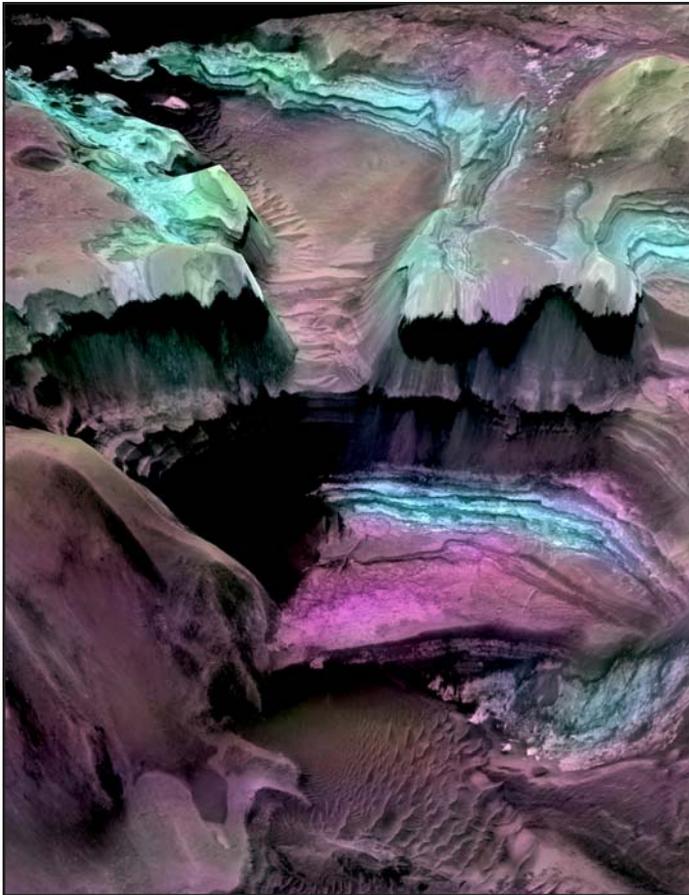


Young Clay Layers on Mars Could Have Been Habitable

by Alan D. Fischer



*This photograph, taken by the HiRISE camera, was featured on the cover of the October issue of *Geology*. It shows a depression, or trough, in the huge canyon system on Mars called Valles Marineris that was studied by PSI Scientist Cathy Weitz. This particular trough shows about 350 meters of elevation with the topography exaggerated to show the layers. To represent the different minerals detected, color was added to the image: sulfates appear blueish-green in color, while the clays appear reddish-pink. Typically on Mars, clays are older minerals found beneath younger sulfates. In this trough, and another that Weitz examined, there are clay mineral layers above the sulfates, indicating the clays are actually younger. This means that some localized areas on Mars like these troughs may have experienced active water processes that made them more habitable places in the recent geologic past when the rest of Mars was dry.*

Image credit: NASA/JPL/University of Arizona/The Johns Hopkins University Applied Physics Lab/Planetary Science Institute.

According to research by PSI Senior Scientist Cathy Weitz, two small depressions on Mars found to be rich in minerals that formed through water activity could have been places for life relatively recently in the planet's history. Weitz is lead author on the paper "Diverse mineralogies in two troughs of Noctis Labyrinthus, Mars" that was featured in the October issue of the journal *Geology*.

Weitz and her co-authors studied approximately 350 meters of vertically-exposed layered rocks within the 30- to 40-kilometer-wide depressions, called troughs, near the western end of the Valles Marineris canyon system on Mars. Finely-detailed images from the High Resolution Imaging Science Experiment (HiRISE) camera and hyperspectral data from the Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) on the Mars Reconnaissance Orbiter (MRO) spacecraft, were combined with digital terrain models to determine elevations and view geometric relationships between units. As a result, the team was able to map hydrated minerals and understand how the water chemistry varied with time within each trough, explained Weitz, a HiRISE team member.

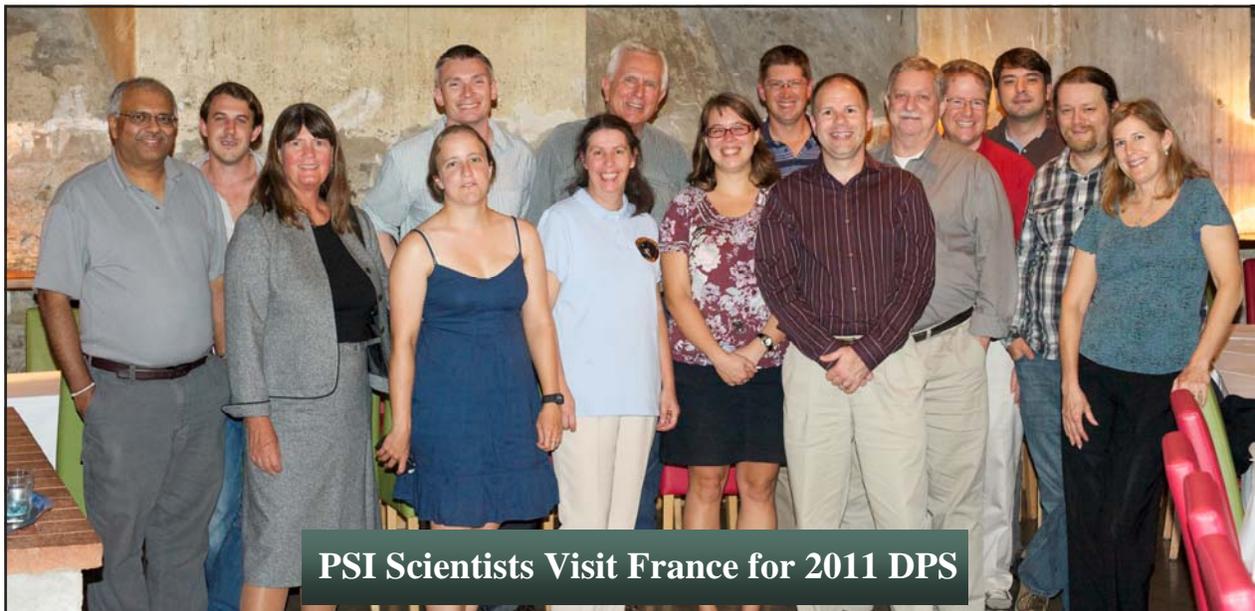
Each trough probably experienced multiple episodes where water partially filled low-lying regions and deposited or altered minerals. As each trough enlarged and experienced collapse over time, older minerals became buried and separated, followed by deposition of younger minerals, then finally erosion to re-expose buried units.

Activity from the Tharsis volcanoes to the west may have created subsurface water that was subsequently transported through the ground and into the troughs. Localized volcanic activity that produced ash and gases, hydrothermal activity, and melting snow/ice within the troughs could have also produced some of the minerals. The observed minerals indicate water varied in pH levels over time: in one trough from acidic to neutral, and in the other trough from neutral to acidic and back to neutral.

Continued on next page

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PSI scientists attended the Division of Planetary Sciences' annual October meeting held this year in Nantes, France. Our scientists, from Tucson unless otherwise indicated, l-r: Nalin Samarasinha, Joe Michalski (UK), Candy Hansen (UT), Susan Conway (U. Nantes), Henry Throop (DC), Beatrice Mueller, Bill Hartmann, Julie Rathbun (CA), Tyler Nordgren (Julie's husband), Paul Abell (guest from NASA), Keith Holsapple (WA), Jeff Morgenthaler (ME), Pasquale Tricarico, Tommy Grav (MD), and Carol Raymond (guest from JPL). (Photograph by Henry Throop)

Young Clay Layers on Mars *Continued from front page*

"We discovered locations at Noctis Labyrinthus that show many kinds of minerals that formed by water activity," said Weitz. "The clays we found, called iron/magnesium (Fe/Mg)-smectites, are much younger at Noctis Labyrinthus relative to those found in the ancient rocks on Mars, which indicates a different water environment in these depressions relative to what was happening elsewhere on Mars."

Smectites are a type of clay mineral that readily expands and contracts with adsorbed water. They contain silica, plus aluminum, iron or magnesium in their structures. They form via the alteration of other silicate minerals in the presence of non-acidic water.

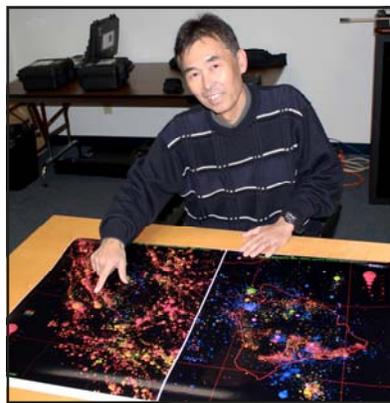
"These troughs would be fantastic places to send a rover, but unfortunately the rugged terrain makes it unsafe both for landing and for driving," Weitz said. She and her co-authors identified the same sulfates and Fe/Mg-smectites in the Noctis Labyrinthus troughs found elsewhere on Mars, but the progression of minerals over time, from sulfates to Fe/Mg-smectites, indicates a reverse order relative to what happened globally across Mars. Consequently, these two troughs are unique and could have been more habitable regions on Mars at a time when drier conditions dominated the surface.

The study was funded by grants to PSI from NASA, the Jet Propulsion Laboratory and the University of Arizona.

Prize-Winning Japanese Teacher Visits PSI

by Alan Fischer and Bill Hartmann

Yoshio Okamoto, a Japanese geophysicist and teacher, visited PSI on December 9, 2011. Okamoto adapted PSI's crater-counting technique for dating Mars to classroom use, and his class at Tennoji High School won a silver medal in an international competition (see PSI Newsletter, Fall 2011). The school is attached to Osaka Kyoiku University. Okamoto, with PSI's Sanlyn Buxner and Thea Cañizo, discussed PSI's Education/Public Outreach program and possible joint efforts.



Yoshio Okamoto (at left and below) shows PSI researchers Thea Cañizo, Sanlyn Buxner, Beatrice Mueller, and Bill Hartmann his three-dimensional mapping of earthquake epicenter locations. (Photographs by Alan Fischer)





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Alan Fischer, *Contributing Science Writer/Photographer*
Amy Hartmann-Gordon, *Friends of PSI Update*

With special thanks to Emily Joseph, Carol Neese, and Elaine Owens

Brent Garry: PSI Scientist/NASA Desert RAT

In December 2011 at Johnson Space Center in Houston, NASA's Desert Research and Technology Studies (Desert RATS) program tested vehicles and techniques for exploring a near-Earth asteroid. Two crew members, NASA Astronaut Mike Gernhardt and PSI Research Scientist Brent Garry, lived and worked in the next-generation space exploration vehicle on a three-day simulated test mission to an asteroid. During the test, the crew evaluated several different simulators, including virtual reality, the ARGOS system, and docking on an air-bearing floor. NASA plans to send humans to a near-Earth asteroid in 2025. The only experience we have of humans exploring another planetary body is from the Apollo missions to the Moon, 1969-1972. The goal of NASA's Desert

RATS is to test concepts of space vehicles, robots, and exploration techniques now so that we will be ready to go when the time comes to launch astronauts to the surface of another planetary body.



The Multi-Mission Space Exploration Vehicle (MMSEV) above, seen here in Building 9 at the Johnson Space

Center, is the second-generation prototype vehicle designed for planetary exploration. The crew practiced docking the MMSEV on an air-bearing floor. The MMSEV floats on a cushion of air as thrusters at the base of the vehicle move it around the floor. At right, Brent is trained on the control systems of the MMSEV. A computer simulation of the asteroid is projected outside the front windows.



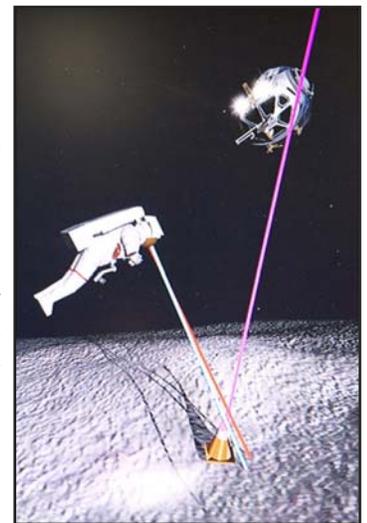
Brent conducts a geologic sampling of a boulder, below, using the horizontal harness on ARGOS at the space center. The ARGOS system responds to a user's actions allowing them to "float" around in micro-gravity. ARGOS was used to simulate spacewalks on the surface of an asteroid during the test.



Photographs credited to NASA.



The Virtual Reality Lab (VRL) is used by NASA astronauts to train for EVAs (extra-vehicular activities) on the International Space Station. During the Desert RATS test, the lab was used to conduct "spacewalks" on the "asteroid." At left, Brent is hooked into the VRL system. The headgear responds to motions as you look around the environment and the gloves respond to hand motions so that the user can grab onto objects. On the chest plate are the controls for SAFER (Simplified Aid for EVA Rescue), a mini-jetpack, that is used to fly around the surface. Below right is a view of the MMSEV and a crew member on an EVA in the virtual reality environment. Both crew members could communicate with and see each other in the virtual environment.



Brent joined PSI in 2010 as a Research Scientist after completing a post-doctoral fellowship at the Center for Earth and Planetary Studies at the Smithsonian Institution's National Air and Space Museum. He finished his Ph.D. at the University at Buffalo, New York (2006) and holds a B.S. in Geology from the College of William and Mary, Virginia (1999), and an M.S. in Geology from the University of Kentucky (2001).

When he is not being a Desert RAT, the focus of Brent's research is on the emplacement of lava flows on Earth, the Moon, and Mars. His current research projects primarily focus on lunar volcanism and studies of lava flows in Hawai'i and New Mexico. As a member of the Lunar Reconnaissance Orbiter Camera (LROC) science team, he is studying the formation of long lava flows in Mare Imbrium and the formation of the largest lunar sinuous rille, Vallis Schröteri. Recently selected as a Participating Scientist on the Dawn Mission, he will help unravel the volcanic evolution of the asteroid Vesta.

In addition to volcanoes, Brent is interested in the human exploration of space. This passion was fostered through watching space shuttle launches in the early 1980s while living in Florida and while working as a counselor at Space Camp in Huntsville, Alabama, in 2000. Also with the NASA Desert RATS team in 2008 and 2009, he served as the crew geologist on a lunar mission simulation where he lived inside the Lunar Electric Rover (LER) for 3 days and 14 days, respectively, in Arizona.

When not in the field, Brent enjoys SCUBA diving, watching movies, and teaching kids about space exploration.

A belated but very warm "Welcome to PSI!" to Desert RAT Brent Garry!

Henry Throop Brings his Talents to PSI



Henry Throop joined PSI in May 2011 as a Senior Scientist. Before coming to PSI, Throop spent ten years at Southwest Research Institute (SWRI) in Boulder, Colorado. Henry brings a diverse background to PSI, studying topics from Jupiter's rings and organic molecules to supernovae and star formation.

Soon after joining PSI, Henry received nearly \$270K in funding for a new grant from NASA's Astrophysics Theory Program. That work involves modeling the earliest stages of planet formation. As he puts it, "most existing models for making the solar system assume you have the Sun, isolated, just one lonely star. But as we look up in the sky, we see that most stars actually form in big clusters, with thousands of stars competing for the same gas and dust. It's this big competition, and it's so different from just one solitary system. In fact, our Sun probably formed in a group of thousands of other stars, so in addition to learning about other planets in this work, we're learning about our own."

Another major area of Henry's research is planetary rings. He was involved with Cassini's flyby of the Jupiter system and was the first discover of "clumps" of material moving within these rings. His research, funded through the NASA Outer Planets program, will continue studies of the Jupiter ring, as observed by the New Horizons flyby in 2006. "Astronomers used to think that rings would stay exactly like they are for millions of years, never changing. But now, with all the great spacecraft that have flown past Jupiter recently, we see that the ring keeps changing. We're trying to figure out why."

Director's Note

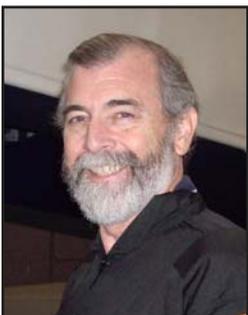
Forty years ago, in the early days of solar system exploration, a group of young scientists with backgrounds in astronomy, geology, and dynamics decided to form an institute run by scientists for the benefit of scientists in this exciting new field. The Planetary Science Institute was born in Tucson, Arizona, where its peculiarly egalitarian culture was nurtured and has thrived.

Today we have spread to seventeen states, the District of Columbia and several other countries, taking our culture with us. Two of our founders, Bill Hartmann and Don Davis, and an early member, Stu Weidenschilling, continue to actively push the boundaries of our knowledge of the solar system. PSI has come a long way since it started around the desk in Bill's living room, and our

horizons and ambitions have only gotten bigger over the decades.

Happy Birthday PSI!

Mark V. Sykes
January, 2012



Henry continues to work on one major SWRI project: the New Horizons mission to Pluto. On that mission, set to fly past Pluto on July 14, 2015, he will be using the spacecraft to search for new rings and satellites hidden within the Pluto system. Henry was involved with the construction and calibration of the spacecraft, and fondly remembers watching its 2006 launch from the Cape.

Henry also recalls his years living in Mexico City as his most exciting life adventure. Henry spent two years on sabbatical from SWRI at the National Autonomous University of Mexico, a campus of 300,000 students in a city of 26 million. His partner Heidi works for the US Department of State, and was posted to the US Embassy in Mexico City. At the university, he worked with several students and faculty, and gave regular talks about his research at local K-12 schools. "Mexico City has these beautiful canals where you can hire boats. There are floating taco boats, flower boats, mariachi boats, floating photographers... it's packed with Mexicans on Saturday afternoons and it's awesome." Henry spent many weekends exploring bat-filled Mayan ruins, searching for whales, getting lost on the Metro, diving caves, longboarding, and finding edible insects across the various corners of Mexico.

Henry was born in Australia to wanderlust-filled parents, and grew up in Corvallis, Oregon. After attending Grinnell College in Iowa, he received his PhD in Astronomy from the University of Colorado, Boulder. As a Principal Investigator, he has received over \$1M in NASA funding. He currently lives in Washington, D.C. with his two children: Piper is nine and strongly believes that Pluto is a planet, and Finn is two and likes fire trucks.

Henry was an active climber and mountaineer in Colorado and he misses that in DC. He enjoys photography and posts many pictures on his website at <http://www.eaubergine.com/images>.

Another talented and interesting scientist has been added to PSI. Welcome aboard, Henry!

2012 Upcoming Events with PSI

March 8 <i>8am-7pm</i>	Youth Engineering and Science Fair	Windemere Hotel Sierra Vista, AZ
March 14 <i>5:30-8pm</i>	SARSEF Future Innovators Night	Tucson Convention Center
March 31 <i>10am-1pm</i>	From Dinosaurs to Nanotechnology	Children's Museum Tucson
April 13 <i>5-9pm</i>	Yuri's Night	Pima Air and Space Museum, Tucson
April 18 <i>9am-1pm</i>	Pima College Earth Day	PCC Northwest Campus, Tucson
April 26 <i>6pm</i>	2nd Annual PSI Dinner	Westward Look Resort, Tucson
May 20 <i>Afternoon</i>	Solar Eclipse	Children's Museum Tucson
June 5 <i>Evening</i>	Venus Transit	Location: to be Announced
June 19 <i>Evening</i>	40th Anniversary Reception	Cosmos Club Washington, DC

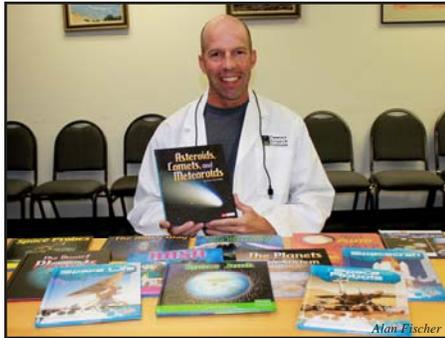
Additional information available on our website: www.psi.edu

Congratulations

Kortenkamp's 20th Children's Science Book

by Alan Fischer

PSI Senior Scientist Steve Kortenkamp reached a literary milestone last fall when his 20th children's science book "Asteroids, Comets, and Meteoroids" was published. Beginning in 2007 with his first book, the controversial and acclaimed "Why Isn't Pluto a Planet?", Kortenkamp has written books on an array of space science topics including the Milky Way, space robots, dwarf planets, NASA, space junk, and planets of our solar system.



The peer-reviewed books are published by Capstone Press for grades K-5. "Kids like space, and these books get them reading," Kortenkamp said. "Each of my books addresses national and state education standards in Earth and space sciences." Thus far, six of Kortenkamp's books have been incorporated into the Accelerated Reader program used in elementary schools nationwide.

"Why Isn't Pluto a Planet?" has proven his most popular title, reaching a peak of No. 6 on amazon.com's rankings for all children's astronomy and space books. Kortenkamp started out as a book consultant for Capstone Press in 2004 and worked on more than a dozen titles. Impressed with his comments and suggestions, the editors at Capstone eventually asked Kortenkamp to begin writing the books himself. Kortenkamp hopes to continue his prolific literary output. "I'm trying to interest Capstone in books about rings, satellites and space dust," he said.

His favorite title is still his first: "Why Isn't Pluto a Planet?" "This is a controversial topic with older generations," he said. "But kids in school nowadays are learning from the Pluto controversy that science is about discovering new things and that it is okay to change your mind when you learn something new."

The books are available at amazon.com.



Yes, it's true, after a 40-year-long engagement, Chris Holmberg (PSI Newsletter Editor) and Pete Kasper threw caution to the wind and became husband and wife in November 2011. Fingers crossed!

Williams Selected as Participating Scientist on Mars Science Laboratory Mission

by Emily Joseph and Rebecca Williams

Congratulations to PSI Senior Scientist Becky Williams for being selected as an MSL Participating Scientist. Becky joins PSI Senior Scientists Aileen Yingst and David Vaniman as members of the MSL Science Team.



The Mars Science Laboratory (MSL) was launched from Cape Canaveral on November 26, 2011. The spacecraft is carrying a rover named Curiosity that is about the size of a small SUV and contains scientific instruments from all over the world. The spacecraft is scheduled to reach Mars on August 5 of this year, and will land near a mountain in Gale Crater, a 96-mile-wide impact close to the Martian equator.

Once the rover lands, Williams, Yingst, Vaniman and an additional 300-plus scientists will begin the search for clues that could divulge whether Mars ever had an environment capable of sustaining life. As a Participating Scientist, Dr. Williams will conduct experiments and help with the daily operational duties of the rover during its 23-month mission on the martian surface. Working with data obtained from the cameras on Curiosity, her research focus will be to determine the magnitude and duration of water flow events in forming the landscape at Gale crater.

The proposal, titled "Investigation of the Aqueous History at the Mars Science Laboratory Landing Site," was one of 22 US investigations selected out of 149 total proposals submitted. This marks Williams' fourth Mars mission, but first exploration from the ground.

PSI Scientists Witness Launch of MSL



NASA launched the Mars Science Laboratory on November 26, 2011 headed for a landing on Mars in August 2012 where it will release its newest rover named Curiosity. At right, PSI Scientists Henry Throop, Rebecca Williams, Cathy Weitz and Melissa Lane gather at about T-20 minutes in a viewing area at Kennedy Space Center next to the shuttle vehicle assembly building (VAB). MSL itself is at launch complex 41 just off to the right, several miles away.

(Photographs by Henry Throop)



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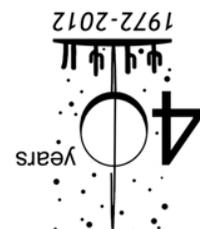
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