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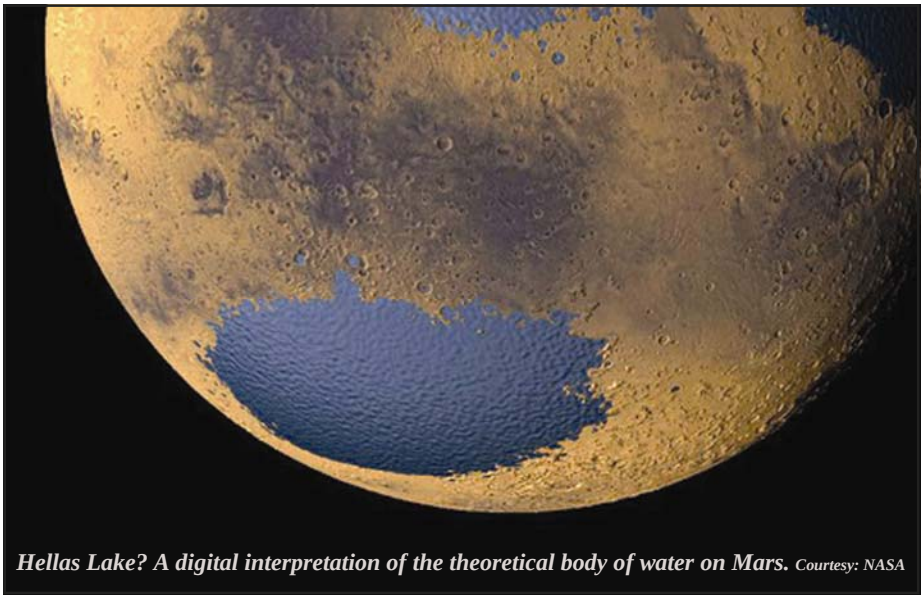
Map Supports Theory for Huge, Ancient Lake on Mars

by Alan Fischer and Les Bleamaster

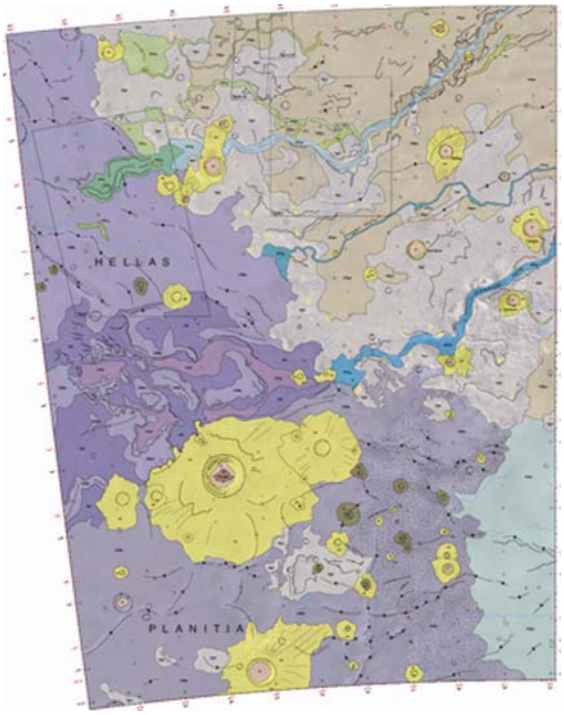
A recently published geologic map by PSI's Les Bleamaster and David Crown offers new evidence that an expansive lake may have existed long ago on Mars.



Hellas Lake? A digital interpretation of the theoretical body of water on Mars. Courtesy: NASA

The project, funded by NASA's Planetary Geology and Geophysics Program, used a variety of data from NASA spacecraft to identify a series of finely-layered sedimentary deposits at the edge of the Hellas impact basin in the southern hemisphere of Mars. These sediments may have been deposited within and/or adjacent to a large standing body of water covering the basin floor. This mapping study constrains the timing of this proposed lake to the Early-Middle Noachian Period on Mars, between about 3.5 and 4.5 billion years ago.

The Hellas basin, more than 2,000 km across and 8 km deep at its deepest, is one of the largest recognizable impact structures on the Martian surface and if completely flooded could have contained as much as 25 million cubic km of water. The Hellas map publication, and original summer 2010 PSI press release, preceded an additional claim from researchers at the University of Colorado at Boulder citing geomorphic evidence for a northern ocean on Mars that may have contained as much as 125 million cubic km.



Geologic map of eastern Hellas; purples show the planitia floor, whereas the beiges, blues, and greens represent materials shed from the highlands (yellowish greens are craters).

Although each of these volumes is considerably less than the current volume of Earth's oceans — about 1.4 billion cubic km — these studies reinforce a long-held idea that significant amounts of water once flowed on the surface of Mars. Such additional evidence of the presence of surface water on Mars lends support to the idea that the planet may have once supported habitable environments.

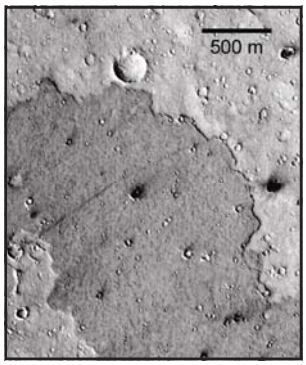
The discovery of the sedimentary deposits began with a systematic search of all the then newly available high-resolution images of the eastern Hellas region. Bleamaster realized this area was significant when he found

(Continued on next page)

Inside this issue:

Hartmann Receives Barringer Award for Planetary Dating Technique *by Alan Fischer*

NEW YORK — On July 27, the Meteoritical Society awarded its 2010 Barringer Medal to PSI Senior Scientist and co-founder William K. Hartmann. The award from the international society for meteoritics and planetary science recognizes outstanding work in the field of impact cratering. "The award primarily recognizes our work in developing a system for estimating ages of planetary surface features, especially on Mars," Hartmann noted.



Orbital photo of Mars shows basis for crater dating technique. A dark lava flow has flowed across an older, more heavily cratered terrain. Lower crater density on the lava flow indicates its age as roughly 100 million years. *(Photo: Mars Global Surveyor, NASA, and Malin Space Science Systems).*

"The idea is that if you create any surface in the solar system — lava flows, lakebed deposits or even a parking lot — asteroid impact craters will accumulate over millions of years. Therefore, the older the surface, the more craters. By careful counting and analyzing of impact craters, we've been able to show that while many surfaces on Mars are very old — say 3.5 to 4.5 billion years, almost as old as the planet itself — other surfaces such as some lava flows and water-erosion features can't be much older than 100 million years, which is the last two percent of geologic time. This suggests that Mars has had volcanic activity and even occasional water release in 'modern' geologic time. That is very exciting, to realize that Mars is a geologically active planet, just from counts of asteroid impacts on various surfaces," Hartmann said.

Clark R. Chapman, of the Southwest Research Institute in Boulder, CO, and former PSI scientist, introduced Hartmann at the event. "Bill Hartmann is one of the few scientists during the past half-century who has studied cratering from the broadest, most open-minded perspective, trying to elucidate the fundamental role it has played in shaping the surfaces of the planets and the properties of the smaller bodies in the solar system," Chapman said. "Bill Hartmann's vision of lunar and planetary cratering, and his career of research and public outreach on that topic, make him eminently qualified to receive the prestigious Barringer Medal."

The Barringer medal features the famous asteroid impact crater in Northern Arizona, where the Barringer family maintains a public museum.

The Barringer Award was established in 1982 to honor the memory of D. Moreau Barringer Sr. and his son D. Moreau Barringer Jr. and is sponsored by the Barringer Crater Company. The senior Barringer was the first to seriously propose an impact origin for the crater that now bears his name. For nearly two decades he defended this theory against the vast majority of scientific opinion. The junior Barringer was the first to identify the Odessa crater, the second known impact site on Earth.

Members of the Barringer family celebrate with Bill and Gayle Hartmann (right) after awarding of the Barringer prize.

"The Barringer family, from Flagstaff, bought Meteor Crater near Winslow and developed it into a significant Arizona attraction with a wonderful museum," Hartmann said. "The family has always been terrific about supporting science and research into meteorites and cratering." □

Theory for Huge, Ancient Lake on Mars

(continued from front page)

finely-layered rocks on the eastern slope of the Hellas basin. They revealed extensive erosion of highland materials from Hellas' rim that had moved downhill into a basin-wide, standing body of water.

Hellas Planitia, the name given to the basin floor region, preserves materials shed from the surrounding highlands and holds the key to further unraveling some of Mars' long held secrets. Mapping and evaluation of landforms and materials of the Hellas region can provide further insight into Martian climate regimes and into the abundance, distribution, and flux of volatiles — more specifically water — through history. Projects such as this can offer a glimpse into Earth's past; using discoveries on Mars, we can try to unravel what our planet may have looked like early on in the solar system's evolution.

Bleamaster and Crown, both planetary geologic mappers, use a wide variety of remote sensing data sets collected by orbiting spacecraft — not only of Mars, but Venus, the Moon, and outer solar system satellites — in attempts to reconstruct the geologic histories of important regions on these bodies and to analyze specific geologic events or processes. They try to relate their observations, find space or time connections, to other regions to help understand the geologic evolution of planetary bodies. Terrestrial geologists would call this field work. They do, too — they just don't get their boots dirty.

The geologic map was published at 1:1,000,000 scale and used Viking Orbiter, Thermal Emission Imaging System (THEMIS) infrared (IR) and visible (VIS) wavelength, and Mars Orbiter Camera (MOC) narrow-angle images, combined with Mars Orbiter Laser Altimeter (MOLA) topographic data. The new map and accompanying map pamphlet may be found at http://pubs.usgs.gov/sim/3096/ □

2010 PSI Retreat

Photo: Gil Esquerdo

PSI members at the retreat, front row (l-r): Chris Holmberg, Kelly Yoder, Aileen Yingst, Asmin Pathare, Karly Pitman, Candace Kohl, Elaine Owens. Second row : Gil Esquerdo, Dan Berman, Susan Benecchi, Cathy Weitz, Paul Abell, Bruce Barnett, Carol Neese. Third row: Frank Chuang, Melissa Lane, Beatrice Mueller, Cyrena Goodrich, Thea Cañizo, Emily Joseph, Betty Pierazzo, Deborah Domingue Lorin, Fourth row: Mark V. Sykes, Michael Wendell, Robert Gaskell, Renu Malhotra, Rose Early, Alice Baldridge, Bill Feldman, Mary Chapman. Fifth row: Bob Reedy, Jesse Stone, Kathi Gardner, Kim Kuhlman, Michelle Greer, Eldar Noe Dobrea, Tom Prettyman, Steve Metzger. Sixth row: Faith Vilas, Nick Tosca, Jeff Morgenthaler, David Crown, Jade Bond, Julie Rathbun, Michael G. Gibbs. Seventh row: Mark Everett, Brent Archinal, Tim Hunter, David O'Brien, Linda Rueger, Gavin Nelson, Ed Tedesco, Terrill Yuhas, Nalin Samarasinha, Marc Fries, Bill Hartmann. Back row: Ross Irwin, David Levy, Alan Fischer, Pasquale Tricarico, Keith Holsapple, and Stu Weidenschilling.

Our 6th annual retreat was held late August at the beautiful and hospitable Westward Look Resort in the Catalina Mountain foothills near Tucson. This year, 65 people attended the two-day science-centered program, which creates a platform for new members to present their research through scheduled talks, while also affording many opportunities for everyone to gather into smaller groups to inspire and learn from one another. Scientists from our off-site locations in California, central and northern Arizona, District of Columbia, Kentucky, Maryland, Maine, Nevada, New Mexico, Texas, United Kingdom, Utah, Vermont, Virginia, Washington and Wisconsin joined our Tucson staff to enjoy another highly successful retreat.

The retreat banquet filled the acclaimed Janos restaurant to capacity, and the fabulous cuisine mixed with our good cheer created a memorable affair. After dinner, a special anniversary award was presented to Elaine Owens by the PSI scientists who have enjoyed working with her for over two decades. Visit our website for the complete retreat program: *www.psi.edu/retreat/2010*.

More retreat photos on pages 4-5

PSI Honors Owens' 20 Years

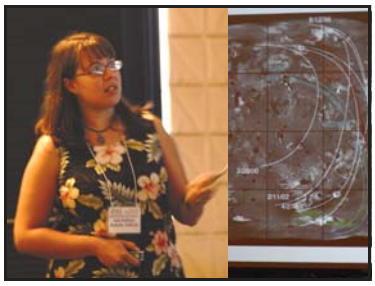
Photo: Gil Esquerdo

PSI's beloved Elaine Owens (in green) received a prized Hartmann painting during a fun– and nostalgia-filled ceremony commemorating her many years at PSI. From left, Bill Hartmann, Don Davis, and Stu Weidenschilling lauded her devotion and her durable (and necessary) sense of humor. Bravo, Elaine!

PSI Retreat Photo Gallery

Opening the retreat, Director Mark Sykes reviews the state of PSI. Prognosis: robust.

Susan Benecchi, who works in Virginia, gave her talk on icy bodies at the edge of our solar system.



Time-variability in active Ionian volcanoes was Julie Rathbun's topic. She works in Redlands, CA.

Marc Fries's (CA) talk was about using Doppler weather radar as a meteorite-finding tool.

Student intern Scott LaPlante presented videos of enhanced visualization techniques for the planetary sciences.

From left, Mark Everett; Trustees Michael Gibbs, Candace Kohl, and Brent Archinal; Mary Chapman.

Sanlyn Buxner presented PSI's first podcast, starring Pasquale Tricarico.

Ross Irwin (MD) described the geology of Holden crater, a potential landing site for the Mars Science Laboratory on Mars.

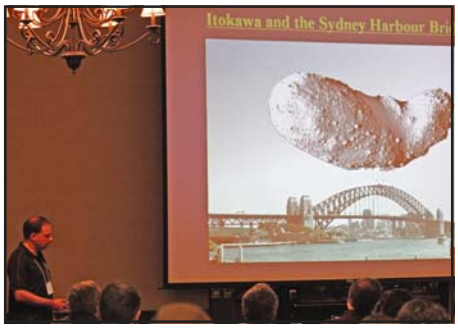
Mary Chapman (CA) presented research suggesting global warming as the cause of mass extinctions 200 million years ago.

Retreat headquarters: The historic Westward Look Resort in Tucson.

Jade Bond (KY) spoke about the diversity of extra-solar terrestrial planets.

Deborah Domingue Lorin (MD) gave an update on the MESSENGER mission. PSI has five participating scientists on the mission.

1. *From left, Aileen Yingst and Cathy Weitz.*
2. *Trustee David Levy and Board Chair Tim Hunter.*
3. *Retreat attendees during a break: Thea Cañizo talks to Alice Baldridge; Jeff Morgenthaler, facing camera at right.*
4. *Terrill Yuhas, Kelly Yoder, and Bruce Barnett.*
5. *Melissa Lane and Alice Baldridge.*



Paul Abell's (TX) presentation was about his participation in the recovery of the Hayabusa spacecraft's sample return capsule in Australia.

Amy Hartmann-Gordon described PSI's new development plans.

Mark Sykes brought us up to date on the Dawn mission; six other PSI scientists are also on the mission.

Bill Hartmann is enthusiastic about a remarkable event: The Almahata Sitta Fall.

Photo: Robert Reedy

Marvin and Kitty Kilgore, of Southwest Meteorite Lab, chat with Mary Chapman (middle) at the banquet.

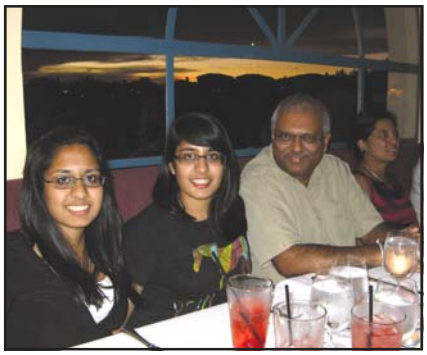
The Retreat Banquet at Janos Restaurant

PSI Retreat attendees filled the dining room at Janos.

Visiting scientist Renu Malhotra (left) and Beatrice Mueller at the retreat banquet.

Nick Tosca (UK), Karly Pitman (CA), Susan Benecchi (VA), and Jade Bond (KY) enjoying the evening at Janos.

From left, Ed Stiles, Trustee Ben Smith, Gina and Alan Fischer.



Nalin Samarasinha is surrounded by his family at the PSI banquet.

Faith Vilas toasts with Brother Guy Consolmagno, a noted Vatican astronomer and author.

It was an honor to have Ewen Whitaker at our banquet as he has been an inspiration to many of our scientists.

Bill Feldman, Tom Prettyman, and Margrethe Feldman all came from New Mexico to attend the retreat.

Except as noted, all retreat photos are credited to Gil Esquerdo and Chris Holmberg.

Remote Sensing of the Moon in Asia

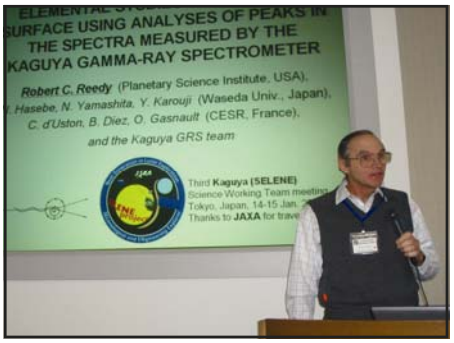
by Robert C. Reedy

After several decades of active collaborations with colleagues in Europe, much of my focus in the last four years has shifted to working with scientists in Asia. This is because Japan, China, and India have all recently put spacecraft into lunar orbit, and Korea wants to do so by 2020. The Japanese *Kaguya* (SELENE), the Chinese *Chang'E-1*, and the Indian *Chandrayaan-1* spacecraft have all carried instruments to measure gamma rays. My connection to these missions is due to the considerable experience I have had — since the early 1970s Apollo Program — in using gamma rays to remotely determine elemental composition.

Chandrayaan-1 had a high-energy x-ray instrument with good spatial resolution. Five years ago, I was asked to consult with Indian space scientists to advise them on what they would be observing. My colleagues and I made some calculations that showed that their instrument could detect the boundaries between the two main terrains on the Moon: the basalts in the lunar maria (seas) and the light-colored material in the lunar highlands. That instrument has not yet reported any results.

In late 2006, I was invited by the Japan Aerospace Exploration Agency (JAXA) to attend the first working team meeting for their upcoming SELENE lunar mission. I was familiar with the mission since I had previously worked with the Principal Investigator for the SELENE gamma-ray spectrometer (GRS) experiment. The main spacecraft was soon named *Kaguya* by a poll of the Japanese public, which is the name of a princess in a Japanese folktale who comes to Earth from the Moon and then returns to the Moon.

It was at the January 2007 meeting at JAXA's Tsukuba Space Center near Tokyo that I was made an official Co-Investigator (Co-I) on the GRS experiment. Although NASA officials were eager to provide some funding for my work on Kaguya now that I was a Co-I, there was a problem. It turned out that my case was very unusual, and that NASA had no procedures in place to provide funds for me *then*. Eventually, NASA established a program for people in my position and I received NASA funds a year ago for my Kaguya GRS work.



Bob Reedy at a Kaguya Science Team Meeting in Japan, where he assisted the Kaguya gamma-ray spectrometer team in interpreting their science data. ***Photo: Japan Aerospace Exploration Agency***

The Kaguya spacecraft was launched in September 2007 and started regular observation of the Moon in December 2007. The mission ended on June 11, 2009, when the Kaguya spacecraft crashed — intentionally — onto the Moon. I attended all four of the Kaguya Science Working Team (SWT) meetings in the Tokyo area. The scientists in those meetings typically numbered about 60 Japanese and 15-20 foreigners (mainly from USA and France). The work on analyses and interpretations of the Kaguya GRS measurements will end in about a year. A PSI press release, dated June 26, 2009 (available on our website), describes the Kaguya GRS team's work to make the first global map of lunar uranium.

After the SWT meeting in January 2009, I spent a week in Daejeon, Korea, where I discussed lunar research and ideas for a possible lunar mission with the Korean scientists. On a personal note, by this time I had become quite adept at eating with chopsticks, and I needed those skills to use the metal chopsticks used in Korea, which are harder to use than wooden or plastic ones. I was even complimented by a Korean on my use of metal chopsticks.

Bob Reedy (third from left) with the Program Committee for the International Symposium on Lunar Science (ISLS) March 25-26, 2010, at Macau University of Science and Technology (MUST). ***Photo: Macau University of Science & Technology***

My connection with Macau began in July 2009, when I exchanged several emails with Mr. Zhu, a graduate student from the Macau University of Science and Technology (MUST), who was analyzing GRS data collected from November 2007 to February 2009 by the Chang'E-1 spacecraft in lunar orbit. I helped him understand what he was observing in the data and offered suggestions for his paper on gamma-ray data used to globally study natural radioactivity in the Moon.

In December 2009, I received a formal invitation from the Rector of MUST to be on the Program Committee for the International Symposium on Lunar Science (ISLS), March 25-26, 2010. Soon after, the organizers of ISLS asked me to give an invited speech, and later with my help several more foreign invited speakers were added to the meeting. A one-day workshop on lunar gamma-ray spectroscopy was set for March 27, 2010, in Macau, with a Chinese colleague from Taiwan and me as co-chairs.

So last March, after a few days in Tokyo, I flew to Hong Kong and took the 40-mile ferry ride to Macau for the ISLS meeting. In Macau, the meeting organizers kept me very busy. There were about fifty Chinese, eight Japanese, three Americans, and four other non-Chinese scientists at the symposium where the talks centered mainly on results from the Chang'E-1 and Kaguya lunar missions. At the ISLS formal dinners (necktie *required*), I was specially introduced to high officials from MUST and from the foundations that helped support the meetings. About 25 scientists participated in the GRS workshop the day after the symposium. All the meetings were highly successful with lively discussions as the Chinese were quite interested in learning about the other countries' results and in presenting their work. And for me, it has been a novel and interesting experience working with my new colleagues in Asia. □

Read more about Bob Reedy's science history in the 2009 Spring issue of the PSI Newsletter available on our website, www.psi.edu .

Arizona Teachers Learn About PSI Educational Outreach Efforts *by Alan Fischer*

Thea Cañizo, PSI Education Support Specialist, right, discusses upcoming planetary science workshops with Gwyn Ungermann, a teacher at Thornydale Elementary School in Marana Unified School District. *Photo: Alan Fischer*

Hundreds of Tucson area teachers learned about educational opportunities presented by the Planetary Science Institute at a Teacher Appreciation Night, held at the Arizona-Sonora Desert Museum, August 28.

Thea Cañizo, PSI Education Support Specialist, discussed upcoming PSI workshops that help teachers instruct students on a variety of planetary science topics. Some teachers who had attended earlier workshops stopped by the PSI display to say hello.

PSI's display featured a meteorite kit containing samples from meteorites found on Earth. A sliver of material from a Martian meteorite was popular with the teachers.

"This event was great. We spoke with many teachers interested in learning more about planetary science and a large number of teachers signed up to be notified of future teacher workshops," Cañizo said. "Events like Teacher Appreciation Night at the Arizona-Sonora Desert Museum help boost PSI's education and public outreach efforts."

Debra Colodner, education director at the Arizona-Sonora Desert Museum, termed the event a big success, with more than 340 people attending despite seasonal thunderstorms. □

Teachers lined up to learn about educational opportunities offered by PSI at Teacher Appreciation Night held at the Arizona-Sonora Desert Museum. *Photo: Alan Fischer*

Dorothy August, right, a teacher at Myers/Ganoung Elementary School, checks out a sliver of material from a Martian meteorite as Thea Cañizo explains the specimen. *Photo: Alan Fischer*

Director's Note: *PSI's Future is Bright*

Over the past several years, PSI has been growing and expanding without interruption — and so is our vision of the Institute's future. We are reaching out to the public through our new membership program, expanding our education programs particularly in the area of teacher training (see article above), and our science is covering more and more areas of solar system exploration.

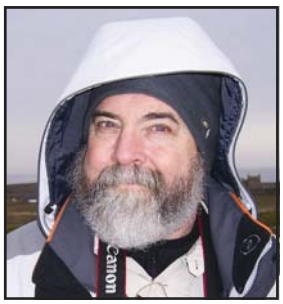
A significant fraction of our scientists work in their home offices around the country and the world. We want to be the best model of a company with such a distributed workforce and are continually investing in our communications infrastructure, such as increasing our video connectivity.

And, in a few years we hope to begin a capital campaign to build a permanent home for the Institute — one that will be a local architectural landmark and a model of environmental design principles that address the challenges of living and working in a desert while demonstrating cost-effective technologies for sustainability.

Within a few years, PSI will also be engaged in human space exploration! We will begin flights of the Atsa Suborbital Observatory, a human-tended telescope that will fly on a commercial spacecraft. It is being designed by, and will be operated in space by, PSI Senior Scientist Faith Vilas and co-designer Luke Sollitt of the Citadel. I intend to go through suborbital flight testing myself and travel into space as an operator — how could one not want to do that!

In addition, we are looking into partnering with Capitol College, which runs a very cool satellite operations center manned by students, with the idea of extending the lives and usefulness of NASA satellites while providing real-time student research and engineering experiences.

There are so many opportunities that are made possible by PSI's scientific strengths and administrative flexibility. From my perspective, there is no limit to what the future holds for us.



Mark V. Sykes
September 2010

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