong evidence from orbital data for past and persistent water activity. The rovers' scientific instruments will be used to read the geologic record at each landing site, investigate what role water played there, and determine how suitable the conditions would have been for life. The rovers and the spacecraft that will deliver them to Mars were built at the Jet Propulsion Laboratory (JPL) in Pasadena, CA. The science instruments on each rover were built by the Principal Investigator, Dr. Steve Squyres at Cornell University. Both the MER Project at JPL and Dr. Squyres have done a phenomenal job getting the rovers and instruments built and analyzed so they can perform once they arrive at Mars.

The rovers will land with the same entry-descent-landing system that was successfully used on the 1997 Mars Pathfinder mission. Obviously, we are hoping that this landing system will work again for both Spirit and Opportunity. After landing, the rovers can travel dozens of meters each day if needed; however, we won't know until we land on Mars just how easy it will be to drive around on the surface. Since the rovers are solar powered, the amount of time we will have to work on Mars will be limited by dust accumulating on the solar panels. At a minimum, each rover needs to survive at least 90 sols (a day on Mars is called a "sol"), but we hope they will last longer.

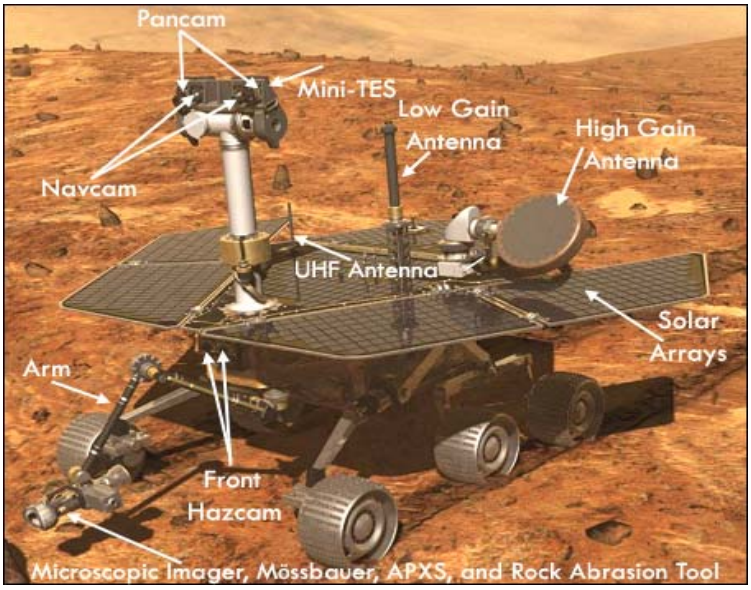

Illustration of the Mars Exploration Rover and its science payload.

Each rover has a full toolbox equipped with all it needs to search for signs of ancient water and climate. There are six science tools on each rover, called the Athena Science Payload (shown above). The panoramic camera (**Pancam)** views the surface around the rover using two high-resolution stereo color cameras to complement the rover's navigation cameras. Delivering panoramas of the Martian surface with unprecedented detail, the instrument's narrow-angle optics provide angular resolution more than three times higher than that of the Mars Pathfinder cameras. The Mini-Thermal Emission Spectrometer (**Mini-TES**) is an instrument that sees infrared radiation emitted by objects and can be used to determine from afar the mineral composition of Martian surface features. Pancam and Mini-TES are located atop a 1.5 meters high mast to survey the scene around the rover and look for the most interesting rocks and soils.

Attached to the front of each rover is a robotic arm that carries the four other science tools. When an interesting rock or soil is identified by Pancam or Mini-TES, the arm is deployed to this location for detailed analyses. The Alpha-Particle-X-Ray Spectrometer (**APXS**) will accurately determine the elemental chemistry of rocks and soils in order to complement and constrain the mineralogical analyses of the other instruments. The **Mössbauer Spectrometer** is designed to determine, with high accuracy, the composition and abundance of iron-bearing minerals that are difficult to detect. Identification of iron-bearing minerals will yield information about early martian environmental conditions. The **Microscopic Imager** is a combination of a microscope and a camera. It will produce extreme close-up views of rocks and soils examined by other instruments on the instrument arm and provide contextual information for the interpretation of mineral and element composition data. Finally, the Rock Abrasion Tool (**RAT**) can be used on rocks to abrade and expose an area nearly 5 centimeters (2 inches) in diameter, and grinds down to a depth of about 5 millimeters (0.2 inches). This exposed area can then be examined by the other science instruments to determine the composition of fresher rock surfaces if Martian rocks are weathered or covered by material distinct from the actual rock composition. All four of these instruments are on a turret at the end of the arm; the turret will rotate an instrument onto the target of interest, then rotate the next instrument to the same target for a complementary analysis.

In addition to these science tools, there are also six engineering cameras on each rover. The two navigation cameras (**Navcams)** have a wider field of view but poorer resolution than the Pancam. The Navcams will be used by the engineers to assess driving conditions, and the scientists will use the images to complement any Pancam images of the site to support science analyses. The hazard avoidance cameras (**Hazcams**) on the front and back of the rover, are used to see what is directly in front of or behind the rover, both to determine any hazards in moving the rover and to help in the placement of the robotic arm on interesting rocks or soil. Scientists will also use the Hazcam images to see the rover's tracks and understand properties about the soil, such as whether it is a soft soil that the rover wheels might sink into or a hard duricrust that shows no sign of disruption by movement of the wheels.

Obviously, the landing site is a big factor in determining the kind and quality of science we will achieve on this mission. Because of the importance of selecting the safest and scientifically most interesting sites to best meet the mission's science objectives, we had a site "downselection" process that involved much of the Mars community. In addition, the cameras on both

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PSI Welcomes Les Bleamaster

Leslie (Les) Bleamaster has recently joined us from Dallas, TX, where he just finished his Ph.D. in Geology at Southern Methodist University. His dissertation, entitled "The Ix-Chel, Kuanja, Vir-Ava Chasmata System, Venus: Geologic History, Crustal Structure, and Magma Production & Transport," was the result of working with advisor Professor Vicki Hansen (now at the University of Minnesota, Duluth) and focused primarily on geologic and structural mapping, and volcano-tectonic processes on Venus. His 1:5,000,000 scale geologic map of Ovda Regio (V35) will soon be available through the US Geological Survey, whereas other works have been submitted to the *Journal of Geophysical Research* and *Geological Society of America Bulletin*.

Throughout his undergraduate (Trinity University in San Antonio, TX) and graduate schooling, Les has conducted field work in Texas, Oklahoma, Colorado, Montana and Hawaii. He has also received training in remote sensing from the University of Texas, Dallas. Les' objective is to bring together terrestrial field work, remote sensing, and planetary research in an attempt to formulate robust hypotheses about both the world we live in and the worlds we don't. Les says that he is excited about shifting gears and joining the Mars team here at PSI.

With three young children, Caden Zane (7), Sean Leslie (4) and Bode Everett (1), Les has become very concerned about the general decline in science education (specifically Earth Science education) in our primary and secondary schools. Les has already taken part in Texas classrooms where he volunteered with 1st and 5th grade classes doing various exercises to encourage curiosity, creativity and critical thinking about the Earth and the solar system. It is one of his hopes to help expand PSI's role in education and public outreach.

Les' wife, Jana, has a BS in Biology from Trinity University (where they met) and is currently enjoying staying at home after supporting the family through Les' graduate school. Les is a veteran of the US Navy, where he served with SEAL Team Four in Little Creek, Virginia (1990-1994); he is currently an applicant for the 2004 astronaut selection.

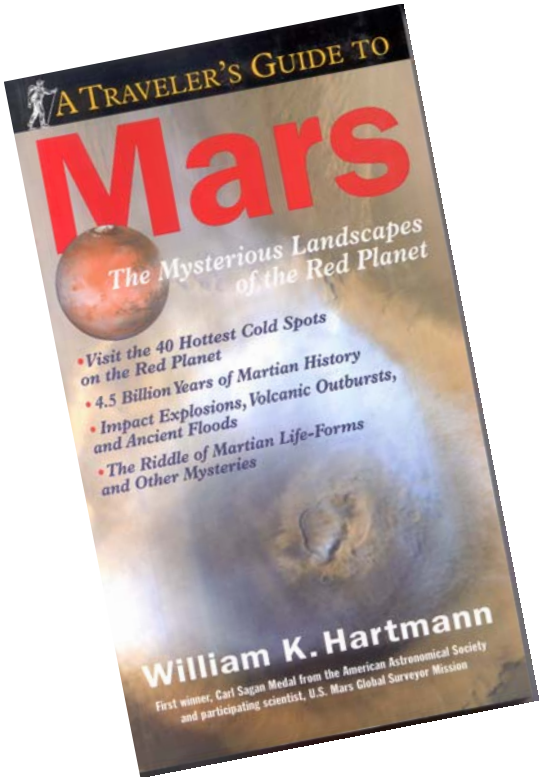
We are very glad that Les has joined the PSI research team.

A Traveler's Guide To Mars

Published to coincide with "the most striking and spectacular Mars apparition in tens of thousands of years" *(The New York Times),* A TRAVELER'S GUIDE TO MARS is a full-color, fully illustrated guide to the mysterious Red Planet. This thrilling new book by PSI's William K. Hartmann is receiving raves including featured reviews in *Scientific American* and *Discovery* and this notice from *Publisher's Weekly*:

> ...melds enjoyable prose with breathtaking pictures in a cleverly conceived "scientific Baedecker" that is likely to delight expert and lay readers alike...easily browsed with great pleasure.
> —-*Publisher's Weekly* starred review, May 12, 2003

Bill is donating 25 percent of the royalties of A TRAVELER'S GUIDE TO MARS to the PSI building fund. The book is Bill's experiment in using a writing project to help support our non-profit Institute. Please support PSI and Bill Hartmann and enjoy a fabulous book by patronizing your favorite bookstore to purchase this acclaimed new Mars book. To arrange for an autographed and/or personalized copy, e-mail Bill at hartmann@psi.edu. Do your holiday shopping early! PSI and Bill Hartmann thank you!



Frank Chuang Joins PSI's Mars Team

Frank Chuang joined PSI in mid May as a Research Associate and Software Specialist. Frank works with Dr. David Crown on Mars research where the current focus is the study of debris aprons in the eastern Hellas and Tempe/Mareotis regions of Mars. Their presence suggests that ice is stored in the Martian regolith, either currently or in the recent geologic past. Frank and David are using some of the latest Mars Global Surveyor and Mars Odyssey mission data in their work. Frank's software specialist tasks are to install, maintain, and assist staff in the use of major software packages such as ArcGIS, ENVI, IDL, and ISIS. He is also helping with the long-term development of a PSI Mars lab that will serve as a central resource for Mars research. This lab will house paper maps, digital data, and high-powered desktop computers and peripherals.

Prior to joining PSI, Frank was a Research Assistant in the Geophysics Unit of the US Geological Survey (USGS) in Menlo Park, CA. At USGS, he worked with geophysicist Robert Jachens and geologist Edwin McKee on two separate projects. With Robert Jachens, he helped collect and process potential field gravity data in the San Francisco Bay Area to study potential strike-slip basins along the Calaveras fault system. Results from this work were presented at the 2002 GSA Cordilleran Section meeting in Corvallis, OR. With Edwin McKee, Frank used Arc/Info (a Geographic Information System (GIS) software package) to integrate large regional geologic datasets in the assessment of large regional groundwater basins in the desert southwest United States. The results of this work will be published as an online USGS Open-File Report in 2003. Frank received his Master of Science (Geology) in 2000 at Arizona State University (ASU). His advisor was Dr. Ronald Greeley, who heads the Planetary Geology Group at ASU. His thesis "Large mass movements on Callisto" was a comparative study of landslides on Callisto to those on Earth with similar dimensions and morphology. This work was also published as a manuscript in the *Journal of Geophysical Research-Planets*. In addition to research, Frank participated in several outreach activities such as Earth Science Day at ASU and public lectures to grade school students in the Phoenix area.

From 1996 to 1997, Frank worked for renowned Mars scientist Dr. Michael Carr at the USGS in Menlo Park, CA. One of his two main tasks was to provide image processing support of Galileo nominal mission data for the four large Galilean satellites: Callisto, Europa, Ganymede, and Io. The other task was to map, digitize, and import Martian valley network data into Arc/Info GIS for spatial analysis. The results of his work were included by Dr. Carr in a 1997 *JGR-Planets* paper on which Frank was a co-author.

Prior to joining Dr. Carr at USGS, Frank received his first exposure to planetary science working as an intern at the Center for Earth and Planetary Studies (CEPS), Smithsonian Institution. He was an intern at CEPS for two consecutive summers, 1995 and 1996. Frank's supervisor was Dr. Robert Craddock. His main duty was to collect topographic profiles of both fresh and degraded impact craters in the southern cratered highlands of Mars. The profile data was used as part of Dr. Craddock's study of general crater degradation.

PSI is very pleased to welcome Frank to our science staff.

Director's Notes

PSI's Widgets

In dealing with flinty-eyed bankers to arrange a mortgage for PSI as part of our effort to purchase our new digs, the question inevitably asked was, "What do you produce?" (The term "flinty-eyed bankers " is a bad stereotype which does not describe these professionals. One is a delightful young man who grew up just a few blocks from the old PSI and is unusually knowledgeable about astronomy. Another is an affable gentleman who looks as if he would fit in well with the country club set; while the third banker, the most energetic of the three, has disappeared and does not return calls.)

So, what are PSI's widgets? Basically, our ultimate product is new knowledge resulting from research. Publications in the peer-reviewed literature are the tangible unit of knowledge that we generate. Being able to show the bankers reprints of papers, chapters in books, or articles in publications helped them to understand the nature of our business which is quite different from the typical company to which they lend. Fortunately, they did grasp enough of what we do, and the fact that we have a 30+ year track record and current audited financial statements convinced two of the banks to approve us for a mortgage.

Another hurdle passed on our road to acquiring a permanent home for the Institute! Keep your fingers crossed that there are no insurmountable bumps in the remainder of our journey, and that by year's end, PSI will be a homeowner.

Ah, to be home at last.

Donald R. Davis
Director

WE'VE MOVED!

On September 4, Planetary Science Institute moved into its new quarters at 1700 E. Ft. Lowell, Suite 106, Tucson, AZ 85719. A detailed article with photos will be in the next issue when we recover from the move trauma.

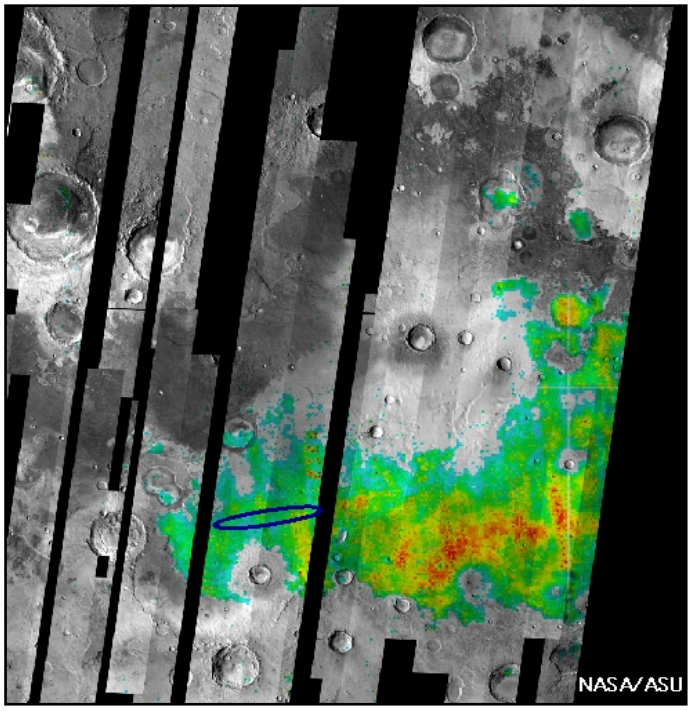
Mars Exploration Rovers *continued from page 2*

Mars Global Surveyor and Mars Odyssey were targeted to potential sites to acquire as much imagery as possible to assess the science and safety of these possible sites. After over two years and four landing site workshops, the science community and MER Project came up with four landing sites and this list was presented to the Associate Administrator of NASA in April of this year. The two sites that were selected are Gusev Crater and Meridiani Planum. Because Gusev Crater is located further to the south than Meridiani and the Sun will be moving steadily to the north with time, we get more total power, and subsequently more science, if the first rover goes to Gusev Crater. Thus, Spirit will land at Gusev Crater and Opportunity will land at Meridiani Planum.

Gusev Crater (shown below) has a large channel system called Ma'adim Vallis, which is several 100s of kilometers long and flows into the crater. So, we know that water once flowed into Gusev; what we don't know is how much and for how long that water existed inside the crater. Once Spirit lands at Gusev, we will search for chemicals in the rocks and soils that would tell us about the early water history at this site. We will also look at the shape and distribution of the rocks and soil particles looking for similarities to ones on Earth that formed in association with water activity. By learning about the early water history at Gusev, we can also determine whether the past environment was favorable for life.

Viking color mosaic of Gusev Crater where Spirit is scheduled to land on January 3, 2004. A large channel system can be seen flowing from the south into Gusev, suggesting that the crater was once filled with water.

The other site, called Meridiani Planum, (above right column) has been studied extensively by our fellow scientists here at PSI, Melissa Lane and William K. Hartmann. This region on Mars where the rover Opportunity will land was originally discovered by the Thermal Emission Spectrometer (TES) onboard the Mars Global Surveyor spacecraft. The site is one of only three places on Mars where the mineral crystalline hematite has been identified by TES. This gray, crystalline hematite usually forms on Earth in places where there is liquid water, such as by chemical precipitation from iron-rich waters. However, it can also form by thermal oxidation of magnetite-rich lavas, which does not require the presence of liquid water. We are hoping



Mosaic of THEMIS daytime infrared images of Meridiani Planum (black and white strips). Superimposed on the THEMIS images is the abundance of crystalline hematite (color) as determined by the Thermal Emission Spectrometer (TES) on Mars Global Surveyor. The landing site for Opportunity is shown by the blue ellipse.

Opportunity will tell us that Meridiani Planum was once a water-rich place and that's why we see hematite there. If, in the past, it was wetter and warmer compared to the cold, dry conditions we see now, then perhaps, under those more favorable conditions, this place supported life. We'll have to wait until data come back from the rover to put all the pieces together about what this site is like now and what it was possibly like in the past. Stay tuned next January!

Dr. Weitz is the Mars Exploration Rover Project Scientist at NASA Headquarters; she is working there under a cooperative agreement between PSI and NASA.

The Better Part of Valor

While tooling around in the Gusev,
It's important to stay unobtrusive.
For if word should leak out
There are rovers about,
The Martians may turn quite abusive.

Anne Raugh, 2003

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