



The Lunar and Planetary Institute
presents its:

50th Anniversary Science Symposium

March 17, 2018

USRA - Lunar and Planetary Institute
3600 Bay Area Boulevard
Houston, TX 77058

***Inspiration and Exploration
Since 1968***



Dear Friends and Colleagues,

It is my great pleasure to welcome you to our 50th Anniversary Science Symposium. The original Lunar Science Institute (LSI) was established in 1968 to provide a base for non-NASA scientists, encouraging them to visit the Manned Spacecraft Center in Houston, and use its laboratories, lunar photographs, and rock samples. President Lyndon Johnson announced the formation of the LSI during a historic speech, in which he noted that *“This new institute is a center of research designed specifically for the age of space.....we will strengthen the co-operation between NASA and our universities. And we will set new patterns of scientific co-operation which will have profound effects on man’s knowledge of his universe.”*

This institute has been fulfilling President Johnson’s charge ever since. After Apollo, NASA asked the institute to expand its portfolio to the entire Solar System, and in 1978 the Lunar Science Institute (LSI) became the Lunar and Planetary Institute (LPI). The current LPI provides an academic atmosphere that serves as a focal point for lunar and planetary science activities, and as a forum to encourage participation of US and international scientists in NASA’s Planetary Science Division programs. We continue to maintain a close working relationship with the Johnson Space Center, especially the Astromaterials Research and Exploration Science (ARES) Division.

This Symposium has two goals: first, to highlight some of the exciting discoveries that have been made during the last five decades of planetary exploration; and second, to celebrate the LPI’s contributions during this time.

I would like to thank all of our speakers and moderators for contributing their time and expertise so that we can present this interesting and diverse program. Finally, my greatest appreciation and thanks go to the staff at the LPI who have worked so hard to make this event a reality; I am honored to be a part of this terrific team.

We hope you enjoy the program,

A handwritten signature in cursive script that reads "Louise".

Louise M. Prockter
10th LPI Director



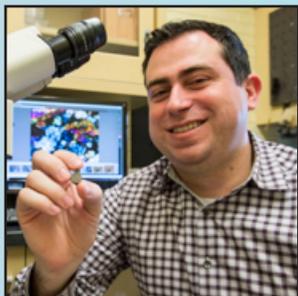
LPI 50TH ANNIVERSARY SCIENCE SYMPOSIUM			
Time	Name	Institution	Title
Session 1 Moderator: Louise Prockter			
10:00	Louise Prockter	LPI	Welcome and Logistics
10:05	Jeff Isaacson	USRA	Welcome from USRA
10:15	Jim Green	NASA HQ	Overview: Fifty Years of Planetary Science at NASA
Session 2 Moderator: Steve Mackwell			
10:30	Sean Solomon	Lamont Doherty	Mercury: From Mariner to MESSENGER
10:50	Lori Glaze	NASA GSFC	Venus: Reflections and Looking Ahead
11:10	Paul Spudis	LPI	Revealing the Moon: Fifty Years of Discovery at the Lunar Science (and Planetary) Institute
11:30	Justin Filiberto	SIU	Comparative Planetary Petrology: Basaltic Rocks Through the Inner Solar System
11:50	David Kring	LPI	The Discovery of the K-T Boundary Chicxulub Impact Crater
12:10	Lunch		
Session 3 Moderator: David Black			
1:15	Eileen Stansbery	NASA JSC/ARES	History: The JSC-LPI Connection
1:30	Scott Murchie	JHU/APL	Mars Revealed by 50 Years of Robotic Exploration
1:50	Tracy Gregg	SUNY Buffalo	Exploring Eruptions in the Solar System: 50 Years and 256 Shades of Gray
2:10	Kevin Righter	NASA JSC/ARES	Scientific Highlights of Four Decades of Antarctic Meteorite Collection, Curation and Analysis
2:30	Jessica Sunshine	U. Maryland	From Dirty Snowballs to Geologic Wonders: Comets 50+ Years Later
2:50	Lindsay Keller	NASA JSC/ARES	Dust from Comets: A Window to the Early Solar System
3:10	Break		
Session 4 Moderator: Louise Prockter			
3:40	Steve Mackwell	USRA	History: The LPI Intern Program
3:50	Renu Malhotra	U. Arizona	Planet Migration in the Solar system - A New Paradigm and its LPI Origins
4:10	Geoff Collins	Wheaton College	From Icy Moons to Ocean Worlds: 50 Years of Outer Solar System Geology
4:30	Paul Schenk	LPI	Pluto Explored: The LPI Contribution
4:50	Pete Schultz	Brown U.	From Laboratory to Planetary Impact Experiments
5:10	Sue Lederer	NASA JSC/ARES	The Ultracool TRAPPIST-1 System: 7 Terrestrial Worlds, 7 Chances for Ice and Life
5:30	CLOSING REMARKS – Thomas Zurbuchen, Associate Administrator, NASA Science Mission Directorate		
5:45	Adjourn for Reception (6-8 pm)		

Geoffrey C. Collins



Dr. Geoffrey Collins began his interplanetary journey as a summer intern at the LPI, working with Paul Schenk on Triton ridge tectonics from fresh Voyager 2 data. He continued on to graduate school at Brown to work with Jim Head to collect and analyze Galileo imaging data at Ganymede. Since 2000, Collins has been a professor of geology at Wheaton College in Massachusetts, where he currently holds the Jennings Chair in the Natural Sciences. Over the past two decades he has worked to understand the geology and geophysics of several ocean worlds, including Ganymede, Europa, Enceladus, Titan, and Pluto. He is a member of the Europa Imaging System team, and currently co-chairs the Geology Working group for the Europa Clipper mission. Originally from the upper Midwest, he is now at home in the Boston suburbs with his wife and two teenage kids.

Justin Filiberto



Dr. Justin Filiberto is an Associate Professor of planetary petrology at Southern Illinois University Carbondale, and a visiting research fellow at the Open University in the United Kingdom. He earned his B.S. in Marine Science and Geology from University of Miami and his Ph.D. in petrology and geochemistry from SUNY Stony Brook University. After his Ph.D., Filiberto joined the Lunar and Planetary Institute as a postdoctoral fellow to investigate volatiles in Martian magmas. In 2008 he helped run the 40th anniversary seminar series celebration! He then moved to Rice University as a postdoctoral fellow but continued as a visiting research scientist at the LPI. In 2011 he secured his faculty position at SIU. Filiberto's book, *Volatiles in the Martian Crust*, edited along with fellow LPI postdoc alumni and current visiting scientist Susanne Schwenzer, reflects his main research focus and is due out this May published by Elsevier.

Lori S. Glaze



Dr. Lori Glaze was a Graduate Fellow at the LPI in 1988 while working on her Master's degree at the University of Texas, Arlington. While at LPI, she worked closely with Peter Francis on remote sensing of active terrestrial volcanoes. After completing her Ph.D. at Lancaster University in the UK, she went on to work at JPL, Proxemy Research, and NASA's Goddard Space Flight Center, where she is currently Chief of the Planetary Geology, Geophysics, and Geochemistry Laboratory. Over the last ten years, Glaze has focused on promoting Venus exploration by serving as Chair of the Venus Exploration Analysis Group and playing key roles on multiple Venus mission concept studies, including the 2009 Venus Flagship study and three missions studied as part of the 2010 Planetary Decadal Survey. She has participated in several Venus proposals submitted to NASA's Discovery and New Frontiers programs, most recently as the Principal Investigator of the DAVINCI and VICI missions.

James L. Green



Dr. Jim Green received his Ph.D. in Space Physics from the University of Iowa in 1979 and began working at NASA's Marshall Space Flight Center. At MSFC he developed and managed NASA's first Internet, the Space Physics Analysis Network and worked on the Dynamics Explorer mission. In 1985 he moved to Goddard Space Flight Center where he served as head of the National Space Science Data Center and then Chief of the Space Science Data Operations Office. In August 2006, Jim became the Director of the Planetary Science Division at NASA Headquarters. Under his leadership, several missions have been successfully executed, including the New Horizons spacecraft flyby of Pluto, the MESSENGER spacecraft to Mercury, the Juno spacecraft to Jupiter, the Grail spacecraft to the Moon, the Dawn spacecraft to Vesta and Ceres, and the landing of the Curiosity rover on Mars, just to name a few. He has written over 115 scientific papers in refereed journals and over 50 technical articles.

Tracy K. P. Gregg

Professor Tracy Gregg (“Dr. G.” to her students) has been part of the volcanology group in the Geology Department at the University at Buffalo since 1998. She grew up in Iowa, where there are neither obvious rocks nor volcanoes. Her first foray into planetary geology was taking GEO 5 (“Mars, Moon and Earth”) from Jim Head, followed quickly by learning about impact craters from Pete Schultz in GEO 81 (“Planetary Geology”) at Brown University, where she received her Sc.B. in 1990 (and during which time was an LPI intern). Gregg worked with Ron Greeley and Jon Fink at Arizona State University, earning a Ph.D. in 1995. She then spent 3 years at the Woods Hole Oceanographic Institute, applying remote sensing and modeling techniques to mid-ocean ridge eruptions. After having a son, Gregg decided that she didn’t like spending several months each year at sea, and happily moved to Buffalo. She managed to earn tenure while raising a young family. During 2008-9, she was a distinguished speaker for the National Association of Geoscience Teachers, tasked with teaching instructors how to incorporate planetary science into their core geoscience courses. Significantly, Gregg turns 50 this year, too.



Jeffrey A. Isaacson

Dr. Jeff Isaacson is the President and Chief Executive Officer of Universities Space Research Association (USRA). Isaacson’s career spans both industry and the nonprofit sector, and includes experience in engaging academia and the broader scientific and technical communities in support of national objectives. Prior to joining USRA, he was Vice President for Defense Systems and Assessments at Sandia National Laboratories. Much of Isaacson’s career has been at RAND Corporation, where he held a variety of research and management positions including Vice President and Director of the Arroyo Center, the U.S. Army’s federally funded research and development center for studies and analysis. Isaacson also worked at Lockheed Martin Space Systems where he directed systems engineering and integration of the Space Based Infrared System-High. Isaacson earned degrees at Columbia University, Princeton University, and the Massachusetts Institute of Technology, where he received his Ph.D. in theoretical physics. He is a member of the Army Science Board and a veteran of Operation Enduring Freedom, having served in Afghanistan as a mobilized reservist.



Lindsay P. Keller

Dr. Lindsay P. Keller is a Space Scientist at the NASA Johnson Space Center. He completed his Ph.D. in Geology (1989) at Arizona State University and joined NASA in 2000. He was a Co-Investigator on the NASA’s Stardust Mission and currently is a Co-Investigator on the OSIRIS-REx mission on its way to collect and return samples from asteroid Bennu. Keller’s research interests include the nature and origin of early solar system materials (comets) and interstellar dust, the mineralogy of meteorites, and the space weathering of lunar and asteroidal regolith samples. These materials are studied using high-resolution transmission electron microscopes to make mineralogical and chemical measurements at the atomic scale. The mineralogy and chemistry data are combined with isotopic and spectroscopic measurements to maximize the science return from these precious tiny dust samples.



David A. Kring

Dr. David Kring’s research explores the origin of the solar nebula and its evolution into a geologically active planetary system; the geologic history of the Earth, Moon, Mars, and several smaller planetary bodies; impact cratering on the Earth, its effect on Earth’s environment, and its possible role in the biological evolution of our planet; and the chemical and physical properties of meteorites. He has worked extensively with the Chicxulub impact crater, which his team linked to the Cretaceous-Tertiary mass extinction event. Kring is currently a senior staff scientist at the LPI, but first came to the institute as a summer intern in 1983. He was formerly a Professor at the University of Arizona, where he was the Founding Director of the University of Arizona Meteorite Recovery Program. Kring is a Fellow of the Geological Society of America and the Meteoritical Society. He is currently integrating his field experience in impact-cratered terrains with his analytical experience of Apollo, Luna, and lunar meteorite sample collections from the Moon to lead the development of spacecraft missions in response to the President’s lunar exploration initiative.



Susan M. Lederer



Dr. Susan Lederer is a Planetary & Space Scientist at NASA JSC. She was involved in the Japanese spacecraft mission Hayabusa to asteroid Itokawa, and was part of an international team of scientists who studied Comet Tempel 1, the target of the Deep Impact Spacecraft mission. She conducts hypervelocity impact experiments that were inspired by these missions, using NASA's Experimental Impact Laboratory at Johnson Space Center to learn how collisions on asteroids and comets affect their surfaces. As part of NASA's Orbital Debris Program Office, she studies non-functional spacecraft and fragments generated by collisions, explosions, or shedding. A former LPI Visiting Scientist, Lederer is also a ground-based astronomer who was the NASA PI for the infrared telescope UKIRT on Mauna Kea for several years. She is PI of MCAT, an optical telescope on Ascension Island that she helped build and is now tasked for debris observations. Lederer is very humbled to have been part of an amazing international team that discovered the seven TRAPPIST-1 Earth-like exoplanets. To date, the team has collected data of TRAPPIST-1 with 9 ground-based telescopes situated across the globe, and NASA's Hubble, Spitzer, and Kepler space-based telescopes.

Stephen J. Mackwell



Dr. Stephen Mackwell is the Corporate Director, Science Programs, at the Universities Space Research Association in Columbia, Maryland. He received a B.Sc. in Physics and Mathematics and M.Sc. in Astrophysics from the University of Canterbury in New Zealand and Ph.D. in Geophysics from the Australian National University. He was a Postdoctoral Fellow in the Department of Materials Science and Engineering at Cornell University, then faculty in Geosciences at the Pennsylvania State University. In 1998, he moved to the Bayerisches Geoinstitut in Bayreuth, Germany, where he was Professor and Institute Director. Mackwell was USRA's Director of the Lunar and Planetary Institute in Houston, Texas, from 2002 until 2016. He is an Adjunct Professor in the Department of Earth Science at Rice University. Mackwell is an experimental geophysicist, studying the mechanical and chemical properties of planetary materials at high-temperatures and pressures. He has published more than 75 refereed papers in respected international journals. He is a Fellow of the American Geophysical Union, the American Association for the Advancement of Science, and the Mineralogical Society of America.

Renu Malhotra



Dr. Renu Malhotra is Louise Foucar Marshall Science Research Professor and Regents' Professor of Planetary Sciences at The University of Arizona in Tucson, where she directed the Theoretical Astrophysics Program during 2011-2016. She was born in New Delhi and grew up in Hyderabad, India. She earned her M.S. in Physics from the Indian Institute of Technology in Delhi in 1983, and her Ph.D. in Physics from Cornell University in 1988. She did post-doctoral research at Cornell and at Caltech, and worked as a staff scientist at the Lunar and Planetary Institute in Houston. Malhotra's work in planetary dynamics has spanned a wide variety of topics, including extra-solar planets and debris disks around nearby stars, the formation and evolution of the Kuiper belt and the asteroid belt, the orbital resonances amongst the moons of the giant planets, and the meteoritic bombardment history of the planets. She has revolutionized our understanding of the history of the solar system by using the orbital resonance between Pluto and Neptune to infer large-scale orbital migration of the giant planets and to predict the existence of the "Plutinos" and other small planets in resonance with Neptune. Malhotra is an elected member of the National Academy of Sciences and of the American Academy of Arts and Sciences.

Scott L. Murchie



Dr. Scott Murchie is the Supervisor of the Planetary Exploration Group at The Johns Hopkins University Applied Physics Laboratory in Laurel, Maryland. His research focuses on the stratigraphy and formation of planetary crusts, how planetary crusts incorporate and are modified by volatiles, and the composition and geologic processes of asteroids and planetary moons. His research combines imaging and spectroscopy. A former LPI staff scientist, Murchie was a Participating Scientist on Mars Pathfinder and a Co-Investigator on the NEAR mission. As a Co-Investigator on MESSENGER, he helped to conceive the overall mission concept, and played a leading role in design of the imaging and reflectance spectroscopic investigations of Mercury's crustal composition, stratigraphy, and evolution. As Principal Investigator of the CRISM imaging spectrometer on the Mars Reconnaissance Orbiter, he led design and implementation of the investigation, analysis of the data, and dissemination of CRISM data products, which have supported over 800 refereed publications on Mars climate and geologic history. Murchie won the NASA Distinguished Public Service medal in 2011, and is a Fellow of the American Geophysical Union.

Kevin Righter

Dr. Kevin Righter studied Geology at Bryn Mawr College (B.A.), the University of Michigan (M.S.), and the University of California Berkeley (Ph.D.). He landed an LPI Summer internship in 1987, spurring him on to field and experimental studies of planetary igneous rocks - pallasites and Mexican basalts. After spending 8 years with Mike Drake at the University of Arizona doing planetary geochemistry, Righter was lucky enough to be hired at NASA-Johnson Space Center (JSC). At JSC he is the Antarctic meteorite curator, OSIRIS-REx curation lead, and has established a high PT experimental petrology laboratory where he pursues research related to core formation and planetary magmatism.



Paul M. Schenk

A space-groupie since Gemini days in the mid 1960's, Dr. Paul Schenk's first formal introduction to planetary sciences was as a NASA Planetary Geology summer intern in 1979 at JPL during the Voyager 2 Jupiter encounter. Working for Voyager during one of its encounters was "a wondrous and unforgettable experience", and since 1992 Schenk has been a staff scientist at the LPI and an advisor for LPI's summer intern program. In 1988 he completed his Ph.D. at Washington University in St. Louis under Dr. William B. McKinnon. Since arriving at the LPI in 1991 he has used Voyager, Galileo, and Cassini stereo and monoscopic images to map the topography and geology of the icy outer planet satellites (and dabbled a bit on Mars and the Moon). Schenk is the author of *Atlas of the Galilean Satellites* (2011) and co-editor of *Enceladus and the Icy Moons of Saturn* (2018). Schenk is a Participating Scientist on the DAWN asteroid mission to Vesta and Ceres and on Cassini at Saturn, and is also a Co-Investigator on the New Horizons mission to Pluto and beyond, responsible for cartography and topography.



Peter H. Schultz

Dr. Pete Schultz's research focuses on impact cratering processes as revealed by laboratory impact experiments, the planetary surface record, and terrestrial ground truth. After receiving his Ph.D. from UT-Austin, Schultz went to NASA Ames as an NRC post-doctoral researcher, then became a Staff Scientist at LPI (1976-1984), and finally a Professor at Brown University. His laboratory research includes atmospheric effects on ejecta emplacement, impactor survival, secondary impact processes, antipodal shock effects, high-speed spectroscopy of impact vapor/plasma, impact angle effects (shock propagation, vaporization, target damage, and flow-field evolution), and crater-scaling relations. This basic research led to participation in several NASA planetary missions including Magellan, Deep Impact, Stardust-NExT, EPOXI, and LCROSS. On Earth, Schultz's research has included the distribution of ejecta around Meteor Crater, discovery of 8 impacts in Argentina, and documentation of a witnessed crater-forming impact in Peru in 2007. He served as the Science Coordinator for the NASA Ames Vertical Gun Range from 1980 to 2014, and was Director of the NASA Rhode Island Space Grant program.



Sean C. Solomon

Dr. Sean Solomon is Director of the Lamont-Doherty Earth Observatory at Columbia University, where he also serves as the Associate Director for Earth Systems Science at Columbia's Earth Institute and the William B. Ransford Professor of Earth and Planetary Science in the Department of Earth and Environmental Sciences. Before 2012, Solomon served for 19 years as Director of the Carnegie Institution's Department of Terrestrial Magnetism in Washington, D.C. From 1972 to 1992, Solomon was a member of the faculty of the Department of Earth, Atmospheric, and Planetary Sciences at the Massachusetts Institute of Technology. He holds a B.S. degree from Caltech and a Ph.D. from MIT. He served as Principal Investigator for the MESSENGER mission to Mercury and Co-Investigator on the Magellan mission to Venus, the Mars Global Surveyor mission, and the GRAIL mission to the Moon. Solomon is a member of the National Academy of Sciences and the American Academy of Arts and Sciences. He has received the Geological Society of America's G. K. Gilbert Award, the American Geophysical Union's Harry H. Hess Medal, NASA's Public Service Medal, and the National Academy's Arthur L. Day Prize. In 2014, Solomon was awarded the National Medal of Science by President Barack Obama. Solomon is a former LPI visiting scientist and currently chairs the LPI Science Council.



Paul D. Spudis



As a senior staff scientist at the LPI, Dr. Paul Spudis researches the geological history and evolution of the Moon and the impact processes and volcanism that have shaped its surface. Spudis was Deputy Leader of the Science Team for the Clementine mission, which mapped the Moon's topographic shape and surface color in the visible and near-infrared parts of the spectrum. He was the Principal Investigator of the Mini-SAR experiment on the Indian Chandrayaan-1 mission, which mapped the Moon from 2008-2009. The Mini-SAR imaging radar mapped the permanently dark regions of the poles and found reflections diagnostic of water ice deposits in permanently shadowed craters. Spudis is a Co-Investigator of the similar Mini-RF experiment, currently orbiting the Moon on NASA's Lunar Reconnaissance Orbiter. He is currently working on plans for follow-up robotic missions to the surface of the lunar poles to document the extent and variability of water ice there. Spudis has received several awards including the NASA Distinguished Service Award, the Theodore von Karman Medal from the American Institute of Aeronautics and Astronautics, and most recently, the Columbia Medal by the Aerospace Division of the American Society of Civil Engineers.

Eileen K. Stansbery



Dr. Eileen Stansbery currently serves as the Chief Scientist and the Deputy Director, Exploration Integration and Science at NASA's Johnson Space Center (JSC), where she provides advocacy and advice for science at the executive leadership level and is responsible for the direction and focus for exploration through research, strategy, mission planning, systems development & integration. Stansbery earned her doctorate in Space Physics from Rice University. Prior to joining NASA in 1992 she taught Physics at Houston Baptist University and was a Principal Engineer at Lockheed Engineering and Sciences Co. At NASA she played a major role in the Genesis Mission as the Mission Contamination Control Lead, Curation Scientist, and the JSC Project Manager. She also held the position of Director, Astromaterials Research and Exploration Science from 2008-2014. Her expertise includes space physics, contamination control, astromaterials curation, planetary protection, and strategic planning for planetary science. Stansbery has received many internal NASA awards including the Exceptional Service, Outstanding Leadership, and Equal Employment Opportunity Medals.

Jessica M. Sunshine



Dr. Jessica Sunshine is a Professor of Astronomy and Affiliate Professor of Geology at the University of Maryland, and a current member of the LPI Science Council. Her expertise is in the spectroscopy and geology of planetary surfaces with a particular emphasis on the composition of asteroids, meteorites, and comets. She was a Co-I on the Deep Impact and Stardust-NExT missions to comet Tempel 1 and Deputy PI for the Deep Impact eXtended Investigation (DIXI) to comet Hartley 2. Using the Deep Impact IR spectrometer, Sunshine has detected water ice on the surface and in the ejecta of Tempel 1. As a Co-I on the Moon Mineralogy Mapper (M3) spectrometer on-board Chandrayan-1, she was also part of the team that discovered hydration on the surface of the Moon. She was thrilled to be able to confirm this result with lunar data from the Deep Impact spectrometer that was collected in order to help calibrate the cometary observations. Sunshine has a ScB in Applied Mathematics and a MSc and Ph.D. in Geological Sciences from Brown University.

Thomas H. Zurbuchen



Dr. Thomas Zurbuchen is the Associate Administrator for the Science Mission Directorate at the Agency's Headquarters in Washington, D.C. Previously Zurbuchen was a professor of space science and aerospace engineering at the University of Michigan in Ann Arbor. He was also the university's founding director of the Center for Entrepreneurship in the College of Engineering. His experience includes research in solar and heliospheric physics, experimental space research, space systems, and innovation and entrepreneurship. During his career, Zurbuchen has authored or coauthored more than 200 articles in refereed journals on solar and heliospheric phenomena. He has been involved with several NASA science missions: Ulysses, the MESSENGER spacecraft to Mercury, and the Advanced Composition Explorer (ACE). He also has been part of two National Academy standing committees, as well as various science and technology definition teams for new NASA missions.

