

**ANNUAL PROGRESS REPORT  
of the  
Lunar and Planetary Institute  
Cooperative Agreement NNX08AC28A**

Stephen J. Mackwell, Ph.D.  
Principal Investigator



Submitted by  
Universities Space Research Association  
10211 Wincopin Circle, Suite 500  
Columbia, Maryland 21044

October 31, 2011

A handwritten signature in purple ink, appearing to read "S. Mackwell".

---

Stephen J. Mackwell Director  
Lunar and Planetary Institute

## Table of Contents

EXECUTIVE SUMMARY	3
Overview	3
Science Related Activities	3
Service	4
Education and Public Outreach (E/PO)	5
APPENDIX I: Peer-reviewed Publications	7
APPENDIX II: Scientific Staff - Conference Attendance and Abstracts Presented	16
APPENDIX III: Invited Presentations	33
APPENDIX IV: Funding	37
APPENDIX V: Scientific Staff - Service to NASA and the Scientific Community	47
APPENDIX VI: Summer Student Activities LPI/ NASA JSC Undergraduate Summer Intern Program	53
APPENDIX VII: Mentoring	54
APPENDIX VIII: Scientific Staff - Education/Public Outreach Activities	57
APPENDIX IX: Seminar Speakers	61
APPENDIX X: NASA Regional Planetary Image Facility and Library	63
APPENDIX XI: Meeting and Publication Services - Conferences and Workshops	65
APPENDIX XII: Department of Education and Public Outreach	67

## **EXECUTIVE SUMMARY**

### **Overview**

In the last twelve months, the Lunar and Planetary Institute (LPI) has continued its focus on scientific excellence both within the Institute and throughout the community. The LPI continues its strong support of NASA's research, outreach, and education programs, ranging from hosting a center of the NASA Lunar Science Institute team activities, to providing materials and speakers to town libraries. Of particular note, this year's efforts have resulted in record numbers of postdoctoral fellows (15), visiting scientists (2), and research interns (30).

### **Science Related Activities**

The Institute's scientific activities continue to grow. Science productivity at LPI remained high, with 53 peer-reviewed publications in the past year, and with 22 more peer-reviewed articles currently in press (Appendix I). Scientists and postdoctoral fellows were very active in professional meetings, with numerous oral and poster presentations (see Appendices II and III). Success at obtaining grants for scientific research from funding agencies remains high (Appendix IV), with over \$2M in PI external science grants. The largest single grant is the Cooperative Agreement for the LPI-JSC node of the NASA Lunar Science Institute (the Center for Lunar Science and Exploration), which includes and serves researchers at the LPI, NASA-JSC, universities across the country, and the Texas teaching consortium.

Scientific service to the NASA and scientific community remains strong, as demonstrated by the many activities included in Appendix V. The LPI was integral to the National Academy of Science's Decadal Survey of Planetary Science for NASA; Dr. Stephen Mackwell served on the steering committee and Inner Planets panel, and Dr. Allan Treiman served on the Inner Planets panel. Dr. Mackwell also served on the steering committee and Survey and Detection Panel for the Academy Committee to Review Near-Earth Object Surveys and Hazard Mitigation Strategies. LPI scientists also served on NASA science analysis groups, including CAPTEM, LEAG, MEPAG, OPAG, SBAG, and VEXAG. LPI scientists also contributed to NASA's grant review process, with service to the R&A Programs of: Planetary Geology and Geophysics, Cosmochemistry, Mars Fundamental Research, Lunar Advanced Science and Exploration Research, Origins, and Planetary Atmospheres.

The Institute continues to emphasize development and training of the next generation of planetary scientists, at undergraduate, graduate, and post-graduate levels. The LPI supported and sponsored 15 postdoctoral fellows and two visiting scientists, who worked at LPI and at JSC. Six post-doctoral fellows have 'graduated' from the LPI this period, and all have found continuing work in their research areas, mostly in permanent positions.

In the past year, the LPI hosted and sponsored a total of 30 summer interns and students (Appendix VI). Twelve of these summer participants were in the LPI/JSC Summer Undergraduate Intern program. Ten were graduate students in the Lunar Exploration Summer Interns program, created at the LPI to allow budding lunar scientist to work on science questions relevant to the Human Spaceflight Program (formerly Constellation Systems at JSC). Five other graduate and undergraduate students worked at the LPI under support from various PI grants and external

sources. Three of the students were from the India Institute of Technology (IIST), in a new intern program sponsored by the Indian Space Research Organization (ISRO). The students participated in research on lunar geology and remote sensing over a ten week period, advised by members of the LPI science staff. This intern program will continue to grow as we solidify our cooperation with the IIST and ISRO.

The LPI science staff has also mentored several undergraduate and graduate students, and young faculty members (Appendix VII).

LPI scientists participated in numerous Education and Public Outreach activities locally, nationally and internationally, as summarized in Appendices VIII & IX. Activities ranged across the full spectrum of target audiences and impact scales. At one end of the spectrum is development of the LPI Lunar Science and Engineering Portal, which aims to serve as the one-stop shop for scientific and engineering data relevant to lunar explorations. At the other end of the spectrum is Science Staff participation in local community events like Family Space Day at the LPI (targeted at elementary-age children, including home-schoolers).

LPI scientists have been active in space science missions and proposals with NASA and space agencies from around the world. LPI scientist Paul Spudis served as Instrument PI for the Mini-SAR instrument on the Indian Space Research Organization's **Chandrayaan-1** Lunar Orbiter. Chandrayaan-1 completed a successful mission this summer generating significant new data that the instrument team is currently working to process and interpret. Dr. Spudis is also Deputy Principal Investigator for the mini-RF radar instrument on NASA's **Lunar Reconnaissance Orbiter** (LRO), now returning data from the Moon. LPI scientists Walter Kiefer and Paul Schenk were selected as Participating Scientists for the **Dawn** spacecraft mission's encounter with Vesta slated for next year. Dr. Steve Clifford is Deputy Science Team Lead for the WISDOM VHF ground penetrating radar and the EISS HF ground penetrating radar for ESA's 2013 **ExoMars Mission** rover and lander respectively. Dr. Allan Treiman is a co-Investigator for the CheMin instrument, and Dr. Laurel Kirkland is a co-Investigator for the ChemCam instrument on the Mars Science Laboratory, set to launch in November 2011. Treiman was also a co-investigator on the **SAGE** mission proposal, a Venus atmosphere probe and Lander, which was in Phase A study. Five LPI scientists were participants in proposals for Discovery class spacecraft missions (submitted in Sept. 2010); Dr. Stephen Mackwell was Principal Investigator on one such proposal, a Venus orbiter.

This science staff of the LPI has been relatively stable the last year. Dr. Donald Bogard has continued to work at the LPI as a Heritage Fellow. Dr. Bogard is a distinguished and honored scientist, who worked for many years at JSC, first on the returned Apollo samples, and then on many aspects of solar system chronology. Dr. Virgil (Buck) Sharpton has returned part-time to the LPI to focus on his research activities, after stepping down as Vice Chancellor at the University of Alaska. He was recently designated by President Obama to serve as acting chair of the US Arctic Research Commission. He will transition in the coming year to full service on the science staff. As noted above, the LPI continues to place its post-doctoral fellows into permanent research positions in earth and planetary sciences.

## Service

The LPI service organization is responsible for a variety of functions, including conference and workshop coordination, publications, scientist resources such as the library, the NASA Regional Planetary Image Facility (Appendix X), the LPI website (<http://www.lpi.usra.edu/>), and a range of

electronic tools to enhance planetary science activities and effective communication within the planetary science community.

In 2011, the LPI meeting group organized 23 conferences and workshops for the planetary science community (Appendix XI). While many of these meetings were modest in size, a number of conferences had attendance exceeding 100 participants. This year marked the 42nd Lunar and Planetary Science Conference (LPSC), which was held for the third time at The Woodlands Waterway Marriott Hotel and Convention Center just north of Houston. The LPSC Program Committee Meeting again incorporated the latest video conferencing technology to include participation of committee members at remote sites, reducing travel costs. The online Program Committee System tool was enhanced providing an easy and intuitive interface for the committee members to arrange the session schedule and construct the final meeting program. The LPSC was attended by almost 1800 participants from 33 different countries, with students comprising more than one-fourth of the attendees. This year's LPSC was selected as the optimal forum for the first public release of the community-wide Planetary Science Decadal Survey Report, and a special evening event featured a presentation by Dr. Steve Squyres, Chair of the Decadal Survey Committee, followed by comments by Dr. Jim Green of NASA Headquarters. These presentations and a later press conference were streamed over the internet and reached over 5,200 unique viewers from 10 countries. In its fourth year, the LPI Career Development Awards attracted nearly 100 applications for 15 travel stipends. The winners of the stipends were again recruited to work at the poster session and registration desk, reducing staffing costs while providing the young scientists an opportunity to meet a large cross-section of the planetary science community.

The interactive Meeting Portal, designed to be a single point of access for LPI's meeting-related services, was expanded to allow users more opportunities to access meeting information, submit abstracts, register for conferences and workshops, and participate on program committees.

During this reporting period, Renée Dotson of the Meeting and Publication Services group completed prepress services for the production of the *Exoplanets* volume in the prestigious Space Science Series of the University of Arizona Press. Prepress services included copyediting, formatting, page layout, and compiling the index. *Exoplanets* was released in January 2011. The collaborative agreement between the University of Arizona Press and the LPI serves to keep the price of these invaluable volumes affordable to graduate students and other researchers. LPI staff completed three issues of the *Lunar and Planetary Information Bulletin*, a quarterly newsletter that provides updates to the planetary science community, educators, and the general public about the latest news from missions; resources for researchers; scientific awards; education and public outreach events; new books, DVDs, games and other products available from a variety of publishers; tributes to recently deceased members of the scientific community, and a calendar of upcoming scientific workshops and conferences.  
<http://www.lpi.usra.edu/publications/newsletters/lpib/>.

### **Education and Public Outreach (E/PO)**

The LPI Education Department has had a very successful year, with direct contacts to approximately 60,000 teachers, children and parents. The LPI only supports a small portion of the educational activities out of the funding provided by the Cooperative Agreement, as most activities are supported by outside funding.

In addition to managing the NLSI funded LPI-JSC team's education program, the LPI is also

leading the education efforts for the NLSI team based at the Southwest Research Institute (SwRI), and is collaborating with the Applied Physics Laboratory (Johns Hopkins University) on their education efforts. The LPI continues to collaborate with lunar scientists, educators, artists, and the public to engage a population of new lunar enthusiasts between 18 and 25 through the new media portal called MyMoon. The website has received positive reviews and continues to grow in popularity. More details of LPI's Education and public outreach efforts are included in Appendix XII.

## APPENDIX I: Peer-reviewed Publications

### Published

1. **Abramov, O.** and Mojzsis S.J., Abodes for life in carbonaceous asteroids?, *Icarus* 213, 273-279, 2011.
2. Bierhaus E.B, **Schenk P.M.**, Constraints on Europa's surface properties from primary and secondary crater morphology (2010) *JGR*, 115, 12004.
3. **Bogard D.D.**, (2011) K-Ar ages of meteorites: Clues to parent-body thermal histories. D.D. Bogard. *Chemie der Erde*. DOI:10.1016/j.chemer.2011.03.001.
4. Bussey D.B.J., McGovern J.A., **Spudis P.D.**, Neish C.D., Noda H., Ishihara Y., Sørensen S.-A. (2010) Illumination conditions of the south pole of the Moon derived using Kaguya topography. *Icarus* 208, 558-564.
5. Ciarletti V., Corbel C., Plettemeier D., Cais Ph., **Clifford S.M.**, Hamran S.E., WISDOM a GPR designed for shallow and high resolution sounding of the Martian subsurface, *Special Issue of the Proceedings of the IEEE on Solar System Radar and Radio Science*, 99, 824 – 836, May 2011.
6. Crawford I.A., Fagents S.A., **Joy K.H.**, Rumpf M.E. (2011). Lunar Palaeoregolith Deposits as Recorders of the Galactic Environment of the Solar System and Implications for Astrobiology. *Earth, Moon and Planets*. Vol. 107, pp. 75-85. DOI:10.1007/s11038-010-9358-z
7. Fairen, A.G., Chevrier V., **Abramov O.**, Marzo G.A., Gavin P., Davila A.F., Tornabene L.L., Bishop J.L., Roush T.L., Gross C., Kneissl T., Uceda E.R., Dohm J.M., Schulze-Makuch D., Rodriguez J.A.P., Amils R. and McKay C.P., Noachian and more recent phyllosilicates in impact craters on Mars, *Proc. Nat. Acad. Sci.*, 107, 12095-12100, 2010.
8. Filiberto J., Dasgupta R., **Kiefer W.S.**, Kirchoff M.R., and **Treiman A.H.** (2010) High pressure, near-liquidus phase equilibria of the Home Plate basalt Fastball and melting in the martian mantle. *Geophysical Research Letters* 37, L13201.
9. Filiberto J., Musselwhite D., **Gross J.**, Burgess K., Le L., and **Treiman A.H.** (2010) Experimental petrology, crystallization history, and parental magma characteristics of olivine-phyric shergottite NWA 1068: Implications for the petrogenesis of “enriched” olivine-phyric shergottites. *Meteoritics and Planetary Sciences* 45, 1258-1270. DOI: 10.1111/j.1945-5100.2010.01080.x.
10. **Galgana, G.A., P.J. McGovern**, and E.B. Grosfils. Evolution of large venusian volcanoes: Insights from coupled models of lithospheric flexure and magma reservoir pressurization, *J. Geophys. Res.*, 116, doi:10.1029/2010JE003654, 2011.
11. **Gross J., Treiman A.H.**, Filiberto J., and Herd C.D.K. (2010) Primitive olivine-phyric shergottite NWA 5789: Petrography, mineral chemistry and cooling history imply a magma similar to Yamato 980459. *Meteoritics and Planetary Sciences* 46, 116-133.

12. Guilbert A., **Lasue J.**, Federico C., Coradini A., Orosei R. (2011) New 3D thermal evolution model for small icy bodies. Application to Trans-Neptunian Objects, *Astronomy & Astrophysics* Vol. 529, A71, doi:10.1051/0004-6361/201014194, 2011.
13. Hadamcik E., Lvasseur-Regourd A.C., Renard J.B., **Lasue J.**, Sen A. (2011) Polarimetric observations and laboratory simulations of asteroidal surfaces : the case of 21-Lutetia, *JQSRT* Vol. 112, p. 1881–1890, 2011.
14. Hadamcik E., Renard J.B., Lvasseur-Regourd A.C., **Lasue J.** (2011) Laboratory measurements of the light scattered by clouds and layers of solid particles by an imaging technique, in: Proceedings of the NATO Advanced Study Institute on Special Detection Technique (Polarimetry) and Remote Sensing, Yalta, Ukraine 20 September – 1 October 2010, NATO Science for Peace and Security Series C: Environmental Security, Mishchenko, M.I.; Yatskiv, Y.S.; Rosenbush, V.K.; Videen, G. (Eds.), Springer, 137-176, 2011.
15. Herrin J.S, Zolensky M.E., **Ito M.**, Le L., Mittlefehldt D.W., Jenniskens P., and Shaddad M.H. (2010) Thermal and fragmentation history of ureilitic asteroids; Insights from the Almahata Sitta fall. *Meteoritics & Planetary Science*, 45, 1789-1803. DOI: 10.1111/j.1945-5100.2010.01136.x
16. **Ito M.** and Messenger S. (2010) Thermal metamorphic history of a Ca, Al-rich inclusion constrained by high spatial resolution Mg isotopic measurements with NanoSIMS 50L. *Meteoritics & Planetary Science*, 45, 583-595.
17. **Joy K.H.**, Crawford I.A., Grindrod P.M., Lintott C.J., Bamford S., Smith A. (2011a). The Moon Zoo Citizen Science Project. *Astronomy and Geophysics*. Vol. 52, pp. 2.10-2.12. DOI:10.1111/j.1468-4004.2011.52210.x
18. **Joy K.H.**, Burgess R., Hinton R., Fernandes V.A., Crawford I.A., Kearsley A.T., Irving A.J., EIMF (2011b). Petrogenesis and Chronology of Lunar Meteorite Northwest Africa 4472. *Geochimica et Cosmochimica Acta*. Vol. 75, pp. 2420-2452. DOI:10.1016/j.gca.2011.02.018.
19. Keefner J.W., **Mackwell S.J.**, Kohlstedt D.L., Heidelbach F. (2011) Dependence of the creep of dunite on oxygen fugacity: Implications for viscosity variations in Earth's mantle, *J. Geophys. Res.*, 116, B05201, doi:10.1029/2010JB00748
20. Kirchoff M.R., McKinnon, W.B., **Schenk P.M.**, (2011) Global distribution of volcanic centers and mountains on Io: Control by asthenospheric heating and implications for mountain formation (2011) *E&PSL*, 301, 22.
21. Kminek G., Rummel J.D., Cockell C.S., Atlas R., Barlow N., Beaty D., Boynton W., Carr M., **Clifford S.**, Conley C.A., Davila A.F., Debus A., Doran P., Hecht M., Heldmann J., Helbert J., Hipkin V., Horneck G., Kieft T.L., Klingelhofer G., Meyer M., Newsom H., Ori G.G., Parnell J., Prieur D., Raulin F., Schulze-Makuch D., Spry J.A., Stabekis P.E., Stackebrandt E., Vago J., Viso M., Voytek M., Wells L., Westall F., (2010) Report of the COSPAR mars special regions colloquium, *Advances in Space Research* 46, 811–829.

22. **Kramer G.Y.**, Combe J.-P., Harnett E., Hawke B.R., Blewett D., Noble S., Giguere T.A., McCord, T.B. (2011) Characterization of Lunar Swirls at Mare Ingenii: A Model for Space Weathering at Magnetic Anomalies. *J. Geophys. Res.* 116, E04008, doi:10.1029/2010JE003669
23. **Kramer G.Y.**, Besse S., Dhingra D., Nettles J., Klima R., Garrick-Bethell I., Clark R., Combe J.-P., Head J. III, Taylor L., Pieters C., Boardman J., and McCord T. M3 Spectral Analysis of Lunar Swirls and the Link between Optical Maturation and Surface Hydroxyl Formation at Magnetic Anomalies. *J. Geophys. Res.*, 116, E00G18, doi:10.1029/2010JE003729
24. Kumar P.S., Head III J.W., and **Kring D.A.** (2010) Erosional modification and gully formation at Meteor Crater, Arizona: Insights to crater degradation processes on Mars, *Icarus* 20, pp. 608-620.
25. **Lasue J.**, Botet R., Levasseur-Regourd A.C., Hadamcik E., Kofman W., (2011) Appearance of layered structures in numerical simulations of polydisperse bodies accretion: application to cometary nuclei.» *Icarus* Vol. 213, p. 369–381, 2011.
26. **Lasue J.**, Wiens R.C., Stepinski T.F., Forni O., Clegg S.M., Maurice S., and the ChemCam Team, (2011) Nonlinear mapping technique for visual inspection and clustering assessment of LIBS data: application to ChemCam data, *Analytical and Bioanalytical Chemistry* Vol. 400, p. 3247–3260, 2011.
27. McCord T.B., Taylor L., Combe J.-P., **Kramer G.**, Pieters C., Sunshine J., Clark, R. (2011) Sources and physical processes responsible for OH/H<sub>2</sub>O in the lunar soil discovered by the Moon Mineralogy Mapper (M3) *J. Geophys. Res.* 116, E00G05, doi:10.1029/2010JE003711
28. **Nahm A. L.**, and Schultz R. A. [Magnitude of global contraction on Mars from analysis of surface faults: Implications for martian thermal history](#)
29. Nakamura-Messenger K., Keller L.P., Clemett S., Messenger S., and **Ito M.** (2011) Nanometer-Scale Anatomy of Entire Stardust Tracks. *Meteoritics & Planetary Science*, 46, 1033-1051.
30. Narendranath S., Athiray P.S., Sreekumar P., Kellett B. J., Alha L., Howe C.J., **Joy K.H.**, Grande M., Huovelin J., Crawford I.A., Unnikrishnan U., Lalita S., Subramaniam S., Weider S.Z., Nittler L.R., Gasnault O., Rothery D., Fernandes V.A., Bhandari N., Goswami J.N., Wiezoreck M.A. and the C1XS team. "[Lunar X-ray fluorescence observations by the Chandrayaan-1 X-ray Spectrometer \(C1XS\): Results from a lunar highland region.](#)" *Icarus*. DOI:10.1016/j.icarus.2011.04.010. Vol. 214, Issue 1, pp. 53-66.
31. Neish C.D., Bussey D.B.J., **Spudis P.**, Marshall W., Thomson B.J., Patterson G.W., Carter L.M. (2011) The nature of lunar volatiles as revealed by Mini-RF observations of the LCROSS impact site. *Jour. Geophys. Res.* **116**, E01005, DOI:10.1029/2010JE003647, 2001.
32. Nettles J.W., Staid M., Besse S., Dhingra D., Isaacson P., Klima R., **Kramer G.**, Pieters C.M. Optical maturity variation in lunar spectra as measured by Moon Mineralogy Mapper data. *J. Geophys. Res.*, 116, E00G17, doi:10.1029/2010JE003748

33. O'Sullivan K., Kohout T., Thaisen K., and **Kring D.A.** (2011) Calibrating key lunar stratigraphic units representing 4 billion years of lunar history within Schrödinger Basin, in W.A. Ambrose and D.A. Williams (eds.), *Recent Advances and Current Research Issues in Lunar Stratigraphy*, Geological Society of America Special Paper 477, pp. 117-127.
34. Pieters C.M., Besse S., Boardman J., Buratti B., Cheek L., Clark R., Combe J.-P., Dhingra D., Goswami J., Green R.O., Head J. III, Isaacson P., Klima R., **Kramer G.**, Lundeen S., Malaret E., McCord T., Mustard J., Nettles J., Petro N., Runyon C., Staid M., Sunshine J., Taylor L., Thaisen K., Tompkins S., and Whitten J. (2011) Mg-Spinel Lithology: A New Rock-type on the Lunar Farside. *J. Geophys. Res.* 116, E00G08, doi:10.1029/2010JE003727
35. Raney R.K., **Spudis P.D.**, Bussey B., Crusan J., Jensen J.R., Marinelli W., McKerracher P., Neish C., Palsetia M., Schulze R., Sequeira H.B., and Winters H. (2010) The Lunar Mini-RF Radars: Hybrid Polarimetric Architecture and Initial Results. *Proc. IEEE* **99**, 1-6, DOI:10.1109/JPROC.2010.2084970.
36. Rao, M.N., Nyquist L.E., **Bogard D.D.**, Garrison D.H., Sutton S.R., Michel R., Reedy R.C., and Leya L., (2011) Isotopic evidence for a martian regolith component in shergottite meteorites. *J. Geophys. Res.* 116, E08006, 2011. DOI:10.1029/2010JE003764.
37. Ruiz, J., **P.J. McGovern**, A. Jiménez-Díaz, V. López, J.-P. Williams, B.C. Hahn, and R. Tejero, The thermal evolution of Mars as constrained by paleo-heat flows, *Icarus*, 215, 508-517.
38. **Sandu C.**, Lenardic A., O'Neill C.J., Cooper C.M., (2011), Earth's evolving stress state and the past, present, and future stability of cratonic lithosphere, *International Geology Review*.
39. **Schenk P.**, Hamilton D.P., Johnson R.E., McKinno, W.B., Paranicas C., Schmidt J., Showalter M.R., (2011) Plasma, plumes and rings: Saturn system dynamics as recorded in global color patterns on its midsize icy satellites (2011) *Icarus*, 211, 740.
40. Seyfried W.E. Jr., Pester N., and **Fu Q.** (2010) Phase equilibria controls on the chemistry of vent fluids from hydrothermal systems on slow spreading ridges: Reactivity of plagioclase and olivine solid solutions and the pH-silica connection. In *Diversity of Hydrothermal Systems on Slow Spreading Ocean Ridges* (eds. P. Rona, C. Davey, J. Dymont, and B. Murton). *Geophysical Monograph Series* **188**. American Geophysical Union, Washington D.C.
41. **Spudis P.D.** (2011) The Moon: Port of Entry to Cislunar Space. In *Toward a Theory of Space Power: Selected Essays*, C.D. Lutes and P.L. Hays, eds., Institute for National Strategic Studies, National Defense University, Washington DC, Chapter 12, <http://www.ndu.edu/press/space-Ch12.html>
42. Staid M., Pieters C.M., Besse S., Boardman J., Dhingra D., Green R.O., Head J. III, Isaacson P., Klima R., **Kramer G.**, Mustard J., Runyon C., Sunshine J., and Taylor L. (2011) The Mineralogy of Late-Stage Lunar Volcanism as Observed by the Moon Mineralogy Mapper on Chandrayaan-1. *J. Geophys. Res.* 116, E00G10, doi:10.1029/2010JE003735

43. Thaisen K., Head J. III, Taylor L., **Kramer G.**, Isaacson P., Nettles J., Petro N., and Pieters C. (2011) Geology of the Moscoviense Basin. *J. Geophys. Res.* 116, E00G07, doi:10.1029/2010JE003732
44. **Treiman A.H.** and Essene E.J. (2011) Chemical composition of magnetite in Martian meteorite Allan Hills 84001: Revised appraisal from thermochemistry of phases in Fe-Mg-C-O. *Geochimica et Cosmochimica Acta* 75, 5324-5335.
45. **Usui, T.**, Sanborn, M., Wadhwa, M. and McSween, H. Y. (2010). Petrology and trace element geochemistry of Robert Massif 04261 and 04262 meteorites, the first examples of geochemically enriched Iherzolitic shergottites. *Geochimica et Cosmochimica Acta.* 74, 7283–7306.
46. **Usui, T.**, McSween, H. Y., Mittlefehldt, D. W. and Prettyman, T. H. (2010). K-Th-Ti systematics and new three-component mixing model and of HED meteorites: Prospective study for interpretation of gamma-ray and neutron spectra for the Dawn mission. *Meteoritics & Planetary Science.* 45, 1170–1190.
47. **Usui, T.** and Namiki, N. (2011). Report of the 4th Mars Science Laboratory Landing Site Workshop. *Planetary Geology News* 23 (issue 1), 1-3. (in Japanese).
48. **Usui, T.**, (2010) Reviews of Scientific Results of Mars Exploration Rovers. In “Mars: Why is Mars Red?” Eds. Miyamoto, H., Hirata, N. Tachibana, S. The University Museum, The University of Tokyo, pp. 175. (in Japanese)
49. Weider S.Z., Crawford I.A., **Joy K.H.** (2010). Individual lava flow thicknesses in Oceanus Procellarum and Mare Serenitatis Determined from Clementine multispectral data. *Icarus* Vol. 209, pp. 323-336. DOI:10.1016/j.icarus.2010.05.010.
50. Weirich J., **Wittmann A.**, Isachsen C.E., Rumble D., Swindle T.D., and **Kring D.A.** (2010) The Ar-Ar Age and Petrology of Miller Range 05029: Evidence for a large impact in the very early Solar System: *Meteoritics and Planetary Science* 45, 1868-1888.
51. Williams D.A., Keszthelyi L.P., Crown, D.A., Yff J.A., Jaeger, W.L., **Schenk, P.M.**, Geissler P.E., Becker T.L., (2011) Volcanism on Io: New insights from global geologic mapping. (2011) *Icarus*, 214, 91.
52. **Wittmann A.**, Swindle T.D., Cheek L.C., Frank E.A., and **Kring D.A.** (2010) Impact craters on the H-chondrite parent asteroid, *Journal of Geophysical Research* 115, E07009, doi:10.1029/2009JE003433, 22p.
53. Zhang X., Ganguly J., and **Ito M.** (2010) Ca-Mg Diffusion in Diopside: tracer and chemical inter-diffusion coefficients. *Contributions to Mineralogy and Petrology* 159, 175-186.

### **In Press**

1. Boisson J., Heggy E., **Clifford S.M.**, Yoshikawa K., Anglade A., Lognonné P., Radar sounding of temperate permafrost in Alaska: Analogy to the Martian mid- to high-latitude ice-rich terrains, *CO<sub>2</sub>, Journal of Geophysical Research*.
2. Ehrenfreund P., McKay C., Rummel J.D., Foing B.H., Neal C.R., Masson-Zwaan T., Ansdell M., Peter N., Zarnecki J., **Mackwell S.**, Perino M.A., Billings L., Mankins J., Race M. (2011) Toward a global space exploration program: A stepping stone approach, *Adv. Space Res.*, doi:10.1016/j.asr.2011.09.014.
3. Gowen R.A. et al., [48 authors, including **Joy K.H.**]. (2011). "[Micro-Penetrators For In Situ Sub-Surface Investigations of Europa](#)". *Advances in Space Research (ASR) Special Issue on Europa Lander Science*. DOI:10.1016/j.asr.2010.06.026.
4. Green R., Pieters C., Mouroulis P., Eastwood M., Boardman J., Glavich T., Isaacson P., Besse S., Barr D., Buratti B., Cate B., Chatterjee A., Clark R., Cheek L., Combe J.-P., Dhingra D., Essandoh V., Geier S., Green R., Haemmerle V., Head J., Hovland L., Hyman S., Klima R., Koch T., **Kramer G.**, Lee K., Lundeen S., Malaret E., McCord T., McLaughlin S., Mustard J., Nettles J., Petro N., Plourde K., Racho C., Rodriguez J., Runyon C., Sellar R.G., Smith C., Sobel H., Staid M., Sunshine J., Taylor L., Thaisen K., Tompkins S., Tseng H., Vane G., Varanasi P., White M., Wilson D. The Moon Mineralogy Mapper (M3) Imaging Spectrometer for Lunar Science: Instrument Description, Calibration, On-Orbit Measurements, Science Data Calibration and On-Orbit Validation. *J. Geophys. Res.*
5. **Gross J.**, and **Treiman A.H.** (2012?) Unique spinel-rich lithology in lunar meteorite ALHA81005: Origin and possible connection to M3 observations of the farside highlands. *Journal of Geophysical Research*, in press.
6. **Joy K.H.**, **Kring D.A.**, **Bogard D.D.**, McKay D.S., Zolensky M.E., (2011) Re-examination of the formation ages of the Apollo 16 Regolith Breccias. *Geochim. Cosmochim. Acta*.
7. **Kiefer W.S.** (2011), Lunar Heat Flow Experiments: Science Objectives and a Strategy for Minimizing Lander-Induced Perturbations, *Planet. Space. Sci.*, in press.
8. **Lasue J.**, Wiens R.C., Clegg S.M., Vaniman D.T., **Joy K.H.**, Humphries S., Mezzacappa A., Melikechi N., McInroy R.E., Bender S. (In Press 2011) "Laser Induced Breakdown Spectroscopy (LIBS) for Lunar Exploration". *Journal of Geophysical Research – Planets* (In Press 2011).
9. Max M.D., **Clifford S.M.**, Johnson A., System Analysis for Methane Hydrate Exploration on Mars. American Association of Petroleum Geologists Special Publication (book) on Detection and Exploitation of Extraterrestrial Resources, in press.
10. **Sandu C.**, A. Lenardic, and **P. McGovern**, The Effects of Deep Water Cycling on Planetary Thermal Evolution, *J. Geophys. Res., JGR-Solid Earth*, in press, 2011.
11. Schwenzer S.P. et al. (including **P.J. McGovern**), A Case Study of Gale Crater: Developing an Exploration Strategy for Targeting Noachian Impact Craters to Study Impact Processes and Potential Habitats for Life, *Icarus*, in press, April 2011.

12. Smith A. et al. [60 co-authors including **K.H. Joy**] (Accepted in Press). Lunar Net – A proposal in response to an ESA call in 2010 for a medium sized mission. *Experimental Astronomy* (Accepted in Press).
13. Snape J.F., **Joy K.H.**, and Crawford I.A. (Accepted in Press) “Characterization of Multiple Lithologies within the Lunar Feldspathic Regolith Breccia Meteorite Northeast Africa 001”. *Meteoritics and Planetary Science*.
14. **Spudis P.D.** and Lavoie T., Mission and Implementation of an Affordable Lunar Return. *Space Manufacturing* 14, Space Studies Inst., Princeton NJ
15. Schwenzer S.P., **Abramov O.**, Allen C.C., **Clifford S.**, Filiberto J., **Kring D.A.**, **Lasue J.**, **McGovern P.J.**, Newsom H.E., **Treiman A.H.**, Vaniman D.T., Wiens R.C., **Wittmann A.** Targeting Noachian impact craters: an exploration strategy for studying the Martian subsurface, hydrothermal systems and potential habitats for life., *Icarus*.
16. **Treiman A.H.** (2011) Eruption age of the Sverrefjell volcano, Spitsbergen Island, Norway. *Polar Research*, in press.
17. **Treiman A.H.**, and Bullock M.A. (2012?) Mineral reaction buffering of Venus’ atmosphere: A thermochemical constraint and implications for Venus-like planets. *Icarus*, in press.
18. **Usui, T.** (in press) New views of Mars: Reviews of recent Mars explorations and meteorites studies. Chikyū-Kagaku (Geochemical journal published by the Geochemical Society of Japan) (in Japanese)
19. Weider S.Z., Swinyard B.M., Kellett B.J., Howe C J., **Joy K.H.**, Crawford I.A., Gow J., Smith D.R. (2011). [Planetary X-ray fluorescence analogue laboratory experiments and an elemental abundance algorithm for C1XS](#). *Planetary and Space Science*. DOI:10.1016/j.pss.2011.05.005
20. **Wittmann, A.**, Friedrich J. M., Troiano T., Macke R.J., Britt, D.T., Swindle T.D., Weirich J.R., Rumble D. III, **Lasue J.**, **Kring D.A.** (in press) H/L chondrite LaPaz Icefield 031047 – A feather of Icarus?: *Geochimica et Cosmochimica Acta*.
21. **Wittmann A.**, **Kring D.A.**, Friedrich J.M., Troiano J., Macke R.J., Britt D.T., Swindle T.D., Weirich J.R., Rumble III D., **Lasue J.**, LaPaz Icefield 031047 - Petrology of a recently degassed, highly porous and compositionally intermediate ordinary chondrite., *Geochimica and Cosmochimica Acta*.
22. Yamaguchi A, Barrat J-A, **Ito M.**, and Bohn M. (2010) Post eucritic magmatism on Vesta: Evidence from the petrology and thermal history of diogenites. *JGR-Planets*.

Submitted

1. **Abramov O.**, and Mojzsis S.J., Thermal and Geochemical Effects of Impact Bombardments on the Crust of the Hadean Earth, *Geochim. Cosmochim. Acta*, submitted, September 2011.

2. **Abramov O.**, Wong S.M., and **Kring D.A.**, Differential Melt Scaling for Oblique Impacts on the Earth, Moon, and Mars, *Icarus*, submitted, August 2011.
3. Cedillo-Flores Y., **Treiman A.H.**, **Clifford S.M.**, and **Lasue J.** (submitted) CO<sub>2</sub> Gas fluidization in the formation of Martian polar gullies. To *Geophysical Research Letters*. In revision.
4. Debaille V., O'Neill C., Brandon A.D., Haenecour P., Yin Q.Z., Mattielli N., and **Treiman A.H.** (submitted) A delayed onset for modern plate tectonics revealed by Nd isotopes. To *Nature*.
5. **Fu Q.**, Socki R., and Niles P.B. (2011) Evaluating reaction pathways of hydrothermal abiotic organic synthesis at elevated temperatures and pressures using carbon isotopes. Submitted to *Earth Planet. Sci. Lett.*
6. **Galgana G.A.**, E.B. Grosfils, and **P.J. McGovern**, Radial Dike Formation on Venus: Insights from Models of Uplift, Flexure and Magmatism, *Nature Geoscience*, submitted October 2011.
7. **Gross J.**, **Treiman A.H.**, and **Mercer C.N.** (submitted) No magma ocean on the Moon: New evidence from anorthosites in lunar meteorites. To *Nature*.
8. Herrick R., **McGovern P.**, Verner K., **Galgana G.**, et al., Applications of the Magellan Stereo-derived topography. (submitted, July 2011).
9. Herrick R.R., D. L. Stahlke, M. S. Gilmore, **P.J. McGovern**, **G.A. Galgana**, P.G. Resor, K.R. Verner, and V.L. Sharpton, Stereo-derived topography brings Venusian tectonic terrains into focus, *Geology*, submitted, August 2011.
10. Howard A.D., Moore J.M., **Schenk P.M.**, and **White O.L.** (2011) Sublimation-driven erosion on Hyperion: Topographic analysis and landform simulation model tests. *Icarus*.
11. **Joy K.H.**, **Kring D.A.**, **Bogard D.D.**, McKay D.S. and Zolensky M.E. 2010. (In Revision). "Re-examination of the formation ages of Apollo 16 regolith breccias." Submitted to *Geochimica et Cosmochimica Acta* (Submitted Jan. 2011).
12. **Kiefer W.S.** (2011), Gravity Constraints on the Structure of the Marius Hills: The Magmatic Plumbing of the Largest Lunar Volcanic Dome Complex, submitted to *J. Geophys. Res.*
13. **Kiefer W.S.**, Macke R.J., Britt D.T., Irving A.J., and Consolmagno G.J. (2011), The Density and Porosity of Lunar Rocks, submitted to *Geophys. Res. Lett.*
14. **Lasue J.**, Wiens R.C., Clegg S.M., Vaniman D.T., **Joy K.H.**, Humphries S., Mezzacappa A., Melikechi N., McInroy R.E., Bender S., Laser-Induced Breakdown Spectroscopy (LIBS) for lunar exploration, *J. Geophys. Res.*
15. Marchi S., Bottke W.F., **Kring D.A.**, and Morbidelli A., The onset of the lunar cataclysm as recorded in its ancient crater populations. *Science*.
16. **McGovern P.J.**, and M.M. Litherland, Loading Stresses and Magma Ascent in and around Large Lunar Impact Basins, *Geophysical Research Letters*, submitted October 2011.

17. Mouginit J., Pommerol A., Beck Pierre, Kofman W., **Clifford S.M.**, Radar map of the Martian northern plains reveals the remnant of an ancient ocean, submitted to *Nature*.
18. **Öhman T.** and **Kring D.A.** (2011) Photogeologic analysis of impact melt-rich lithologies in Kepler crater, the Moon. *Journal of Geophysical Research – Planets*. (submitted)
19. Robinson K.L., **Treiman A.H.**, **Joy K.H.** (In Revision). “Basaltic Fragments in Lunar Highlands Meteorites: Connecting Sample Analyses to Orbital Remote Sensing”. Submitted to *Meteoritics and Planetary Science*. (Submitted June 2010).
20. **Sandu C.**, and **Kiefer W.S.** (2011), Degassing History of Mars and the Lifespan of its Magnetic Dynamo, submitted to *Geophys. Res. Lett.*
21. Schmieder M., Jourdan F., Buchner E., Moilanen J. and **Öhman T.** (2011) A Mesoproterozoic age for the Keurusselkä impact structure (Finland) – Evidence from  $^{40}\text{Ar}/^{39}\text{Ar}$  dating of melt lithologies. *Meteoritics & Planetary Science*. (in revision)
22. Schwenzer S.P., **Abramov O.**, Allen C.C., **Clifford S.**, Filiberto J., **Kring D.A.**, **Lasue J.**, **McGovern P.J.**, Newsom H.E., **Treiman A.H.**, Vaniman D.T., Wiens R.C., and **Wittmann A.** (submitted) A case study on Gale Crater: Developing an exploration strategy for targeting Noachian impact craters to study impact processes and potential habitats for life. To *Icarus*.
23. Schwenzer S.P., **Abramov O.**, Allen C.C., Clifford S., Filiberto J., **Kring D.A.**, **Lasue J.**, **McGovern P.J.**, Newsom H.E., **Treiman A.H.**, Vaniman D.T., Wiens R.C., and Wittmann, A. (submitted) Puncturing Mars: how impact craters interact with the Martian cryosphere forming a liquid water and alteration. To *Earth Planet. Sci. Lett.*
24. **Spudis P.D.**, **McGovern P.J.**, and **Kiefer W.S.** (2011), Large Shield Volcanos on the Moon, submitted to *J. Geophys. Res.*
25. Weider S.Z., Kellett B.J., Swinyard B.M., Crawford I.A., **Joy K.H.**, Grande M., Howe C.J., Sreekumar P., Huovelin J., Narendranath S., Alha L., Anand M., Athiray P.S., Ahandari N., Carter J., Cook A.C., d’Uston L.C., Fernandes V.A., Gasnault O., Goswami J.N., Gow J.P.D., Holland A.D., Koschny D., Lawrence D.J., Maddison B.J., Maurice S., McKay D.J., Okada T., Pieters C., Rothery D., Russell S.S., Shrivastava A., Smith D.R., and Wieczorek M. (In Revision). The Chandrayaan-1 X-ray Spectrometer: First Results. Submitted to *Planetary and Space Science* (Submitted Feb. 2011).
26. **White O.L.**, Stofan E.R., and Guest J.E. (2011) Evolutionary precursors of large volcanoes on Venus. *Icarus*.

## **APPENDIX II: Scientific Staff - Conference Attendance and Abstracts Presented**

### **Abramov**

Abramov O., Kring D.A., and Mojzsis S.J., Modeling of impact-induced age resetting and partial Pb-loss in zircon grains, *Lunar Planet. Sci. XLII*, abstract 2674, 2011.

Schwenzer S.P., Abramov O., Impact-generated hydrothermal systems on Noachian Mars: Clays, carbonates and more, *2010 AGU Fall Meeting*, Abstract P44B-03, San Francisco, CA, December 13-17, 2010.

### **Bogard**

Bogard D.D., How the Moon makes water: A conceptual view, Workshop on Wet VS. Dry Moon, *LPI*, June, 2011.

### **Clifford**

Clifford\* S.M., Delemere W.A., and Gogineni S., Mars Global Subsurface Sounder, *EPSC-DPS Joint Meeting 2011*, Nantes, France, October 2011.

Ciarletti\* V., Plettemeier D., Cais Ph., Clifford S.M. and the WISDOM team, Radar Sounding Investigations of the Martian Subsurface by the 2018 ExoMars-C Rover, *EPSC-DPS Joint Meeting 2011*, Nantes, France, October 2011.

Clifford\* S.M., Max M.D. and Johnson A., Methane Hydrate on Mars, *Mars Society Annual Meeting*, Dallas, TX, August 2011.

Ciarletti\* V., Clifford S.M., Plettemeier D., and Corbel C., The ExoMars WISDOM GPR: Searching for evidence of past and present life in the Martian near-subsurface, *International Conference: Exploring Mars Habitability*, Lisbon, 2011.

Clifford\* S.M. and Max M.D., Evidence for the long-term persistence of habitable conditions in the deep-subsurface of Mars, *International Conference: Exploring Mars Habitability*, Lisbon, 2011.

Clifford\* S.M., Lasue J., Heggy E., Mouginit J., Grima C. and Holt J., Radar Sounding Investigations of the Martian Hydrosphere and Cryosphere, *International Space Science Institute & Europlanet Workshop on Quantifying the Martian Geochemical Reservoirs*, Bern, Switzerland, April 2011.

Clifford\* S.M., Evidence for the Survival of Subsurface H<sub>2</sub>O in the Martian Equatorial Region to the Present Day, *EGU General Assembly*, Vienna, 2011.

Ciarletti\* V., Clifford S., Vieau A.J., Lustrement B., Hassen-Kodja R. and Cais P., The 2018 ExoMars WISDOM GPR on Mt. Etna: First Field Test Results in a Mars Analogue Volcanic Environment, *EGU General Assembly*, Vienna, 2011.

Ciarletti V., Clifford S., Vieau A.J., Lustremont B., Hassen-Kodja R. and Cais P., Results from the first field tests of the WISDOM GPR (2018 ExoMars Mission), *LPSC XLII*, Abstract No. 2613, 2011.

Clifford\* S.M., Lasue J., Le Gall A., and Heggy E., The Response of Martian Ground Ice to Burial by a Volatile-Poor Mantle: Potential Implications for the Volatile Evolution of the Medusae Fossae Formation., *LPSC XLII*, Abstract No. 2142, 2011.

Max\* M., Johnson A. and Clifford S.M., Methane hydrate on mars; a resource-rich stepping stone to the outer planets?, *7th International Conference on Gas Hydrates*, Edinburgh, Scotland, July 2011.

Clifford\* S.M., Lasue J., Le Gall A., and Heggy E., The Response of Martian Ground Ice to Burial by a Volatile-Poor Mantle: Potential Implications for the Volatile Evolution of the Medusae Fossae Formation. *2010 AGU Fall Meeting*, P23A-1614.

Boisson\* J., Heggy E., Clifford S.M., Yoshikawa K., Anglade A., and Lognonne P., Exploring dielectric signature of Martian mid-latitude ice using Earth analog study. *2010 AGU Fall Meeting*, P23A-1622.

Heggy\* E., Boisson J., Clifford S.M., Plaut J.J., Ferro A., and Y. Gim, Constraining the Equatorial Basins Sedimentation Chronology from MARSIS Tomographic Data Analysis. *2010 AGU Fall Meeting*, P23A-1625.

Herique A., Kofman\* W.W., Barucci A., Beck P., Biele J., Clifford S.M., Goutail J., Heggy E., Ho T., Kumamoto A., Lasue J., Levasseur-Regourd A., Michel P., Nielsen E., Ono T., Pujet P., Plettemeier D., Ulamec S., and Zine S., ASSERT for Mascot/Hayabusa 2 mission: A radar tomography of 1999 JU3, *2010 AGU Fall Meeting*, P33E-04.

## **Fu**

Socki R., Fu Q., and Niles P.B. (2011) Hydrogen isotope measurements of organic acids and alcohols by Pyrolysis-GC-MS-TC-IRMS. *AGU Fall Meeting 2011*.

Fu Q.\*, Socki R., and Niles P.B. (2011) Carbon isotope systematics in mineral-catalyzed hydrothermal organic synthesis processes at high temperatures and pressures. *Lunar Planet. Sci. XLII*, Abstract #1057.

Socki R., Fu Q., and Niles P.B. (2011) Carbon isotope measurements of experimentally-derived hydrothermal mineral-catalyzed organic products by pyrolysis-isotope ratio mass spectrometry. *Lunar Planet. Sci. XLII*, Abstract. #2311.

Fu Q., Socki R., and Niles P.B. (2010) Experimental study of abiotic organic synthesis at high temperature and pressure conditions: Carbon isotope and mineral surface characterizations. *AGU Fall Meeting 2010*, Abstract #V51B-2191.

Socki R., Fu Q., and Niles P.B. (2010) Carbon isotope characterization of organic intermediaries in hydrothermal hydrocarbon synthesis by Pyrolysis-GC-MS-C-IRMS. *AGU Fall Meeting 2010*, Abstract #V51B-2189.

## **Galgana**

McGovern P., Grosfils E., and Galgana G., Structure and evolution of Galapagos volcanic edifices: Insights from lithospheric flexure models and comparisons with planetary analogs. Abstract submitted to the *AGU Chapman Conference: The Galapagos a Laboratory for the Earth Sciences*, Puerta Ayora, Galapagos, Ecuador, July 25-30, 2011.

Hamburger M., Galgana G., and Johnson K.. Seismicity and Active Crustal Deformation in the Wabash Valley Seismic zone: A Postseismic Effect of the 1811-1812 New Madrid Earthquakes? *Earthscope National Meeting*, Austin, Texas, May 17-21, 2011.

## **Ito**

Ross D.K., Ito M., Hervig R., Rao M.N and Nyquist L. (2011) Recognizing the influence of terrestrial contamination on D/H ratios in shergottite phosphates. *Lunar Planetary Science XLII*, Abstract #1920.

Nguyen A.N., Messenger S., Ito M., Rahman Z. (2011) Fe and Mg Isotopic Analyses of Isotopically Unusual Presolar Silicate Grains. *Lunar Planetary Science XLII*, Abstract #2711.

Yamaguchi A., Ito M., and Barrat J.A. (2010) Structure of Vestan crust inferred from thermal history of diogenites. The *2010 Annual Meeting of Japan Association of Mineralogical Sciences*, Abstract # R3-10.

## **Joy**

Alexander L., Snape J.F., Crawford I.A., Joy K.H., and Burgess R. 2011. A study of the mineralogy and textures of basalt fines from Apollo 12 regolith sample 12023,155. *74th Annual Meeting of the Meteoritical Society*, Abstract #5084.

Braun S.A., Brandon A.D., Joy K.H., Kring D.A. 2011. Did meteorite bombardment sample deep lunar crust?: Major and trace element compositions of granulite clasts in lunar regolith breccia MAC 88014, *Lunar and Planetary Science XXII*, Abstract #2762.

Joy K.H., Kring D.A., Zolensky M.E., McKay D.S., Ross D.K. 2011. Investigating the sources and timing of projectiles delivered to the lunar surface, *Lunar and Planetary Science XXII*, Abstract #2103.

Joy K.H., Kring D.A., Zolensky M.E., McKay D.S., Ross D.K. 2011. An archive of Solar System bombardment preserved in the lunar regolith. *RAS National Astronomy Meeting 2011*, Abstract #291.

Joy K.H., Kring D.A., and Zolensky M.E. 2011. Petrography of lunar meteorites Dhofar 925 and 961. *74th Annual Meeting of the Meteoritical Society*, Abstract #5100.

Kearsley A.T., Smith C.L., Spratt J., Benedix G.K., Hunt A., Russell S.S., Joy K.H., and Gounelle M. 2011. Meteorite polished sections: x-ray map imagery for documentation, curation and 'virtual-loan' of irreplaceable materials. *74th Annual Meeting of the Meteoritical Society*, Abstract #5280.

Lasue J., Wiens R.C., Clegg S.M., Vaniman D.T., Joy K.H., Humphries S. 2010. Applicability of LIBS on the Moon: elemental analysis of lunar simulants in vacuum. *Lunar and Planetary Science XXII*, Abstract #1165.

Snape J.F., Crawford I.A., Joy K.H., R. Burgess. 2010. A petrographic study of basalt fragments in Apollo regolith sample 12003. *Lunar and Planetary Science XXII*, Abstract #2020.

Snape J.F., Beaumont S., Burgess R., Crawford I.A., Joy K.H. 2011. an evaluation of techniques used in the age and petrologic analysis of Apollo 12 basalts. *Lunar and Planetary Science XXII*, Abstract #2011.

Weider S.Z., Kellett B.J., Swinyard B.M., Crawford I.A., Joy K.H., and the C1XS team (2010). Western Oceanus Procellarum as seen by C1XS on Chandrayaan-1. *Lunar and Planetary Science XXII*, Abstract #1684.

Vaughan W.M., Wittmann A., Joy K.H., Lapen T., Kring D.A. 2011. Provenance of impact melt and granulite clasts in lunar meteorite PCA 02007, *Lunar and Planetary Science XXII*, Abstract #1247.

### **Kiefer**

\*Kiefer, W., and Hood L., Gravity and Magnetic Constraints on the Magma Chamber Structure of Apollinaris Patera, Mars, session T106, abstract 92-12, *GSA Annual Meeting*, Denver CO, Nov. 2010.

\*Kiefer, W.S., Li Q., Filiberto J., and Sandu C., The Importance of Mantle Composition in Controlling Magma Production Rates on Mars and Venus, abstract DI33B-05, *Fall AGU*, San Francisco CA, Dec. 2010.

\*Sandu C., and Kiefer W.S., Chemical Evolution of the Martian Mantle and Implications for its Magmatic History, abstract DI43A-1953, *Fall AGU*, San Francisco CA, Dec. 2010.

\*Kiefer W.S., and Lillis R.J., Geophysical Observations of Hadriaca Patera and Tyrrhena Patera, Mars: Implications for Magma Chamber Structure and for the End of the Martian Magnetic Dynamo, *LPSC abstract 1662*, March 2011.

\*Kiefer W.S., Potter R.W.K., Collins G.S., McGovern P.J., and Kring D.A., Thermal Evolution of Large Lunar Impact Basins: Implications for Basin Compensation and the Duration of the Lunar Cataclysm, *LPSC abstract 2349*, March 2011.

\*Lillis R.J., Dufek J., Kiefer W.S., Karlstrom L., Bleacher J.E., and Manga M., Magmatic Intrusions Beneath Martian Highland Volcanoes: Clues from Eruptive History, Thermal-magnetic-gravity Modeling and Electron Reflectometry, *LPSC abstract 2180*, March 2011.

\*Macke R.J., Kiefer W.S., Britt D.T., A Irving., and Consolmagno G.J., Densities, Porosities, and Magnetic Susceptibilities of Meteoritic Lunar Samples: Early Results, *LPSC abstract 1986*, March 2011.

\*Potter R.W.K., Collins G.S., Kring D.A., Kiefer W.S., and McGovern P.J., Numerical Modeling of Lunar Multi-ring Basins, *LPSC abstract 1452*, March 2011.

\*Sandu C., and Kiefer W.S., Degassing of the Martian Mantle and Its Effects on the Thermal Evolution and Magnetic Field History, *LPSC abstract 2566*, March 2011.

\*Spudis P.D., McGovern P.J., and W.S. Kiefer, Large Shield Volcanoes on the Moon, *LPSC abstract 1367*, March 2011.

\*Macke R.J., Britt D.T., Kiefer W.S., A.J. Irving, and G.J. Consolmagno, Porosity, Magnetic Susceptibility, and Density of Meteorites, *Meteoritical Society abstract 5093*, August 2011.

\*Jawin, E.R., Kiefer W.S., and Spudis P.D., The Relationship Between Radar Scattering and Surface Roughness at Lunar Volcanic Domes, *LPI Undergraduate Summer Intern Conference*, August 2011.

\*Kiefer W.S., McGovern P.J., Potter R.W.K., Collins G.S., and Kring D.A., The Collapse of Super-isostasy: Volcanic Intrusions as an Alternative Model for Lunar Mascon Gravity Anomalies, *Fall AGU* (submitted), December 2011 (invited talk).

\*Kiefer W.S., A Planetary Geophysicist Does EPO: Lessons Learned Along the Way, *Fall AGU* (submitted), December 2011 (invited talk).

\*Sandu C., and Kiefer W.S., The Effects of Mantle Degassing on the Thermal and Magmatic Evolution of Mars, *Fall AGU* (submitted), December 2011.

### **Kramer**

Kramer, G.Y., New Spacecraft Missions and Data Integration, *The Lunar Swirls Workshop Without Walls*, September 7, 2011

*A Wet vs. Dry Moon: Exploring Volatile Reservoirs and Implications for the Evolution of the Moon and Future Exploration*, Workshop at LPI, June 13-15, 2011.

Kramer, G. Y., Kring, D. A., Integrated Spectral and Geomorphological Analysis of the Schrödinger Basin, *NASA Lunar Science Institute Forum*, July 19-21, 2011.

Kramer G.Y., R. Christoffersen, R. Clark, J.-P. Combe, L. Keller, D. Kring, T. McCord, S. Noble, N. Petro, C. Pieters, *The New Lunar Water Debate: Surface Phenomenon vs. Internal Processing*.

Kramer, G.Y., Kring D.A., Pieters C.M., Head III J.W., Isaacson P.J., Klima R.L., McCord T.B., Nettles J. W., Petro N.E., Analysis of Schrödinger Basin using on Mineralogy Mapper Spectra, *Lunar and Planetary Science Conference XLII*, March 13-18, 2011

Kramer G., Besse, S., Neish C., Tsunakawa H., Haruyama J., Saito Y., Matsunaga T., Ogawa Y., Ohtake M., Futaana Y., Wieser M., Bandeld J., Glotch T., Harnett E. New Data Integration towards Solving the Mystery of the Lunar Swirls

Isaacson P.J., Nettles J., Besse S., Boardman J., Cheek L., Clark R., Dhingra D. Head J., Klima R., Krame, G., Mall U., Moriarty D., Petro N., Pieters C., Sunshine J., Taylo, L., Tompkins S., Whitten J., A Mineralogical survey of lunar crater central peaks with Moon Mineralogy Mapper data: First results.

Kramer G.Y., Besse S., Boardman J., Buratti B., Busey B., Clark R., Combe J.P., Klima R., McCord T. B., Neish C., Nettles Pieters C., Petro N., The Swirls at South Pole-Aitken. *AGU Fall Meeting*, December 10-14, 2010

### **Kring**

Donohue P.H.\* , R. W. K. Potter, Z. Gallegos, N. Hammond, C. R. Neal, and D. A. Kring (2011) [The importance of lunar sample return in determining the nature of ejecta processes](#), The Importance of Solar System Sample Return Missions to the Future of Planetary Science, Abstract #5035.

Nahm A.L.\* , R.A. Schultz, and D. A. Kring (2011) [Forward mechanical modeling of the Rupes Recta normal fault in eastern Mare Nubium, the Moon](#), *European Geosciences Union annual meeting*, Vienna, Austria, April 3–8, Geophysical Research Abstracts, Vol. 13, EGU2011-8785.

Wittmann A.\* , T. Lapen, T. D. Swindle, and D. A. Kring (2011) [Petrography and provenance of impact melt and granulite particles from the ancient regolith breccias 60016, 61135, and 66035](#), *Lunar and Planetary Science XLII*, Abstract #2289.

[http://www.lpi.usra.edu/nlsi/publications/ - top](http://www.lpi.usra.edu/nlsi/publications/) Wittmann A.\* , T. Hiroi, D. K. Ross, J. S. Herrin, D. Rumble III, and D. A. Kring (2011) [Eucrite impact melt NWA 5218 – Evidence for a large crater on Vesta](#), *Lunar and Planetary Science XLII*, Abstract #1984.

Wittmann A.\* , T. D. Swindle, A. Greshake, D. Rumble III, and D. A. Kring (2011) [Geological context of the ordinary chondrite impact melt NWA 4150](#), *Lunar and Planetary Science XLII*, Abstract #1419.

Joy K.\* , D. A. Kring, M. E. Zolensky, D. S. McKay, and D. K. Ross (2011) [Investigating the sources and timing of projectiles delivered to the lunar surface](#), *Lunar and Planetary Science XLII*, Abstract #2103.

Vaughan W.M.\* , A. Wittmann, K. H. Joy, T. Lapen, and D. A. Kring (2011) [Provenance of impact melt and granulite clasts in lunar meteorite PCA 02007](#), *Lunar and Planetary Science XLII*, Abstract #1247.

Braun S.A.\* , A. D. Brandon, K. H. Joy, and D. A. Kring (2011) [Did meteorite bombardment sample deep lunar crust?: Major and trace element compositions of granulite clasts in lunar regolith breccia MAC 88014](#), *Lunar and Planetary Science XLII*, Abstract #2762.

Nahm A.L.\* and D. A. Kring (2011) [Evidence of normal faulting of the outer rings of Orientale Basin: Preliminary modeling results](#), *Lunar and Planetary Science XLII*, Abstract #1172.

Kramer G.Y.\* , D. A. Kring, C. M. Pieters, J. W. Head III, P. J. Isaacson, R. L. Klima, T. B. McCord, J. W. Nettles, and N. E. Petro (2011) [Analysis of petrologically significant regions of Schrödinger using Moon Mineralogy Mapper spectra](#), *Lunar and Planetary Science XLII*, Abstract #1545.

Öhman T.\* and D. A. Kring (2011) [Photogeologic analysis of impact melt-rich lithologies in the lunar crater Kepler using LROC and Kaguya data](#), *Lunar and Planetary Science XLII*, Abstract #1177.

Marchi S.\*, W. F. Bottke, D. A. Kring, and A. Morbidelli (2011) [New crater counts on the lunar farside](#), *Lunar and Planetary Science XLII*, Abstract #1192.

Potter R.W.K.\*, G. S. Collins, D. A. Kring, W. S. Kiefer, and P. J. McGovern (2011) [Numerical modeling of lunar multi-ring basins](#), *Lunar and Planetary Science XLII*, Abstract #1452.

Kiefer W.S.\*, R. W. K. Potter, G. S. Collins, P. J. McGovern, and D. A. Kring (2011) [Thermal evolution of large lunar impact basins: Implications for basin compensation and the duration of the lunar cataclysm](#), *Lunar and Planetary Science XLII*, Abstract #2349.

Abramov A.\*, D. A. Kring, and S. J. Mojzsis (2011) [Modeling of impact-induced age resetting and partial Pb-loss in Zircon grains](#), *Lunar and Planetary Science XLII*, Abstract #2674.

Kring D.A.\*, J. Balcerski, D. M. Blair, M. Chojnacki, P. H. Donohue, S. A. Drummond, J. M. Garber, M. Hopkins, M. S. Huber, S. J. Jaret, A. Losiak, A. Maier, J. Mitchell, L. Ong, L. R. Ostrach, K. M. O'Sullivan, R. W. K. Potter, S. Robbins, B. Shankar, E. K. Shea, K. N. Singer, M. Sori, S. Sturm, M. Willmes, M. Zanetti, and A. Wittmann (2011) [Fold hinge in overturned Coconino sandstone and its structural displacement during the formation of Barringer Meteorite Crater \(a k a Meteor Crater\)](#), *Lunar and Planetary Science XLII*, Abstract #1740.

Kring D.A.\*, J. Balcerski, D. M. Blair, M. Chojnacki, P. H. Donohue, S. A. Drummond, J. M. Garber, M. Hopkins, M. S. Huber, S. J. Jaret, A. Losiak, A. Maier, J. Mitchell, L. Ong, L. R. Ostrach, K. M. O'Sullivan, R. W. K. Potter, S. Robbins, B. Shankar, E. K. Shea, K. N. Singer, M. Sori, S. Sturm, M. Willmes, M. Zanetti, and A. Wittmann (2011) [Asymmetrical distribution of impact ejected lithologies at Barringer Meteorite Crater \(a k a Meteor Crater\)](#), *Lunar and Planetary Science XLII*, Abstract #1746.

Roy S.\*, R. R. Stewart, and D. A. Kring (2011) [Seismic investigations at Barringer Crater, Arizona](#), *Lunar and Planetary Science XLII*, Abstract #1644.

Souchon A.L.\*, J. Flahaut, P. Sharma, C. E. Jilly, J.-F. Blanchette-Guertin, and D. A. Kring (2011) [Suggested landing sites to study key planetary processes on the Moon: The case of Schrödinger Basin](#), *Lunar and Planetary Science XLII*, Abstract #1791.

Flahaut J.\*, J.-F. Blanchette-Guertin, C. Jilly, P. Sharma, A. L. Souchon, and D. A. Kring (2011) [Testing the lunar magma ocean hypothesis: Science-rich mission sites](#), *Lunar and Planetary Science XLII*, Abstract #1844.

Jilly C.E.\*, J.-F. Blanchette-Guertin, J. Flahaut, P. Sharma, A. L. Souchon, and D. A. Kring (2011) [Lunar landing sites to explore the extent of KREEP and its significance to key planetary processes](#), *Lunar and Planetary Science XLII*, Abstract #1270.

Blanchette-Guertin J.-F.\*, J. Flahaut, C. E. Jilly, P. Sharma, A. L. Souchon, and D. A. Kring (2011) [Mission strategies for determining the vertical extent and structure of the lunar megaregolith](#), *Lunar and Planetary Science XLII*, Abstract #1405.

Sharma P.\* , J.-F. Blanchette-Guertin, C. E. Jilly, J. Flahaut, A. L. Souchon, and D. A. Kring (2011) [Identifying lunar landing sites for sampling lower crust and mantle material](#), *Lunar and Planetary Science XLII*, Abstract #1579.

Potter R.W.K.\* , P. Donohue, Z. E. Gallegos, N. P. Hammond, and D. A. Kring (2011) [Multi-ring basins: Where and how to best determine their structure](#), *Lunar and Planetary Science XLII*, Abstract #1445.

Gallegos Z.\* , P. Donohue, N. Hammond, R. W. K. Potter, and D. A. Kring (2011) Maander Crater: [A case study of a landing site designed to full-fill multiple NRC \(2007\) science objectives](#), *Lunar and Planetary Science XLII*, Abstract #1958.

Shaner A.J.\* , S. Shipp, J. Allen, D. A. Kring (2011) [Educating the Next Generation of Lunar Scientists](#), *Lunar and Planetary Science XLII*, Abstract #2794.

Hörz F.\* , J. Gruener, G. Lofgren, J.A. Skinner Jr., J. Graf, M. Seibert, and the DRATS Science Team (2011) [The traverse planning process for the DRATS 2010 analog field simulations](#). *Lunar and Planetary Science XLII*, Abstract #2054.

Hörz F.\* , C. Evans, D. Eppler, M. Gernhardt, W. Bluethmann, J. Graf, S. Bleisath, and the DRATS Science Team (2011) [Crew field notes: A new tool for planetary surface exploration](#). *Lunar and Planetary Science XLII*, Abstract #2113.

Joy K.H.\* , D. A. Kring, M.E. Zolensky, D.S. McKay, and D.K. Ross (2011) An archive of solar system bombardment preserved in the lunar regolith. *UK National Astronomy Meeting*.

Öhman T.\* , G.Y. Kramer, and D. A. Kring (2011) Impact melt-rich lithologies in lunar crater Kepler. *NLSI Forum*.

Kramer G.\* , D. A. Kring, and others (2011) Integrated spectral and geomorphological analysis of the Schrödinger Basin. *NLSI Forum*.

Joy K.H.\* , M.E. Zolensky, and D. A. Kring (2011) 74th Annual Meteoritical Society Meeting.

Swindle T.D.\* , J.R. Weirich, C.E. Isachsen, A. Wittmann, and D. A. Kring (2011) 40Ar-39Ar dating of Larkman Nunatak 06299: Comparison to paired sample LAR 06298 and to other LL chondrites. *74th Annual Meteoritical Society Meeting*.

Kring, D.A. \* , O. Abramov, and S.M. Wong (2011) Calculating impact melt volumes produced by non-vertical impacts on the Earth, Moon, and Mars. *74th Annual Meteoritical Society Meeting*.

## **Lasue**

Brouet Y., Lasue J., Lvasseur-Regourd A.C., Encrenaz P., Atmospheric entry of fluffy cometary particles under early Earth's conditions, *Origins Conference*, # 460, 2011.

Brouet Y., Lvasseur-Regourd A.C., Lasue J., Encrenaz P. Influence de la structure de poussières d'origine cométaire sur leur température dans la traversée d'une atmosphère primitive, *French Astronomy and Astrophysics Society (SF2A)*, 2011.

Clifford S.M., Lasue J., Le Gall A., Heggy E., The Response of Martian Ground Ice to Burial by a Volatile- Poor Mantle: Potential Implications for the Volatile Evolution of the Medusae Fossae Formation, *European Planetary Science Congress 2010*, EPSC2010-#, 2010.

Cousin O. Forni, Maurice S., Lasue J., Gasnault O., Wiens R., and the ChemCam team, Independent Component Analysis classification for ChemCam remote sensing data, *Lunar and Planetary Science Conference XLII*, #1973, 2011. (2 p)

Hadamcik E., Renard J.B., Carrasco N., Cernogora G., Szopa C., Lasue J., Linear polarization measurements with clouds of tholins produced by radio-frequency plasma, *13th Electromagnetic Light Scattering Conference 2011*, Atti della Accademia Peloritana dei Pericolanti Vol. 89, #. (4 p)

Hadamcik E., Sen A.K., Levasseur-Regourd A.C., Gupta R., Lasue J., Polarization observations of the dust in comet 103P/Hartley 2 coma from OHP (France) and IUCAA (India), *European Planetary Science Conference and Department of Planetary Science joint conference*, #####, 2011. (2 p)

Hadamcik E., Renard J.-B., Szopa C., Buch A., He J., Lasue J., Levasseur-Regourd A.C., Cottin H., Fray N., Carrasco N., Cernogora G., Light scattering by Organic materials in dust clouds when approaching the Sun: Laboratory simulations, *European Planetary Science Conference and Department of Planetary Science joint conference*, #####, 2011. (2 p)

Hadamcik E., Levasseur-Regourd A.C., Lasue J., Sen A.K., Gupta R., Dust properties in comet 67P/Churyumov-Gerasimenko's coma during its 2008-2009 apparition from polarization observations», *European Planetary Science Congress 2010*, EPSC2010-#, 2010.

Hadamcik E., Renard J.-B., Lasue J., Levasseur-Regourd A.C., Buch A., Carrasco N., Cottin H., Fray N., Szopa C., Evolution of Optical Properties of Organic Materials when Approaching the Sun: Laboratory Simulations, *Asia Oceania Geosciences Society*, PS02-A031, 2011.

Herique, Kofman W.W. Barucci A., Beck P., Biele J., Clifford S.M., Goutail J., Heggy E., Ho T., Kumamoto A, Lasue J., Levasseur-Regourd A., Michel P., Nielsen E., Ono T., Pujet P., Plettenmeier D., Ulamec S., Zine S., ASSERT for Mascot Hayabusa 2 mission: A radar tomography of 1999 JU3, *American Geophysical Union, Fall Meeting 2010*, #P33E-04.

Lasue J., Wiens R.C., Clegg S.M., Vaniman D.T., Joy K.H., Humphries S., Applicability of LIBS on the Moon: elemental analysis of lunar simulants in vacuum, *Lunar and Planetary Science Conference XLII*, #1165, 2011. (2 p)

Lasue J., Wiens R.C., Forni O., Clegg S.M., Comparison of Multivariate Data Representation and Quantification Techniques for ChemCam LIBS on Mars, *Laser Induced Breakdown Spectroscopy Conference 2010*, # P-67, 2010.

Lasue J., De Sanctis M.C., Capria M.T., Coradini A., Turrini D., Thermal state of 67P during the Rosetta mission, *European Planetary Science Congress 2010*, EPSC2010-607, 2010.

Levasseur-Regourd A.C., Lasue J., Brouet Y., Interplanetary dust particles of cometary origin, as a possible source of complex carbonaceous compounds on terrestrial planets in the early solar system, *Origins Conference*, # 340, 2011.

Levasseur-Regourd A.C., Hadamcik E., Lasue J., Renard J.B., Recent developments about polarimetry as a tool to provide information about dust particles on asteroids, in cometary comae and in the zodiacal cloud, *American Geophysical Union, Fall Meeting 2011*, #.

Levasseur-Regourd C., Hadamcik E., Renard J.-B., McFadden L.-A., Sen A., Lasue J., Clues to links between some meteorites and the asteroidal targets of Rosetta, from comparisons between polarimetric measurements on meteoritic samples and observations, *Geophysical Research Abstracts*, EGU2011-13651, 2011.

Ollila A.M., Wiens R.C., Maurice S., Clegg S.M., Newsom H.E., Lasue J., Blank J.G., and the ChemCam team, Searching for habitable environments on Mars: contributions from ChemCam, a remote chemistry instrument on the Mars Science Laboratory, *ESA Conference: Exploring Mars Habitability*, 2011.

Ollila A.M., Multari R.A., Wiens R.C., Lasue J., Newsom H.E., Clegg S.M., Distinguishing Similar Igneous Geological Materials (Basalts and Andesites) on Mars with ChemCam using PLS-DA., *North American Symposium on LIBS 2011*, #.

Ollila A.M., Blank J.G., Wiens R.C., Lasue J., Newsom H.E., Clegg S.M., Cousin A., Maurice S., Preliminary results on the capabilities of the ChemCam laser induced breakdown spectroscopy (LIBS) instrument to detect carbon on Mars, *Lunar and Planetary Science Conference XLII*, #2395, 2011. (2 p)

Ollila A.M., Wiens R.C., Lasue J., Newsom H.E., Clegg S.M., Accurate Classification of Rocks and Quantification of Elemental Abundances at Variable Distance using the ChemCam LIBS on Mars, *Laser Induced Breakdown Spectroscopy Conference 2010*, # P-92, 2010.

Wiens C., Ollila A., Spilde M., Boston P., Barefield J., Le L., Clegg S., Lasue J., Newsom H., Vaniman D., Consideration of LIBS for exploration of caves, *First International Planetary Caves workshop*, Carlsbad NM, 2011, # . (2 p)

Wiens R.C., Maurice S., Vaniman D., Clark B., Bridges N., Herkenhoff K., Dromart G., Newsom H., Ollila A., Blaney D., Clegg S., Pinet P., Gasnault O., Lasue J., Barraclough B., ChemCam Targeted Science at Gale Crater, *American Geophysical Union, Fall Meeting 2011*, #.

Wiens R.C., Maurice S., Bender S., Barraclough B.L., Cousin A., Forni O., Vaniman D., Clegg S.M., Lasue J., Blaney D., DeFlores L., Morris R.V., and the ChemCam team, Calibration of the MSL/ChemCam/LIBS remote sensing composition instrument, *Lunar and Planetary Science Conference XLII*, #2370, 2011. (2 p)

### **McGovern**

Sheehan, A.F., et al., (including P.J. McGovern), invited, Physical State of Himalayan Crust and Upper Mantle: Constraints from Velocity and Attenuation Tomography, Seismicity, and Anisotropy, *GSA Annual Meeting* (abstract), Denver, CO.

Galgana G.A., E.B. Grosfils, and P.J. McGovern. Flexural Stresses and Reservoir Stability: Implications for Magma Propagation in the Lithosphere and the Formation of Giant Radial Dike Swarms on Venus, abstract, *AGU Fall Meeting 2010* (Planetary Sciences section).

McGovern P.J., and M.M. Litherland, Lithospheric Stress and Basaltic Magma Ascent on the Moon, with Implications for Large Volcanic Provinces and Edifices, *Lunar Planet. Sci. XLII*, abstract 2587, 2011.

Chadwick J. and P. McGovern, Modelling Subsidence due to the Olympus Mons Load Using Paleo-Slope Indicators, *Lunar Planet. Sci., XLII*, abstract 2688, 2011.

Spudis P.D., P.J. McGovern, and W.S. Kiefer, Large Shield Volcanoes on the Moon. *Lunar Planet. Sci., XLII*, abstract 1367, 2011.

Verne, K., G. Galgana, P. McGovern, and R. Herrick, Insights into the structure and evolution of large volcanoes on Venus from high-resolution stereo-derived topography, *Lunar Planet. Sci., XLII*, abstract 2712, 2011.

Galgana G., P. McGovern and E. Grosfils. The Development of Giant Radiating Dike Swarms on Venus from Coupled Mechanical Models, *Lunar Planet. Sci., XLII*, abstract 2783, 2011.

Potter R.W. K., G.S. Collins, D.A. Kring, W.S. Kiefer, and P.J. McGovern, Numerical Modeling of Lunar Multi-Ring Basins, *Lunar Planet. Sci., XLII*, abstract 1452, 2011.

Kiefr, W.S., R.W.K. Potter, G.S. Collins, P.J. McGovern, and D.A. Kring, Thermal Evolution of Large Lunar Impact Basins: Implications for Basin Compensation and the Duration of the Lunar Cataclysm, *Lunar Planet. Sci., XLII*, abstract 2349, 2011.

P.J. McGovern, K. Powell, G.Y. Kramer, and M. Litherland, Stress-enhanced magma ascent at the margins of large impact basins in the solar system, *AGU Fall Meeting 2011* (submitted), abstract P31E-1736.

Welle, M.B., P.J. McGovern, T. Fournier, O. Katz and J.K. Morgan, Eastern Olympus Mons Basal Scarp: Potential for active slope mobilization?, *AGU Fall Meeting 2011* (submitted), abstract P43D-1711.

W.S. Kiefer, P.J. McGovern, R.W. Potter, G.S. Collins, D.A. Kring (Invited), The Collapse of Super-isostasy: Volcanic Intrusions as an Alternative Model for Lunar Mascon Gravity Anomalies, *AGU Fall Meeting 2011* (submitted), abstract P33G-02.

G.Y. Kramer, A. Nahm, P.J. McGovern, and D.A. Kring, Lunar Pyroclastic Eruptions: Basin Volcanism's Dying Gasps, *AGU Fall Meeting 2011* (submitted), abstract P31E-1732.

## **Öhman**

Öhman T. and Kring D.A. (2011) Photogeologic Analysis of Impact Melt-rich Lithologies in the Lunar Crater Kepler Using LROC and Kaguya Data. *Center for Lunar Science and Exploration Team Workshop*, Lunar and Planetary Institute, Houston, U.S.A., January 6.–7. 2011.

Öhman T., Kramer G.Y. and Kring D.A. (2011) Impact melt-rich lithologies in lunar crater Kepler. 4th Annual NASA Lunar Science Forum, July 19–21, 2011, NASA Ames Research Center, Moffett Field, U.S.A. <http://lunarscience2011.arc.nasa.gov/impact-melt-rich-lithologies-lunar-crater-kepler>

Öhman T. and Kring D.A. (2011) Photogeologic Analysis of Impact Melt-rich Lithologies in the Lunar Crater Kepler Using LROC and Kaguya Data. *Lunar and Planetary Science XLII*, #1177, Lunar and Planetary Institute, Houston, U.S.A. (poster)

Öhman T. and Preeden U. (2011) Shock Metamorphism of Quartz in Saarijärvi and Söderjärden Impact Structures, Finland. *Lunar and Planetary Science XLII*, #1546, Lunar and Planetary Institute, Houston, U.S.A.

### **Sandu**

Sandu C. and Kiefer W.S., (2011) Degassing of the Martian Mantle and Its Effects on the Thermal Evolution and Magnetic Field History. *42nd Lunar and Planetary Science Conference (2011)*, Abstract #2566

Sandu C. and Kiefer W.S. (2010) Chemical Evolution of the Martian Mantle and Implications for its Magmatic History. EOS 91, Abstract DI43A-1953.

Kiefer W.S, Li Q, Filiberto J, Sandu C. (2010) The Importance of Mantle Composition in Controlling Magma Production Rates on Mars and Venus. EOS 91, Abstract DI33B-05

### **Schenk**

*Conferences Attended:*

DPS October 2010  
AGU December 2010  
LPSC March 2011  
OPAG March 2011  
New Horizons Ices Meeting August 2011  
DPS October 2011  
GSA October 2011

Schenk\* P., Geology of Mimas? (2011) *LPSC XLII*, 2729.

Schenk\* P.M., Murphy S.W., The Rayed Craters of Saturn's Icy Satellites (Including Iapetus): Current Impactor Populations and Origins (2011) *LPSC XLII*, 2098.

Bland\* M.T., Singer K.N., McKinnon W.B., Schenk P.M., Constraints on Ganymede's Thermal Evolution from Models of Crater Relaxation (2011) *LPSC XLII*, 1814.

Singer\* K.N., Nowicki L., McKinnon W.B., Schenk P.M., Secondary Craters and Ejecta on Icy Satellites: Size-Velocity Distributions (2011) *LPSC XLII*, 1649.

Bray\* V.J., Melosh H.J., McEwen A.S., Schenk P.M., Morgan J.V., Collins G.S., Studying Cratering and Pit Formation Processes with Galileo and MRO DEMs (2011) *LPSC XLII*, 1570.

Howard\* A.D., Moore J.M., Schenk P.M., Hypothetical Hyperion (2011) *LPSC XLII*, 1256.

Schenk\* P. Cratering on Icy Surfaces (2011) *New Horizons Ices Meeting*, Flagstaff, August 2011.

Bennett Kristen, Paige D., Hayne P., Greenhagen, B.; Schenk, P. Thermal Model of Europa: Calculating the Effects of Surface Topography and Radiation from Jupiter (2010) *DPS*, 42, 2602.

Schenk P.M., Global Topographic Mapping Of Saturn's Midsize Icy Satellites: System-wide Thermal And Impact Effects (2010) *DPS*, 42, 916.

Spencer J.R., Howett C.J., Schenk P., Hurford T.A., Segura M.E., Pearl J.C., An Unexpected Regional Thermal Anomaly on Mimas (2010) *DPS*, 42, 107.

Moore J.M., Howard, A.D., Schenk P., Wood S.E., Erosion, Transportation, and Deposition on Outer Solar System Satellites: Landform Evolution Modeling Studies (Invited) (2010) *2010 AGU Fall Meeting*. P31D..04M

Schenk, P. "Ah . . . not so flat as we were led to believe:" Global and Regional Topography Characteristics of Europa (Invited) 2010 AGU Fall Meeting. P31D.02.

Schenk P., An Eye on Mimas: Endo- and Exogenic Effects on the Surface Evolution of Mimas (Invited) (2010) 2010 AGU Fall Meeting. P21C.06.

Patterson G., Prockter L.M., Schenk P., The topography of chaos terrain on Europa (2010) 2010 AGU Fall Meeting. P21B1598.

Bray V.J., Schenk P., Melosh H.J., McEwen A.S., Morgan J.V., Collins G.S., Ganymede crater dimensions from Galileo-based DEMs (2010) 2010 AGU Fall Meeting. P21B1597.

### **Spudis**

*NLSI Lunar Forum, July 2010*

Spudis P.D. et al. (2010) Results for the poles of the Moon from Mini-SAR, Chandrayaan-1 mission.

*Lunar and Planetary Science Conference, March 2011*

Bussey D.B.J., Spudis P.D. and the Mini-RF Team (2011) New insights into lunar processes and history from global mapping my Mini-RF radar. *Lunar Planet. Sci.* XLII, 2086.

Quinn D.P., Cahill J.T.S., Bussey D.B.J., McGovern J.A., Spudis P.D., Noda H., and Ishihari Y. (2011) Exploration potential for highly illuminated points at the lunar poles using Kaguya, LOLA and LROC data sets. *Lunar Planet. Sci.* XLII, 2518.

Spudis P.D., McGovern P.J., Kiefer W. S. (2011) Large shield volcanoes on the Moon. *Lunar Planet. Sci.* XLII, 1367.

Spudis P.D., Wilhelms D.E., Robinson M.S. (2011) Sculptured Hills: Implications for the relative age of Serenitatis, basin chronologies and the cratering history of the Moon. *Lunar Planet. Sci.* XLII, 1365.

Thomson B.J., Bussey D.B.J., Cahill J.T.S., Neish C., Patterson G.W. and Spudis P.D. (2011) The interior of Shackleton crater as revealed by Mini-RF orbital radar. *Lunar Planet. Sci.* XLII, 1626.

*NLSI Lunar Forum, July 2011*

Spudis P.D. (2011) New Insights into Lunar Basin Formation and Evolution (INVITED REVIEW)

Spudis P.D. and Lavoie T. (2011) Using the resources of the Moon to create a permanent, cislunar space faring system.

### **Treiman**

Gross J. and Treiman A.H. (2011) Lunar spinel-rich rocks by reaction between picritic magma and anorthositic crust, and implications for M3 observations. *Meteoritics and Planetary Sciences* 46 Suppl., Abstr. #5172.

Treiman A.H. (2011) Angra dos Reis: Reconciliation of composition and texture, invoking impact. *Meteoritics and Planetary Sciences* 46 Suppl., Abstr. #5473.

Treiman A.H. and Boyce J.W. (2011) Thermochemistry of apatite and its solid solutions, apatite-melt partitioning, and implications for the moon. *Conference on "A Wet vs. Dry Moon: Exploring Volatile Reservoirs and Implications for the Evolution of the Moon and Future Exploration,"* Abstract #6068.

Mercer C.N. and Treiman A.H. (2011) Energy produced from serpentinization of ultramafic rocks on terrestrial planets: Implications for sustaining microbial communities. *2011 AbGradConf.*

Aveline D.C., Abbey W.J., Choukroun M., Treiman A.H., Dyar M.D. Smrekar S.E., and Feldman S.M. (2011) Rock and mineral weathering experiments under model Venus conditions. *Lunar Planetary Science XLII*, Abstract #2165.

Blake D.F., Treiman A.H., Morris R.H., Bish D.A., Amundsen H.E.F, Steele A., and the AMASE team (2011) Carbonate cements from the Sverrefjell and Sigurd fjell volcanoes, Svalbard Norway: Analogs for Martian carbonates. *Lunar Planetary Science XLII*, Abstract #2167.

Clegg S.M., Sharma S.K., Misra A.K., Dyar M.D., Hecht M., Lambert J., Feldman S., Dallmann N., Wiens R.C., Humphries S.D., Vaniman D.T., Speicher E.A., Carmosino M.L., Smrekar S.E., Treiman A., Wang A., Maurice S., and Esposito L. (2011) Remote Raman – laser induced breakdown spectroscopy (LIBS) geochemical investigation under Venus atmospheric conditions. *Lunar Planetary Science XLII*, Abstract #1568.

Filiberto J., Treiman A.H. and Dasgupta R. (2011) Comparing the effects of H<sub>2</sub>O, F, and Cl on near-liquidus phase equilibria of a model high-Fe basalt: Implications for volatile induced mantle melting. *Lunar Planetary Science XLII*, Abstract #2064.

Gross J., Treiman A.H., and Le L. (2011) Unique spinel-rich anorthositic troctolite in lunar meteorite ALHA81005: Origin and connection to M3 observations of the farside highlands. *Lunar Planetary Science XLII*, Abstract #2630.

Gross J., Treiman A.H., and Filiberto J. (2011) Constraints on the geochemical variations and evolution of the lunar crust and mantle as revealed by Fe, Mn, and Cr correlations in olivine. *Lunar Planetary Science XLII*, Abstract #2805.

McCanta M.C., Dyar M.D., Elkins-Tanton L.T., and Treiman A.H. (2011) Weathering of Hawaiian basalts under sulfur-rich conditions: Applications to understanding surface-atmosphere interactions on Venus. *Lunar Planetary Science XLII*, Abstract #1396.

Mercer C.N. and Treiman A.H. (2011) New lunar meteorite NWA 2996: A window into highland plutonic processes and kreek metasomatism. *Lunar Planetary Science* 42, Abstract #2111.

Morris R.V., Blake D.F., Bish D.A., Ming D.W., Agresti D.G., Treiman A.H., Steele A., Amundsen H.E.F., and the AMASE Team (2011) A terrestrial analogue from Spitsbergen (Svalbard, Norway) for the Comanche carbonate at Gusev Crater, Mars. *Lunar Planetary Science XLII*, Abstract #1699.

Sharma S.K., Misra A.K., Acosta T.E., Dyar M.D., Speicher E.A., Clegg S.M., Wiends R.C., and Treiman A.H. (2011) Raman spectroscopy of low concentration of minerals in basaltic glass analog matrix applicable to planetary exploration. *Lunar Planetary Science XLII*, Abstract #1250.

Spicuzza M.J., Valley J.W., Fournelle J., Huberty J., and Treiman A. (2011) Native silicon and FeSi<sub>3</sub> from the Apollo 16 lunar regolith: Extreme reduction, metal-silicate immiscibility, and shock melting. *Lunar Planetary Science XLII*, Abstract #2231.

Treiman A.H. (2011) An effusive dome on a crater wall near Mawrth Vallis: A possible mud volcano near a MSL landing site. *Lunar Planetary Science XLII*, Abstract #1083.

Treiman A.H. and Bullock M.A. (2011) Atmospheres of Venus-like planets: Stability constraints on mineral reaction buffers. *Lunar Planetary Science XLII*, Abstract #2146.

Treiman A.H., Gross J., Fessler B., and Mercer C. (2010) Geographic Information System for returned samples: Planning, organizing, and correlating analyses. The Importance of Solar System Sample Return Missions to the Future of Planetary Science, Abstr. #5026.

Martin A.M., Richter K., and Treiman A.H. (2010) Stability of basalt + anhydrite + calcite at HP-HT: Implications for Venus, the Earth and Mars. EOS 91, P53B-1520.

Filiberto J., Wood J., Le L., Dasgupta R., Shimizu N., and Treiman A.H. (2010) Effect of fluorine on near-liquidus phase equilibria of basalts EOS 91, V34-07.

## **Usui**

Jones, J. H., Usui, T., Alexander, C. M. O'D., Wang, J. and Simon, J. I. (2011) Martian magmatic volatiles recorded in olivine bearing melt inclusions and matrix of shergottite Y-980459. *Goldschmidt Conference*, Czech, Prague. Abstract #2203.

Senhsu, H. and Usui, T. (2011) Numerical Study on the Thermal Evolution and Birthplace of GRA 06128 and 06129. *Lunar and Planetary Science Conference XLII*, Woodlands, TX. Abstract: #2514.

Usui, T., Shearer, C. K., Richter, K. and Jones, J. H. (2011) Effect of sulfur on siderophile element partitioning between olivine and Martian primary melt. *Lunar and Planetary Science Conference XLII*, Woodlands, TX. Abstract: #1670.

Usui, T., McSween, H. Y., and Clark, B. C. (2010) CO<sub>2</sub>-related explosive alkaline magmatism in Gusev crater, Mars: Implications for oxygen fugacity and carbon inventory in the Noachian Martian mantle (NVITED). *AGU Fall Meeting*, San Francisco, CA. Abstract #P13D-01.

### **White**

White O.L. and Schenk P.M. (2011) Crater Shapes on the Saturnian Satellites: New Measurements Using Cassini Images. *Lunar and Planetary Science Conference XLII*, The Woodlands, Texas, abstract #2283. Oral presentation.

White O.L. and Schenk P.M. (2011) Derivation and Refinement of Topographic Maps of Io using Voyager and Galileo Stereo Images. *Lunar and Planetary Science Conference XLII*, The Woodlands, Texas, abstract #2315. Poster presentation.

White O.L. and Schenk P.M. (2011) Constraining Enceladus' Thermal History Through Crater Shape Measurements on Enceladus, Mimas and Tethys. *Enceladus Focus Group Meeting*, May 23-24, Mountain View, California. Oral presentation.

White O.L. and Schenk P.M. (2011) Crater Shapes on Giant Planet Icy Satellites and Applications to New Horizons at the Pluto-Charon System. *New Horizons Workshop on Icy Surface Processes*, Aug 30-31, Flagstaff, Arizona. Poster presentation.

### **Wittmann**

Wittmann A., Kring D.A., and Swindle T.D. (2010), Impact melts in ancient regolith breccias 60016, 61135, and 66035, *NLSI-CLSE Team Meeting*, November 12, 2010.

Kring D.A., Balcerski J., Blair D.M., Chojnacki M., Donohue P.H., Drummond S.A., Garber J.M., Hopkins M., Huber M.S., Jaret S.J., Losiak A., Maier A., Mitchell J., Ong L., Ostrach L.R., O'Sullivan K.M., Potte, R.W.K., Robbins S., Shankar B., Shea E.K., Singer K.N., Sor, M., Sturm S., Willmes M., Zanetti M., and Wittmann A., Asymmetrical distribution of impact ejected lithologies at Barringer Meteorite Crater (a k a Meteor Crater). *Lunar and Planetary Science Conference*, Houston.

Kring D.A., Balcerski J., Blair D.M., Chojnack, M., Donohue P.H., Drummond S.A., Garber J.M., Hopkins M., Huber M.S., Jaret S J., Losiak A., Maier A., Mitchell J., Ong L., Ostrach L.R., O'Sullivan K.M., Potter R.W.K., Robbins S., Shanka, B., Shea E.K., Singer K.N., Sori M., Sturm S., Willmes M., Zanetti M., and Wittmann A., Fold hinge in overturned Coconino Sandstone and its structural displacement during the formation of Barringer Meteorite Crater (a k a Meteor Crater). *Lunar and Planetary Science Conference*, Houston.

Vaughan W.M., Wittmann A., Joy K.H., Lapen T.J., and Kring D.A., Provenance of impact melt and granulite clasts in lunar meteorite PCA 02007. *Lunar and Planetary Science Conference*, Houston.

Wittmann A., Swindle T.D., Greshake A., Rumble III D., and Kring D.A. (2011) Geological context of ordinary chondrite impact melt NWA 4150.

Wittmann A., Lapen T., Swindle T.D., and Kring D.A. (2011) Petrography and Provenance of impact melt and granulite particles from the ancient regolith breccias 60016, 61135, and 66035.

Wittmann A., Goderis S., and Claeys P. (2011) Preliminary petrography of impactites from El'gygytgyn crater, NE Siberia, including cores from ICDP-lake drilling hole D1.

Wittmann A., Hiroi T., Ross D.K., Herrin J.S., Rumble III D., and Kring D.A. (2011) Eucrite impact melt NWA 5218 - Evidence for a large crater on Vesta.

Goderis S., Elburg M., Vanhaecke F., Claeys Ph., Wittmann, A., and the El'gygytgyn Scientific Party, El'gygytgyn impact crater's fireball layer: Spherules, impact melts, meteoritic component. *Meteoritical Society 74th Annual Meeting*, August 8-12, 2011

Swindle T.D., Weirich J.R., Isachsen C.E., Wittmann A., and Kring D.A. 40Ar-39Ar Dating of Larkman Nunatak 06299: Comparison to paired sample LAR 06298 and to other LL chondrites.

## APPENDIX III: Invited Presentations

### Abramov

- 1) Abramov O., Differential melt scaling for oblique impacts on terrestrial planets, U.S. Geological Survey, Astrogeology branch, Flagstaff AZ, August 8, 2011.

### Clifford

- 1) Clifford\* S.M., J. Lasue, E. Heggy, J. Mouginot, C. Grima and J. Holt (**invited talk**), Radar Sounding Investigations of the Martian Hydrosphere and Cryosphere, International Space Science Institute & Europlanet Workshop on Quantifying the Martian Geochemical Reservoirs, Bern, Switzerland, April 2011.
- 2) Clifford S.M., Professeur Invité (**appointment**), Laboratoire de Planétologie de Grenoble, Université Joseph Fourier, Grenoble, France. Appointment : 10/3-10/26/2010.
- 3) Clifford S.M. (**seminar**), The Evolution and Fate of Water on Mars, Laboratoire de Planétologie de Grenoble, Université Joseph Fourier, Grenoble, France, October 21, 2010.

### Galgana

- 1) Galgana, G. The Formation and Evolution of Giant Radiating Dike Swarms and Large Volcanoes on Venus: Insights from Numerical Models. Rice University, Aug. 16, 2011.
- 2) Galgana, G., "Radial Dike Formation on Venus: Insights from Models of Uplift, Flexure and Magmatism," for the USRA-IIST Student internship Closing Ceremony, June 23, 2011.

### Ito

- 1) Ito M. Isotopic imaging of refractory inclusions in meteorites using NanoSIMS 50L: Understanding of chronology and formation in the Early Solar System. September, 2010 at Kochi Institute for Core Sample Research, Kochi Japan.

### Joy

- 1) CLSE Higher Education Consortium Workshop. The Moon Zoo Project. April, 2011.
- 2) CLSE Team meeting January 2011.
- 3) CLSE Team meeting November 2010.

### Kiefer

- 1) Kiefer W.S., McGovern P.J., Potter R.W.K., Collins G.S., and Kring D.A., The Collapse of Super-isostasy: Volcanic Intrusions as an Alternative Model for Lunar Mascon Gravity Anomalies, Fall AGU (submitted), December 2011 (**invited talk**).
- 2) Kiefer W.S., A Planetary Geophysicist Does EPO: Lessons Learned Along the Way, Fall AGU (submitted), December 2011 (**invited talk**).

### **Kramer**

- 1) Kramer, G. Y., R. Christoffersen, R. Clark, J.-P. Combe, L. Keller, D. Kring, T. McCord, S. Noble, N. Petro, C. Pieters, The New Lunar Water Debate: Surface Phenomenon vs. Internal Processing. *NASA Lunar Science Institute Forum*, July 19-21, 2011.

### **Kring**

- 1) "The Chicxulub Impact Event and Implications for the Evolution of Life on Earth," University of Florida, Gainesville, FL, January 20th, 2011.
- 2) "The Chicxulub Impact Event and Implications for the Origin and Evolution of Life, with Notes about the P-T and T-J Boundaries," University of Southern California, Los Angeles, CA, March 20th, 2011.
- 3) "Impact flux and distribution of PGE's that may be accessible to exploration," NASA Lunar Science Institute, NASA Ames Research Center, Moffett Field, CA, May 19th, 2011.

### **Lasue**

- 1) Our knowledge of the Martian cryosphere and its study by radars, J. Lasue, S. Clifford, C. Grima, ISSI-Europlanet workshop on quantifying the Martian geochemical reservoirs (Bern, Switzerland) 2011.
- 2) The Martian Cryosphere, Los Alamos National Laboratory (Los Alamos, NM, USA) 2011.
- 3) Non linear mapping and multivariate techniques for ChemCam LIBS data analysis, Los Alamos National Laboratory (Los Alamos, NM, USA) 2011.
- 4) Applicability of LIBS for the lunar exploration, Los Alamos National Laboratory (Los Alamos, NM, USA) 2011.

### **McGovern**

- 1) Rice University, Department of Earth Science Seminar, September 1, 2011: "Volcanism on the Moon: Paradigm-busting results from the new wave of lunar exploration."
- 2) Sheehan A.F., et al., (including P.J. McGovern), Physical State of Himalayan Crust and Upper Mantle: Constraints from Velocity and Attenuation Tomography, Seismicity, and Anisotropy, GSA Annual Meeting, Denver, CO, October 2010.

### Mackwell

- 1) Rice University, Department of Physics and Astronomy, October 26, 2011: "The Critical Role of Earth's Moon in Solar System Science and Exploration"

### Schenk

- 1) Saturnian Satellites, Rice University, Autumn 2010. Mimas Geology (see above), AGU, December 2010. Europa Topography (see above) AGU, December 2010. Saturn's Moons through time, GSA, October 2011.

### Spudis

- 1) Space Resources Roundtable, Colorado School Mines, Boulder CO June 2010
- 2) Spudis P.D. (2010) Mini-SAR discoveries about the poles of the Moon
- 3) Space Manufacturing 14, NASA-Amers Research Center, October 29-31, 2010
- 4) Review presentation: Luna Nova: New Discoveries on the Lunar Poles
- 5) Panel participation: Where next for human spaceflight?
- 6) International Lunar Research Park Workshop, NASA-Ames Research Center, April 5, 2011
- 7) International Space Development Conference, Huntsville AL, May 2011.
- 8) **Invited presentation:** Affordable Lunar Return: A Resources-based architecture
- 9) NLSI Lunar Forum, July 2011
- 10) Spudis P.D. (2011) New Insights into Lunar Basin Formation and Evolution (INVITED REVIEW)

### Treiman

- 1) Treiman A.H. (2011) The Lunar Magma Ocean Reconsidered: New Data. Invited talk at Southern Methodist University.

### Sandu

- 1) Sandu, C. (2010), Volatiles and the thermal evolution of planets: implication for the early agnetic field of Mars., Rice University, Earth Science Department, November 2, 2010.

### Usui

- 1) Usui, T., Jones, J. H., and Senshu, H. (2011) Experimental and numerical investigations of the formation of felsic asteroidal crust (**invited**), Goldschmidt Conference, Czech, Prague. Abstract #3701.
- 2) Usui, T., McSween, H. Y., and Clark, B. C. (2010) CO<sub>2</sub>-related explosive alkaline magmatism in Gusev crater, Mars: Implications for oxygen fugacity and carbon inventory in the Noachian Martian mantle (**invited**). AGU Fall Meeting, San Francisco, CA. Abstract #P13D-01.

- 3) **Invited lectures** (1/3/2011-1/13/2011), Tokyo Institute of Technology, Tokyo, Japan.
  1. Reviews of recent Mars explorations and meteorites studies.
  2. Differentiated meteorites and its parent bodies.
  3. CO<sub>2</sub>-related Explosive alkaline magmatism on Mars: Implications for oxygen fugacity and carbon. inventory in the Noachian Martian mantle.
  
- 4) **Invited seminar** (1/12/2011). CO<sub>2</sub>-related Explosive alkaline magmatism on Mars: Implications for oxygen fugacity and carbon inventory in the Noachian Martian mantle, Hiroshima University, Hiroshima, Japan.
  
- 5) **Invited seminar** (1/19/2011). Reviews of recent Mars explorations and meteorites studies. Chiba Institute of Technology, Chiba, Japan.

## APPENDIX IV: Funding

### ACTIVE

#### **O. Abramov**

Principal Investigator  
NASA Planetary Geology and Geophysics Program  
*Exploring Impact Bombardments on Rocky Worlds, NNX11AP57G*

#### **O. Abramov**

Co-Investigator  
NASA Exobiology Program (2011-2014),  
*Investigating the Hadean Earth, NNX11AD57G*

#### **S. M. Clifford**

Principal Investigator  
NASA Mars Data Analysis Program  
*Organization of the 5<sup>th</sup> Mars Polar Science Conference, 3<sup>rd</sup> Early Mars Conference and Related Tasks*

#### **S. M. Clifford**

Participating Scientist  
MARSIS Radar Sounder Investigation  
*Nature and Evolution of the Hydrosphere of Mars*

#### **S. M. Clifford**

Co-Investigator  
NASA Planetary Geology & Geophysics Program  
*Electromagnetic Characterization of Dusty-Ice and Hydrate-Rich Materials in Planetary Environments*

#### **S. M. Clifford**

Co-Investigator  
Joint Project with JPL and the Kuwaiti Institute for Scientific Research (E. Heggy, Principal Investigator)  
*Identification of Groundwater in Terrestrial Hyper-Arid Environments Using Airborne Low-Frequency Radar*

#### **Q. Fu**

Principal Investigator  
NASA Astrobiology: Exobiology and Evolutionary Biology Program  
*Experimental Investigations on Reaction Pathways and Isotope Signatures of Abiotic Organic Synthesis in Hydrothermal Systems*

#### **M. Ito**

Principal Investigator  
NASA Cosmochemistry.  
*Experimental study of oxygen-isotope exchange in melilite during hydrothermal alteration”*

**M. Ito**

Co-Investigator

NASA Origins.

*Coordinated microanalytical studies of refractory inclusions in carbonaceous chondrites.*

**M. Ito**

Co-Investigator

NASA Cosmochemistry

*Origin and history of the solar system starting materials.*

**M. Ito**

Co-Investigator

NASA LARS

*Multianalytical Studies of Stardust Mission Samples.*

**M. Ito**

Co-Investigator

NASA Cosmochemistry

*Diffusion kinetic, Thermal History and Thermodynamic Studies of Planetary Materials and Systems.*

**M. Ito**

Co-Investigator

NASA Cosmochemistry

*The Nature and Origin of Early Solar System and Lunar Materials: Analytical Electron Microscopy Studies.*

**M. Ito**

Co-Investigator

NASA MFR

*Olivine-hosted melt inclusions in Martian meteorites: the search for primordial volatile abundances and lead isotopic source components of Martian magmas.*

**W. S. Kiefer**

Principal Investigator

NASA Mars Data Analysis Program

*Modeling the Martian Gravity Field: Constraints on Subsurface Structure and Lithospheric Properties in Ancient Tharsis and Along the Hemispheric Dichotomy*

**W.S. Kiefer**

Principal Investigator

NASA Discovery Data Analysis Program

*Lunar Prospector Gravity Observations as Constraints on Lunar Volcanic Processes*

**W. S. Kiefer**

Principal Investigator

EPO supplement to Discovery Data Analysis Program grant

*Accessing the Moon: Earth-Moon Comparison Web Portfolios and Institutes for K-12 Educators*

**W. S. Kiefer**

Principal Investigator

NASA Mars Fundamental Research Program  
*Improved Models of Magma Production and the Thermal Evolution of Mars*

**W.S. Kiefer**

Principal Investigator  
EPO supplement to Mars Fundamental Research Program grant  
*Preparing Librarians to Engage Children in NASA Mars Science through Astrobiology*

**W. S. Kiefer**

Co-investigator  
NASA Lunar Science Institute Program  
*Impact Processes in the Origin and Evolution of the Moon: New Sample-driven Perspectives*

**W. S. Kiefer**

Co-investigator  
NASA Planetary Instrument Definition and Development Program  
*High Temperature Seismometer for Venus Applications*

**W. S. Kiefer**

Co-investigator  
NASA Lunar Advanced Science and Exploration Research Program  
*Density and Porosity of Lunar Materials*

**W. S. Kiefer**

Co-investigator  
NASA Dawn at Vesta Participating Scientist Program  
*Crustal Structure of 4 Vesta*

**W. S. Kiefer**

Collaborator  
NASA Mars Fundamental Research Program  
*Effect of Grain Size and Water Fugacity on the Viscosity of Iron-rich Olivine with Application to Convection in the Mantle of Mars*

**D. A. Kring**

Principal Investigator  
NASA Cosmochemistry Program  
*"Petrological and Geochemical Studies of Impact Melts and Impact Breccias"*

**D.A. Kring**

Principal Investigator  
NASA Mars Fundamental Research Program  
*"Modeling of the Thermal Evolution of Impact-Generated Hydrothermal Systems on Mars"*

**D. A. Kring**

Co-Investigator  
Opportunities in Science Mission Directorate Education and Public Outreach  
*"MyMoon: The Public's Portal to Lunar Science Exploration through New Media."*

**D. A. Kring**

Principal Investigator  
NASA Lunar Science Institute Program  
*"Impact Processes in the Origin and Evolution of the Moon: New Sample-driven Perspectives"*

**D. A. Kring**  
Collaborating Scientist  
JSC IR&D  
*"EVA Science and NEA/Surface Hardware Development"*

**P. J. McGovern**  
Principal Investigator  
NASA Planetary Geology and Geophysics Program  
*Mechanical controls on magma ascent, storage, and eruption at large volcanic edifices on Venus*

**P. J. McGovern**  
Co-Investigator  
NLSI Institute Proposal from LPI/USRA.  
*Impact Processes in the Origin Evolution of the Moon: New Sample-driven Perspectives*

**P. J. McGovern**  
Principal Investigator  
NASA Mars Data Analysis Program.  
*Structural Characterization and Evolution of Large Volcanoes on Mars with Insights from Numerical Simulations*

**P. M. Schenk**  
PGG  
*Geology of Impact Craters on Europa*

**P. M. Schenk**  
OPRP  
*Topography of Io*

**P. M. Schenk**  
DPSP  
*Dawn at Vesta*

**P. M. Schenk**  
CDAPS  
*Snow on Enceladus*

**P. D. Spudis**  
Principal Investigator  
*LRO Mini-RF*

**P. D Spudis**  
Deputy PI and Team Member  
*NLSI Polar processes and history*

**A. H. Treiman**

Co-Investigator

*SAGE: Venus Surface and Atmosphere Geochemistry Lander (New Frontiers Mission).*

Submitted July 2009. **PHASE A STUDY** done Spring 2011. Not chosen.

**A. H. Treiman**

Co-Investigator

NLSI Institute

*Impact Processes in the Origin and Evolution of the Moon: New Sample-driven Perspectives*

**A. H. Treiman**

Principal Investigator

NASA Cosmochemistry

*Petrology of the Lunar Highlands: Lithic Clasts in Lunar Meteorites.*

**A. H. Treiman**

Principal Investigator

NASA Mars Fundamental Research Program

*Acid Fog on Mars II: Experimental and Analytical Studies Of Sulfur and Halogens in Martian Basalts and their Fluids.*

**A. H. Treiman**

Co-Investigator

NASA/Ames node of NASA Astrobiology Institute (NAI)

*“Early Habitable Environments and the Evolution of Complexity.”*

**A. H. Treiman**

Co-Investigator

*CheMin: An X-ray Diffraction/X-ray Fluorescence (XRD/XRF) instrument for definitive mineralogical analysis in the Analytical Laboratory of MSL.*

**T. Usui**

Principal Investigator

NASA Mars Fundamental Research Program

Olivine-hosted melt inclusions in Martian meteorites: the search for primordial volatile abundances and lead isotopic source components of Martian magmas

**T. Usui**

Collaborator

NASA Cosmochemistry Program

Parental melts of Martian meteorites (PI: John Jones)

**PENDING**

**O. Abramov**

Principal Investigator

NASA Cassini Data Analysis and Participating Scientist Program

*Endogenic Heat from Enceladus' South Polar Fractures: Modeling and Observations*

Submitted July 2011.

**O. Abramov**

Principal Investigator  
NASA Mars Science Laboratory Participating Scientist Program  
*Assessing the Extent of Hydrothermal Alteration at MSL Landing Sites with Numerical Modeling and Instrument Investigations*  
Submitted March 2011.

**O. Abramov**

Principal Investigator  
NASA Lunar Advanced Science and Exploration Research Program  
*Exploring Lunar Bombardment History Using Shock-Metamorphosed Zircons*  
Submitted February 2011.

**O. Abramov**

Principal Investigator  
NASA Exobiology Program  
*Early Impact Bombardments on Extrasolar Terrestrial Planets: Implications for Habitability*  
Submitted October 2010.

**S. M. Clifford**

Principal Investigator  
NASA Mars Fundamental Research Program  
*Theoretical Investigations of Volatile and Mineralogical processes in the Cryosphere and Vadose Zone of Mars*

**S. M. Clifford**

Co-Investigator  
NASA Earth Venture-2  
*Orbiting Arid Subsurface and Ice Sheet Sounder (OASIS)*

**Q. Fu**

Principal Investigator  
NASA MSL participating scientist program  
*Carbon Isotope Signatures of Abiotic Methane Generation and Oxidation Processes on Mars*

**G. Galgana**

Co-Investigator  
P. McGovern (Principal Investigator)  
NASA PGG program  
*Growth and Evolution of Large Volcanoes on Venus: Insights from Advanced Numerical Modeling of Lithospheric Response to Volcanic Loading*  
Submitted June 2011

**K. Joy**

Principal Investigator  
University of Manchester, UK.  
*UK The Leverhulme Trust, Early Career Fellowship Scheme.*  
Submitted March 2011.

**K. Joy**

Collaborator with Ian Crawford, Chris Lintott and Steven Bamford  
Birkbeck College, UK.

*UK The Leverhulme Trust. Moon Zoo Science Support.*

Support for Post-Doc. and science support

Submitted October 2010.

**K. Joy**

Sarah A. Fagents (Principal Investigator), Christopher W. Hamilton, David Garmire (Collaborators),  
and Ian A. Crawford, and Katherine Joy. No-cost collaborator.

NASA Lunar Advanced Science and Exploration Research Program.

*Preservation of Exogenous Volatiles in Lunar Regolith Deposits: Computational, Experimental and Remote Sensing Studies*

**K. Joy**

Oleg Abramov (Principal Investigator) with David A. Kring (Co-Investigator), Stephen J. Mojzsis (Co-  
Investigator), and (Collaborators) Katherine Joy and Axel Wittmann. No-cost collaborator.

NASA Lunar Advanced Science and Exploration Research Program.

*Exploring Lunar Bombardment History Using Shock-Metamorphosed Zircons.*

**W. S. Kiefer**

Co-investigator

NASA Lunar Advanced Science and Exploration Research Program

*Complete Restoration of the ALSEP Data, April through June 1975, and the Associated Metadata*

**W. S. Kiefer**

Co-Investigator

NASA Cosmochemistry program

*Experimental and Theoretical Studies of Geochemical Evolution and Thermal Structure of the  
Martian Mantle: Test for the Martian Magma Ocean Hypothesis*

**W. S. Kiefer**

Co-Investigator

NASA Mars Fundamental Research Program

*Density and Porosity of Martian Crustal Materials*

**W. S. Kiefer**

Member of Project Advisory Board

NASA Opportunities in Education and Public Outreach for Earth and Space Sciences Program

*Year of the Solar System: Digital Media for K-12 Planetary Sciences*

**G. Kramer**

Kramer is Co-I

NASA LASER program

*"Analysis of Pyroclastic Deposits on the Moon: Characterization of Major and Minor Constituents"*

**G. Kramer**

Kramer is Co-I

NASA LASER program

*"Study of the origin of the high surface albedo at lunar magnetic anomalies"*

**D. A. Kring**

Co-Investigator

NASA Lunar Advanced Science and Exploration Research Program

*"Exploring Lunar Bombardment History Using Shock-Metamorphosed Zircons"*

**D. A. Kring**

Co-Investigator

NASA Lunar Advanced Science and Exploration Research Program

*"A Test Program for In-Situ LDRIMS Rb-Sr Geochronology Instrument"*

**P. J. McGovern**

Principal Investigator

NASA Planetary Geology and Geophysics Program

*Growth and Evolution of Large Volcanoes on Venus: Insights from Advanced Numerical Modeling of Lithospheric Response to Volcanic Loading*

**P. J. McGovern**

Co-Investigator

NASA Planetary Geology and Geophysics Program

*Three-dimensional Analysis of Ring Fault Initiation and Caldera Formation on the Terrestrial Planets*

**P. J. McGovern**

Principal Investigator

NASA Outer Planet Research Program

*Copious volcanism on a compression-dominated planet? Insights into magma ascent and mountain building on Io from advanced numerical modeling.*

**P. J. McGovern**

Principal Investigator

NASA GRAIL Guest Scientist Program

*Volcanic and thermal evolution of the Moon: constraints from integrated analysis of GRAIL gravity and other remotely sensed datasets.*

**S.J. Mackwell**

Principal Investigator

Other PIs: J. Tyburczy at Arizona State University, D. Kohlstedt at University of Minnesota

NSF CSEDI Program

*CSEDI Collaborative Research: Electrical conductivity of deformed partially molten rocks: Implications for upper mantle structure and dynamics*

**P. D. Spudis**

Principal Investigator

*LASER: Studies of the lunar impact process*

**A. H. Treiman**

Principal Investigator

NASA LASER program

*"Volatiles in the Moon's Highlands Crust: Apatite, Nominally Volatile-Free Minerals, and Cordierite."*

Submitted February, 2011.

**A. H. Treiman**

J. Gross is Principal Investigator; Treiman is Co-Investigator  
NASA LASER

*"Spinel-rich lithologies in the lunar highland crust: Linking lunar samples, crystallization experiments and remote sensing."*

Submitted February, 2011.

**A. H. Treiman**

Principal Investigator  
NASA Cosmochemistry

*"Volatiles in the Moon's Highlands Crust: Apatite, Nominally Volatile-Free Minerals, and Cordierite."*

Submitted May 2010.

**A. H. Treiman**

J. Gross is Principal Investigator; Treiman Co-Investigator  
NASA Cosmochemistry NASA LASER program,

*"Spinel-rich lithologies in the lunar highland crust: Linking lunar samples, crystallization experiments and remote sensing."*

Submitted May, 2011.

**A. H. Treiman**

M. McCanta (Tufts University) is Principal Investigator; Treiman is Co-Investigator  
NASA Cosmochemistry

*"Oxygen Reservoirs in the Solar System and the Thermal History of Chondrite Parent Bodies: Perspectives from the R Chondrites"*

Submitted May 2010.

**A. H. Treiman**

M. Choukroun of JPL is Pprincipal Investigator; Treiman is Co-Investigator  
NASA Cosmochemistry

*Weathering of Volcanic Materials under Venus Conditions*

Submitted May 10.

**T. Usui**

Principal Investigator  
NASA Mars Fundamental Research Program

*Experimental and theoretical studies of geochemical evolution and thermal structure of the Martian mantle: Test for the Magma ocean hypothesis*

**T. Usui**

Principal Investigator  
NASA Cosmochemistry Program

*Experimental and theoretical studies of geochemical evolution and thermal structure of the Martian mantle: Test for the Magma ocean hypothesis*

**O. White**

Co-Investigator

Cassini Data Analysis and Participating Scientist Program (2011)

*The Snowpack of Enceladus – the Creep of Craters: Mapping Thermal Histories and Plume Deposition on Saturn’s Mid-Size Icy Satellites.*

## **APPENDIX V: Scientific Staff - Service to NASA and the Scientific Community**

### **Abramov**

- Lunar and Planetary Science Conference (LPSC) Program Committee: Member of Impact Cratering panel. Lunar and Planetary Institute, January 10-January 13, 2011.
- Served on a proposal review panel for NASA Mars Fundamental Research Program, October 2011.
- Served as external manuscript reviewer for Planetary and Space Science (1 review, October 2010), Icarus (1 review, November 2010), and Journal of Geophysical Research (1 review, May 2011).
- Served as external reviewer for the following NASA grant programs: Mars Data Analysis Program (1 review, January 2011), Outer Planets Research Program (1 review, February 2011), and Planetary Geology and Geophysics Program (1 review, August 2011).
- Editor of: Kring, D.A., O. Abramov, M.G. Galenas, K.H. Joy, G.Y. Kramer, C.N. Mercer, A.L. Nahm, T. Niihara, T. Öhman, J. F. Rapp, A.J. Shaner, S. Simmons, M.B. Weller, and O.L. White (2011) Lunar Analogue Training at Meteor Crater, Arizona & the San Francisco Volcanic Field, AZ (Field trip guide), O. Abramov (editor), 113 p., Lunar and Planetary Institute, Houston, TX. LPI Contribution 1618.

### **Clifford**

#### ***Mission Participation:***

- Deputy Science Team Leader, WISDOM VHF ground penetrating radars (Valerie Ciarletti, PI), as part of instrument payload for ESA's 2018 ExoMars Mission rover (w/possible duplication of WISDOM on NASA's Max-C rover).
- Deputy Science Team Leader, EISS/NetStation HF ground penetrating radar (Valerie Claletti, PI). NetStation is an advanced network implementation of the EISS HF GPR originally developed for the ExoMars Humbolt (Lander) Payload. The NetStation GPR is being developed for possible inclusion in ESA's multi-station geophysical network mission in 2020.
- Member, ExoMars Science Working Team (ESWT), group responsible for identifying and developing the operational strategy for addressing the science objective of ESA's contributions to the 2018 ExoMars Mission. Composed of representatives of ESA management and representatives from each of the ExoMars instrument teams.
- U. S. Participating Scientist, MARSIS orbital radar sounding instrument (Giovanni Picardi and Jeff Plautt, PIs), ESA Mars Express Mission.
- Science/Instrument Team Co-I, CONSERT HF radar orbiter/lander (Wlodeck Koffman, PI) on ESA's ROSETTA comet mission.
- Science/Instrument Team Co-I, ASSERT HF radar orbiter/lander (Wlodeck Koffman, PI) for JAXA Hayabusa 2 mission.

#### ***Editorial Roles***

- Guest Editor, 5th Special Issue on Mars Polar Science & Exploration, Icarus, manuscript submission deadline: April 2012.
- Associate Editor, International Journal of Astrobiology.
- Associate Editor, Astrobiology.

#### ***Organization of Meetings, Workshops and Special Sessions:***

- Session Organizer and Co-Chair (w/V. Ciarletti and E. Heggy), P12: Planetary Radar Investigations: Observations, Theory, Lab Measurements, Field Analogues, and Future Opportunities, 2010 Fall AGU Special Session, San Francisco, CA, December 2010.
- Conference Organizer and Co-Convener (w/R. Zurick, S. Byrne, D. Fisher, M. Hecht, T. Titus, and K. Yoshikawa), Fifth International Conference on Mars Polar Science and Exploration, Fairbanks, Alaska, September 2011.
- Session Organizer and Co-Chair (w/ V. Ciarletti, E. Heggy, W. Kofman and N. André), EPSC-DPS Joint Meeting Special Session, Radar Investigations of Planets, Moons and Small Bodies, Nantes, France, October 2011.
- Session Organizer and Co-Chair (w/V. Ciarletti and E. Heggy), Fall AGU Special Session: Planetary Radar Investigations: Observations, Theory, Lab Measurements, Field Analogues, and Future Opportunities, San Francisco, CA, December 2011.
- Conference Organizer and Co-Convener (w/D. Beaty, J-P Bibring, R. Craddock, J. Farmer, F. Forget, and H. Newsom), Third International Conference on Early Mars, Mammoth Lake, CA, May 2012.

Conference Sessions Co-Chaired (but not organized):

- (w/Agustin Chicarro), The Possible Effects that the Planet's Internal Structure and Movements may have had on Habitability Issues, The International Conference: Exploring Mars Habitability June 13-15, 2011 – Lisbon, Portugal.
- (w/Timothy Titus) Special Session: Cryospheres II: Martian Ground Ice and Associated Landforms, 42nd Lunar and Planetary Science Conference, March 2011.
- (w/Timothy Titus) Special Session: Cryospheres III: Active Ice Processes, 42nd Lunar and Planetary Science Conference, March 2011.

***Other:***

- Member, Mars Exploration and Program Analysis Group (MEPAG), 2000-present.
- Mars Group Chief, 2010 NASA Planetary Geology & Geophysics Review Panel (September 2010).
- External Reviewer, NASA Mars Data Analysis Program, 2010.
- External Reviewer, NASA Mars Fundamental Research Program, 2010.

**Fu**

- LPSC 2011 Program committee member (for Astrobiology sessions), January 2011.
- Reviewed manuscripts for:
  - Geology
  - Geochemical Transactions

**Galgana:**

- Reviewed book proposal for Cambridge University Press, August 2011.

**Joy:**

- Program Committee for the Lunar and Planetary Science Conference (March, 2011)
- Session Chair at the Lunar and Planetary Science Conference (March, 2011)
- Session Chair at the RAS UK National Astronomy Meeting (April, 2011)
- Reviewer of grants for NASA LASER program (2011)

- Reviewer of manuscripts for Earth, Moon and Planets, Icarus, Geochemica Cosmochemica Acta and Meteoritics and Planetary Science
- Co-I on the Chandrayaan-1 X-ray Spectrometer (mission finished in 2009, however, science analysis is ongoing)
- Co-I on the Mercury Imaging X-ray Spectrometer for Bepi Columbo mission to Mercury (launch in ~2014)
- Member of the UK Penetrator Consortium
- Participant in the Lunar Net mission submitted to 2010 ESA Cosmic Vision round (Dec. 2010) (Not Selected at Review)
- Member of the Bepi-Columbo (ESA) Surface Composition Working Group

#### **Kiefer:**

- NASA Planetary Geology and Geophysics Review Panel (Group Chief for Geophysics), Sept. 2011.
- Member of Science Team for Dawn Mission Encounter with Asteroid 4 Vesta (2011-2013).
- Venus High Temperature Seismometer instrument development team (2009-present).
- NASA Venus Exploration Analysis Group (2005-present).
- Co-convener and session chair for AGU special sessions “Interior Structure and Evolution of the Terrestrial Planets I and II”, sessions DI-33B and DI-43A, Dec. 2010.
- Judge for Best Student Paper Contest for AGU Study of the Earth’s Deep Interior section. Fall AGU, December 2010.
- Session chair for LPSC session “Planetary Dynamics and Tectonics”, March 2011.
- External reviewer for Mars Fundamental Research Program Review Panel, Mars Data Analysis Program Review Panel, NASA Postdoctoral Program, and for Netherlands Space Office.
- Journal manuscript reviewer for Icarus, Earth and Planetary Science Letters, and Planetary and Space Science.
- Red Team reviewer for ESA Lunar Farside Explorer mission proposal.

#### **Kramer:**

- Co-author: Kring D.A., Abramov O., Galenas M.G., Joy K.H., Kramer G.Y., Mercer C.N., Nahm A.L., Niihara T., Öhman T., Rapp J.F., Shaner A.J., Simmons S., Weller M.B., and White O.L. (2011) Lunar Analogue Training at Meteor Crater, Arizona & the San Francisco Volcanic Field, AZ (Field trip guide). O. Abramov (editor), 113 p., Lunar and Planetary Institute Contribution 1618, Houston, TX.
- LPSC Session Chair, March, 2011
- AGU Session Co-organizer and Chair, December, 2011
- NASA Mars Data Analysis Program Proposal Review Panel Member, January 10-14, 2011
- LPI Seminar Co-Organizer, September, 2011 – present
- Lunar Swirls Workshop Without Walls, NASA Lunar Science Institute, Moffett Field, CA, September 7, 2011
- Lunar Grad Con. July 18, 2011.
- Lunar Swirls Lunch (at LPSC), March 9, 2011

#### **Kring:**

- Chair, Barringer Family Fund for Meteorite Impact Research (2010-2011)
- Chair, Eugene Shoemaker Impact Crater Award (2010-2011)
- Member, Executive Council, NASA Lunar Science Institute (2009-present)
- Member, LEAG Lunar Exploration Roadmap committee

- Co-Organizer of the NLSI South Pole-Aitken Focus Group
- Co-Organizer of the NLSI Lunar Bombardment Focus Group
- Per a request from NASA Headquarters, I prepared a plan to use the Black Point Lava Flow analogue test site to conduct operational tests of a mission to an NEO.
- Lead Instructor: Developed a training program for the new class of astronauts. The subjects were impact cratering processes, the petrology of lunar samples affected by impact events, and an introduction to volcanic processes. The training program involved a short course and laboratory exercises (at LPI in February 2011) and a series of field exercises at Meteor Crater and the San Francisco Volcanic Field (in Arizona in April 2011).
- Member, Science Team, Development of the NASA Desert RATS simulation of mission activities at a Near-Earth Asteroid
- Science Team Leader, Science Operations Room, Mission Control Center (Houston), for the NASA Desert RATS simulation of mission activities at a Near-Earth Asteroid
- Member, Tiger Team - Impactites on Mars, Mars Science Laboratory (MSL) Landing Site Working Group (October-December 2010); I should point out, however, that I was unable to co-chair this Tiger Team as requested, because of other commitments. Thus, my role was simply a supportive one.
- Reviewed proposals for:
  - 1) NASA Moon Mars Analogue Mission Activity Program
  - 2) Research Council of Canada
  - 3) Deutsche Forschungsgemeinschaft (DFG)
- Reviewed manuscripts for:
  - 1) Journal of Geophysical Research
  - 2) Elements

#### **Lasue:**

- Selection committee panel member for NASA Planetary Geology and Geophysics program 2011
- Participant, ChemCam instrument slated for launch on MSL in 2011.
- Participant, MSL landing site selection
- Reviewed various papers for Nature, Icarus, Geophysical Research Letters, Monthly Notices of the Royal Astronomical Society, Journal of Quantitative Spectroscopy and Radiative Transfer

#### **McGovern:**

- Co-convener of Special Session P36 at 2011 Fall AGU Meeting: *Volcanism Associated with Impact Basins in the Solar System*.
- LPSC XLII Program Committee, January 2011.
- Co-Investigator, RAVEN (RADARSAT at Venus) Mission: A Discovery proposal to send a modern radar instrument (RADARSAT) to Venus, to perform Synthetic Aperture Radar (SAR) imaging, topography, and InSAR (Interferometric SAR) analysis of potential ongoing deformation on Venus.
- External reviewer, NASA MFRP program proposals.
- Reviewed papers for journals *JGR-Solid Earth*, *JGR-Planets* (several), *Geophysical Research Letters*, and *Earth and Planetary Science Letters*.

#### **Mackwell:**

- Member of Steering Committee and Inner Planets Sub-committee for NRC Planetary Decadal Survey 2013-2022
- Member of Steering Committee and Vice-Chair of Discovery and Characterization Committee for

- NRC Study to Review Near-Earth Object Surveys and Hazard Mitigation Strategies, 2009-2010
- Member of Senior Review Panel of the Astrophysics Division Operating Missions, NASA
- Advisory Committee, Winchell School of Earth Sciences, University of Minnesota, Minneapolis
- Advisory Committee, Department of Physics, University of Houston - Clear Lake, Houston
- Advisory Committee, Professional Masters Degree Program in Space Studies, Rice University
- Editorial Board, Physics and Chemistry of Minerals, Springer-Verlag, Berlin
- Co-Editor, Comparative Planetary Climatology (with M. Bullock), University of Arizona Planetary Science Series (in progress)
- Gilbert Award Committee, Geological Society of America
- Executive Committee, Lunar Exploration Analysis Group, NASA
- Executive Committee, Venus Exploration Analysis Group, NASA

**Öhman:**

- Reviewer for Meteoritics & Planetary Science
- Reviewer for Geologica Acta

**Schenk:**

- Dawn at Vesta participating scientist.
- Scientific editor, LPIB

**Spudis:**

- Program Committee member, Wet vs. Dry Moon Workshop, LPI, June 2011
- LEAG member, founding-present
- Proposal Reviewer, External: NASA Cosmochemistry, PG&G, NIAC
- Recipient of 2011 National Space Society "Space Pioneer Award" for Best Science/Engineering paper (Spudis and Lavoie, 2010) and space policy advocacy. Presented at International Space Development Conference, Huntsville AL, May 2011.

***Mission Participation***

- Deputy PI, Mini-RF experiment, Lunar Reconnaissance Orbiter (ongoing)
- Co-I, SAR, MuSAR Discovery mission to Venus

**Sandu:**

- External reviewer for ROSES 2011 program (Planetary Geology and Geophysics Division)

**Treiman:**

- \*NRC Decadal Survey: Member of Inner Planets panel (Mercury, Venus, Moon). June 2009 – Sept 2011.
- VEXAG: Member of Steering Committee for the "Venus Exploration Analysis Group." May, 2008 - present.
- VEXAG (Venus exploration analysis group) Member, 2005 – present
- CAPTEM (Curation and Analysis Planning Team for Extraterrestrial Materials), Member, 2007-present.
- MSL-MAHLI-UV Study group: Lead. Small group to investigate what, if anything, can be done with the UV fluorescence capability on the MAHLI camera on MSL. Sept. 2010 ongoing.
- Review Panel Member, Mars Data Analysis Program. January 2011
- Review Panel Member: NASA LARS. Sep. 2011.
- Lunar Sample Acquisition and Curation Review Team, Member Nov. 2008 – Jan. 2010.

- Reviewer of multiple proposals for NASA panels.
- Initial planning for a 2012 meeting: “Second Conference on the Lunar Highlands Crust.”

**Usui:**

- Working group member of Mars Exploration with Lander-Orbiter Synergy (JAXA)
- Review panels: Planetary Geology & Geophysics
- Journal reviews: Geochimica et Cosmochimica Acta, Meteoritics & Planetary Science

**Wittmann:**

- Co-host of the Friday seminar until October 2010.R
- Review Panel member with the Shoemaker Award (1 proposal). October 2010.
- Reviewed 2 manuscripts:
- Meteoritics and Planetary Science (1), Chapter for Textbook on Impact Cratering (1).

**White:**

- Co-chair of the LPI seminar series.
- Member of the Royal Astronomical Society, Geological Society of London and American Geophysical Union.

**APPENDIX VI: Summer Student Activities LPI/ NASA JSC Undergraduate Summer Intern Program**

**June 6- August 12, 2011**

<b>INTERN</b>	<b>UNIVERSITY</b>	<b>ADVISOR</b>
Rachel Barnett	University of New Mexico	John Jones / Dave Draper
Kevin Michael Cannon	Queen's University	Brad Sutter
Mattias Par Karl Ek	University of Gothenburg	David Mittlefehldt
Julia Gorman	University of Rochester	Juliane Gross / Allan Treiman
Samantha Jacob	University of Hawai'i at Manoa	Celestine Mercer / Allan Treiman
Erica Ruth Jawin	Mt. Holyoke College	Walter Kiefer
Kelly Nickodem	University of Notre Dame	Kevin Righter / Lisa Danielson / Cin-Ty Lee
Spenser Pantone	Weber State University	Paul Spudis
Kathryn Elizabeth Powell	Rice University	Pat McGovern
Lee Saper	Brown University	Carlton Allen
Lillian Schaffer	University of Houston	David Kring
Yifan Wang	Imperial College London	John Shebalin

**NLSI Lunar and Exploration Graduate Interns  
May 31 – August 07, 2011**

<b>INTERN</b>	<b>UNIVERSITY</b>	<b>ADVISOR</b>
David Blair	Purdue University	David Kring
Sarah Crites	University of Hawai'i	David Kring
Myriam Lemelin	Universite de Sherbrooke	David Kring
Daniela Nowka	Freie Universitat Berlin	David Kring
Agata Przepiorka	Space Research Centre of the Polish Academy of Sciences	David Kring
Stephanie Quintana	Colorado School of Mines	David Kring
Carolyn Roberts	SUNY at Buffalo	David Kring
Kirby Runyon	Temple University	David Kring
Claudia Santiago	University of Texas, El Paso	David Kring
Tiziana Trabucchi	University of New Brunswick	David Kring

## APPENDIX VII: Mentoring

### Clifford:

- Donald Barker, *Department of Geosciences, University of Houston, Houston, TX*. PhD candidate. Research focus: Mars exploration geophysics and the application of sequence stratigraphy to investigations of the Martian hemispheric dichotomy. Have worked with him on various research projects associated with his 3 previous MS degrees. Currently I serve as his co-adviser and as a member of his PhD committee.
- Yann Berquin, *Laboratoire de Planétologie de Grenoble, Université Joseph Fourier, Grenoble, France*. Low-Frequency sounding radar investigations of Ganymede. PhD student research project collaborator. Principal Adviser: W. Kofman.
- Josephine Boisson, *Institut de Physique du Globe de Paris and Université Paris 7, Paris, France*. PhD defended July 2011. Project: An examination of MARSIS radar sounding data for evidence of subpermafrost groundwater. PhD dissertation committee member Principal Advisors: E. Heggy and Ph. Lognonné.
- Cyril Grima, *Laboratoire de Planétologie de Grenoble, Université Joseph Fourier, Grenoble, France*. PhD defended January 2011. Etude de la surface et de la subsurface de Mars par sondage radar, grâce à l'exploitation des données SHARAD (Mars Reconnaissance Orbiter, NASA) et MARSIS (Mars Express, ESA), 2010-2011. PhD dissertation committee member and Rapporteur Principal Adviser: W. Kofman.

### Galgana:

- Attended Crustal Deformation Modeling Workshop by the Computational Infrastructure on Geodynamics Group, June 20-22, 2011.
- Thesis committee member of MS Geomatics Engineering Student, College of Engineering, University of the Philippines, Diliman, Quezon City (2011-Present).

### Kiefer:

- Post-doc adviser for Dr. Constantin Sandu (LPI), Improved Models of Magma Production and the Thermal Evolution of Mars, July 2010-present.
- Post-doc adviser for Dr. James Solano (NASA Johnson Space Center), Crustal Structure of Asteroid 4 Vesta, July 2011-present. (co-adviser with Dr. Duck Mittlefehldt of NASA JSC).
- Erica Jawin is writing an undergraduate senior thesis at Mt. Holyoke College on the relationship between topographic roughness and radar scattering at lunar volcanic structures. I am serving as a co-adviser of the project. August 2011-present.

### Joy:

- Shoshana Weider, Birkbeck College London, UK. PhD candidate. Project "Studies of lunar evolution by combining remote-sensing datasets with new orbital X-ray fluorescence spectroscopy from C1XS on Chandrayaan-1". Completed January 2011. Principal Adviser: I. Crawford.
- Joshua Snape, University College London, UK. PhD candidate. Project: "Studies of the Lunar Regolith based on Meteorite and Apollo samples" Principal Adviser: I. Crawford.
- Louise Alexander, University College London, UK. PhD candidate. Project: "Apollo 12 regolith basalt fragments". PhD Co-supervisor. Principal Adviser: I. Crawford.

### Kramer:

- LPI Undergraduate Intern Program. “Olivine Detections at the Rim of the Crisium Basin with Moon Mineralogy Mapper”, July-August, 2011
- LPI-sponsored Foreign Intern Program, “The Pristine Basalt Mineralogy of Mare Frigoris” April-July, 2011
- CLSE-sponsored High School Lunar Research Projects, January-May, 2011

**Kring:**

- Lead, The Lunar Exploration Summer Intern Program
- Lead, The Field Training and Research Program at Meteor Crater
- Helped advise a Ph.D. planetary science student at the University of Arizona (study of meteoritic impact melt ages); the student successfully completed his Ph.D. thesis this year.
- Helping advise a Ph.D. geology student at the University of Houston (study of lunar green glasses)
- Helping advise a M.S. geophysics student at the University of Houston (study of Meteor Crater)
- Helping advise a Ph.D. geology student at the University of California- Berkeley (study of Meteor Crater and Martian gullies)
- Through the NLSI-CLSE program, I am supporting five additional graduate students at other universities
- Continuing to work with a team of faculty and graduate students that conducted (at end of last reporting cycle) a series of geophysical surveys of Meteor Crater. The team included student members from the University of Houston and the University of Texas-Austin.
- Hosted an undergraduate student from the University of Houston for a summer study of an Apollo 16 impact melt sample
- Continuing to supervise five post-doctoral researchers in lunar science

**Lasue:**

- Co-advisor, J. Mazoyer, 2011 Summer Student for the Institute de Recherche en Astrophysique et Planetologie (Toulouse, France) and the Los Alamos National Laboratory (Los Alamos, New Mexico)

**McGovern:**

- Intern Co-Advisor (with Dr. Gerald Galgana): Katelyn Verner, Southern Methodist University, 2010 LPI/JSC Summer Intern Program. Katelyn presented her work at LPSC XLII in March 2011 (see abstract in section II. above)
- Intern Co-Advisor (with Dr. Georgiana Kramer): Kathryn Powell of Rice University, 2011 LPI/JSC Summer Intern Program.
- Post-doc Advisor: Gerald Galgana, working on the links between lithospheric stress state, magma ascent, and volcano growth at large edifices on Venus (PG&G-supported).
- Ph.D. Co-advisor: Matthew Weller, Rice University, studying flank deformation of Olympus Mons, Mars (supported by a NASA MDAP grant).
- Postdoctoral Fellow Co-advisor: Thomas Fournier, Rice University, studying volcano flank deformation and mechanics of intrusion.

**Schenk:**

- Edger Rivera-Valentin, August – October, 2010, visiting graduate student

**Spudis:**

- Co-advisor and Scientific supervisor, LPI Summer Intern Program, 2010-present

- Intern advisor, Joel Hecker, Mini-SAR radar data analysis
- Intern advisor, Viabhav Dixit, Visiting Grate Student from ISRO/India, April-June 2011, Mini-SAR radar data analysis

**Treiman:**

Post-Doc Advisor: Dr. Celeste Mercer. LPI. "Highland Lithologies in Lunar Meteorites" & "Acid Fog on Mars II." August 2010 to Aug 2011.

Post-Doc Advisor: Dr. Juliane Gross. LPI. "Highland Lithologies in Lunar Meteorites," & "Acid Fog on Mars II." May 2009 to Sep. 2011.

Post-Doc Advisor: Dr. Justin Filiberto. LPI. "Acid Fog on Mars," Oct. 2006 to Sept. 2009. Dr Filiberto has moved to Rice U., and remains associated as a colleague, and funded under Treiman's grant.

- Graduate Student Advisor: Yolanda Cedillo-Flores, Ph.D. student at the Universidad Nacional Autonoma de Mexico. Advising her on completion of a manuscript on gas fluidization in formation of Martian Gullies. May 2011 through October 2011.

**White:**

- Assisted with supervision of Edgard Rivera-Valentine of the University of Arkansas, as intern outside of the LPI Summer Intern Program, during August-October 2011.

## **APPENDIX VIII: Scientific Staff - Education/Public Outreach Activities**

### **Abramov:**

--E-mail interview, May 6, 2011, with science writer Dr. Thorsten Dambeck, about my recent Icarus paper entitled "Abodes for life in carbonaceous asteroids?"

--E-mail interview, May 8, 2011, with Emily Lakdawalla, who writes for the Planetary Society, about the Icarus paper. Resulting article here: <http://www.planetary.org/blog/article/00003027/>

--Developed science-based materials that can be used in EPO activities. Examples include: (i) Cover illustration of Arizona field trip booklet (see Section IB), (ii) Figures 4-11 in my contribution to the Arizona field trip booklet (pages 39-46, see Section IB), and (iii) aerial photos of Meteor Crater, San Francisco Volcanic Field, and Grand Canyon, presented at LPI Science Lunch and available internally on a shared drive.

### **Clifford:**

--Science Mentor, Opportunities in Education and Public Outreach for Earth and Space Sciences, "Sustainable Trainer Engagement Program: Creating a Sustainable Trainer Engagement Program for Earth and Space Science", PI: Christine Shupla.

### **Joy:**

--Team member of the Moon Zoo citizen science project

- Moon Zoo blog author
- Moon Zoo Forum participation

--Public Talks: Meet the Meteoriticist public presentation in Greenwich UK, part of the 2011 MetSoc conference

--Education illustrations (x2) for CLSE LPI website

### **Kiefer:**

--Content adviser and science reviewer for LPI's "Explore Astrobiology" informal education (library based) program.

--Science reviewer for NASA Year of the Solar System materials.

--Science reviewer for "eruptions and Collisions in the Solar System: Identifying Volcanos and Impacts using Science on a Sphere", a lunar geology module for the Science on a Sphere program.

--W.S. Kiefer, Geophysical and Petrological Constraints on Lunar Crustal Structure, seminar for LPI Lunar Exploration Interns, July 2011.

--W.S. Kiefer, Ther Thermal and Magmatic Evolution of Mars, seminar for LPI Summer Intern Program, July 2011.

--W.S. Kiefer, Roving Mars for Foundation, for International Space Education's United Space School, August 2011.

### **Kramer:**

--Impact Cratering Experiment, Sally Ride Festival, December, 2010

--International Observe the Moon Night, Lunar & Planetary Institute, Houston, TX, October, 2011

--4th grade classroom visit & presentation, Corte Madera, CA, December 12, 2011

--Girl Scout Troop visit, presentation, and star-gazing, Houston, TX, January, 2011

--Mention in popular science articles

--Sky & Telescope "New Insights on Lunar Swirls" by Kelly Beaty, March 24, 2011

--The Planetary Society Blog "Comparing Clementine and Chandrayaan-1 Spectra from the Moon" by Emily Lakdawalla, April 11, 2011

--Lunar Photo of the Day, "Swirling around the Globe",  
<http://lpod.wikispaces.com/September+9%2C+2011>

### **Kring:**

--Working with LPI library and computer staff, Kring continued to update LPI's Lunar Science and Exploration information portal, which is designed to be the "go-to" place for scientists and engineers needing information for their lunar exploration activities.

-- Working with library and computer staff, Kring continued to expand an Apollo Thin-section Atlas ([http://www.lpi.usra.edu/lunar/samples/atlas/thin\\_sections/](http://www.lpi.usra.edu/lunar/samples/atlas/thin_sections/)), which is a component of LPI's Lunar Sample Atlas (<http://www.lpi.usra.edu/lunar/samples/atlas/>).

--Led effort to generate a web-based Lunar Analogue Data Site for Meteor Crater to which we added (a) QuickBird satellite imagery, (b) a new flyover of the crater, (c) two thousand strike and dip measurements of bedding and fracture planes, (d) MODIS satellite imagery, and (e) a new atlas of astronaut images taken from the Space Shuttle and International Space Station. These data are integrated with LPI's guidebook to the geology of the crater and are available at [http://www.lpi.usra.edu/publications/books/barringer\\_crater\\_guidebook/](http://www.lpi.usra.edu/publications/books/barringer_crater_guidebook/). The community response to this data site has been very strong and Kring have preliminary commitments from several other investigators who will contribute their data to the database, which can then be used by the entire planetary science community.

--Continued to lead effort to generate a web-based Lunar Analogue Data site for Black Point Lava Flow, SP Crater, and Colton Crater. This site is used by NASA Headquarters, NASA Centers, and NASA Contractors involved in the lunar and near-Earth asteroid mission simulations in northern Arizona. A version accessible to the public is posted on LPI's system at <http://www.lpi.usra.edu/lunar/analogs/blackpoint/>. The public data site includes satellite images, Space Shuttle images, International Space Station images, aerial photography, and supporting mission simulation documents. This year we dramatically expanded the STS and ISS images on the web site.

--Led effort to develop a web-based set of illustrated briefings about lunar exploration issues that are often misunderstood. These briefings are part of a NLSI-CLSE multi-media web site. One of these illustrated briefings received an enthusiastic response from Jim Green at NASA Headquarters (December 2010). Nine titles have been generated thus far.

--Continued to lead effort to generate classroom illustrations for the educational component of our NLSI activities. This atlas of illustrations has become so large and so successful that we developed (July 2011) an updated web-based interface with the IT staff at LPI.

--Developed new educational card series with the theme Never Stop Exploring. These cards were distributed at LPSC, the NLSI Forum, and several smaller workshops. Electronic versions of the images on the cards can also be downloaded by students and the public from our multimedia page.

--Teacher Education – Kring spoke to a group of about 20 middle school teachers about the geology of impact processes (Rice University, November 2010)

--High School Students – As part of our CLSE program, Kring helped support the "High School Lunar Research Project."

### *Television and Radio Productions:*

--Assisted the BBC with the production of "Planet Dinosaur" (April 2011)

--Interviewed by the Canadian Broadcasting Corporation regarding our Lunar Exploration Intern Program (May 2011).

--Assisted BBC/Discovery in the pre-production phase of a program about impact effects on climate and possible extinctions (June 2011)

*Public Lectures:*

--“Calamitous Climate Change Produced by Impacting Asteroids and Comets.” Presented as part of LPI’s Cosmic Explorations speaker series. January 27th, 2011.

*Electronic Media Events:*

--Featured Scientist, NASA-sponsored podcast titled “How to be a Lunar Scientist.” These and other electronic products that we are developing are posted on the CLSE multimedia web site (<http://www.lpi.usra.edu/nlsi/multimedia/>).

--Featured Scientist, NASA-sponsored podcast titled “Lunar Crater Clues.” These and other electronic products that we are developing are posted on the CLSE multimedia web site (<http://www.lpi.usra.edu/nlsi/multimedia/>)

--Featured Scientist, NASA-sponsored vodcast titled “Understanding Craters.” This product is available for download from NASA at <http://lunarscience.arc.nasa.gov/articles/understanding-craters>.

*Museum & Public Exhibits:*

--As part of the CLSE, I am working with our E/PO staff and artists to generate a series of exhibits for libraries around the country. This year, four exhibits were rotating among U.S. libraries.

--Featured Scientist, interviewed for film to be shown to all visitors at the Meteor Crater Museum

*Interviews & Materials for Print and On-line Media:*

--Provided illustrations for a new educational website that was developed by the Barringer Crater Company; the website is designed to meet national science standards. The educational material is posted at <http://www.barringercrater.com/>.

--Provided text and illustration for a pamphlet that tourist guides use at Tswaing impact crater in South Africa (December 2010).

--Provided content and quotes for the feature article “Agency Spotlight: LPI – The Moon and Beyond,” by Debra Werner for Space News (October 2010).

--Interviewed by Richard Kerr for his article in Science about “NASA Weighs Asteroids: Cheaper Than Moon, But Still Not Easy” (February 18th, 2011).

--Provided content for an article in Imaging News (July 2011) about the detection of new impact craters using orbital assets (June 2011). An on-line version is posted at [http://www.imagingnotes.com/go/article\\_freeJ.php?mp\\_id=274](http://www.imagingnotes.com/go/article_freeJ.php?mp_id=274)

--Interviewed several times by an AP reporter.

--Provided two illustrations and background research results for a professor’s new book titled “Organic Matter in the Universe” to be published by Wiley (February 2011).

**Lasue:**

--News Release, “Rosetta should look south for safe landing site”, European Planetary Science Congress, news release, 2010.

**McGovern:**

--Participated in weekly research group meetings of Prof. Julia Morgan at Rice University.

--Created Earth map materials for use in “Volcanism” unit at Family Space Day at LPI, May 2011.

--Co-Advising (with Prof. Julia Morgan) Ph.D. graduate student and postdoctoral associate at Rice University.

--Brown-bag presentation to LPI summer intern programs: "Venus: a Natural Volcanological Laboratory".

**Öhman:**

--Ask astro: Creating Lunar Craters, Astronomy, April, p. 53.

**Schenk:**

--Interviews with Ron Cowen (August and September, 2011)

--Interview with Earthsim for use of icy satellite topography for visualization

**Spudis:**

--Speaker engagements, LPI teachers workshop, various others

--Hosted space policy workshop for Kingwood High School Debate Team, May 3, 2011

--Write column for Smithsonian Air and Space magazine, "The Once and Future Moon" blog

--Published Op-Ed column, Spudis P.D. and Zubrin R., NASA's mission to nowhere. Washington Times, May 31, 2010, <http://www.washingtontimes.com/news/2010/may/31/nasas-mission-to-nowhere/>

*Media Interviews:*

--The Space Show, Jan. 2011 and April 2011, National Space Policy and Lunar return

--Multiple radio and print interviews on lunar science, space policy

**Treiman:**

--Dwornik award judging. LPSC 2011.

*Presentations:*

--'Cosmic Visions' talk on "Climate Change on Mars,' November, 2011.

--'The Solar System,' five presentation to 4th-grade students at K.E. Little Elementary School, Dickinson ISD, May 6, 2011.

*Public Interviews:*

--Phone interview, Sep. 20 2010, with Michael Schirber of Astrobiology Magazine (astrobio.net) about ALH 84001.

--Email interview with Wired magazine, mid-March 2011.

**Wittmann:**

--Field / Teaching Assistant at the CLSE's Field Training and Research Program at Meteor Crater, Az., Co-supervised 24 students for a week from October 17-23, 2010.

**White:**

--Judged Science Fair at K.E. Little Elementary School, Bacliff TX in February 2011.

--Participated in "Space Day" at K.E. Little Elementary School, Bacliff TX in May 2011.

--Volunteering each month at the LPI Family Space Day activities 2011

## APPENDIX IX: Seminar Speakers

G. Jeffrey Taylor	Hawai'i Institute of Geophysics and Planetology, University of Hawai'i	The Hadley-Apennine KREEP Basalt Igneous Province	February 18, 2011
Takafumi Niihara	The Graduate University for Advanced Studies	U-Pb Isotopic Systematics on Shocked Baddeleyite ~ Implication for Crystallization Age of Shergottites ~	February 23, 2011
Michael Bland	Washington University in St. Louis	The Evolution of Icy Satellites	March 25, 2011
John Sarkissian; Colin Mackeller	CSIRO Parkes Observatory; Editor, Honeysuckle Creek Web Site	The Greatest Show on Earth: The search for the Apollo 11 tapes	March 30, 2011
Peter Isaacson	Brown University	Geology of the Mg-Spinel Lithology and Other Puzzles from the Lunar Farside	April 15, 2011
William Cochran	University of Texas-Austin	Kepler and the Search for Habitable Earths	April 21, 2011
A. W. Needham	Planetary and Space Sciences Research Institute, The Open University	What are we mission in meteoritics? From chondritic cannibalism to water on Mars	May 11, 2011
Maitrayee Base	Washington University in St. Louis	Silicate Stardust in primitive Chondrites	May 12, 2011
Dr. James White	University of Colorado	Sustainability and the New Age of Humans: What you should know	May 20, 2011
Fred John Ciesla	University of Chicago	Particle Transport and Processing in the Solar Nebula	June 10, 2011
Trudi Hoogenboom	Rayleigh-Taylor	Instability as a mechanism for corona formation on Venus	June 30, 2011
Kenneth S. Edgett	Malin Space Science Systems	Mars Volcanism Sampler: Key Questions Addressed Using Orbiter Cameras, 1997-2011	July 22, 2011
Stanley G. Love	NASA JSC	Near-Earth Asteroids: Threats of Extinction, Opportunities for Exploration	July 29, 2011
Aline Zimmer		Target Selection and Mission Analysis of Human Exploration Missions to Near-Earth Asteroids	August 10, 2011
Michelle Kirchoff	SWRI	Investigating the Evolution of	August 26, 2011

		Lunar Impactors with New Crater Distributions	
Dr. Ian Crawford	University College, London	Astrobiological Benefits of Human Space Exploration	September 28, 2011

## **APPENDIX X: NASA Regional Planetary Image Facility and Library**

The NASA Regional Planetary Image Facility (RPIF) at the Lunar and Planetary Institute, one of the first established, is led by Dr. Paul Spudis. As RPIF Director, Dr. Spudis provides overall direction of the facility, interfaces with NASA program management, and serves on the RPIF Board of Directors. As a member of the RPIF network, LPI was the host site for the 2010 RPIF review meeting involving representatives throughout this international network.

As a RPIF, LPI maintains an open-access policy for users and is available to the public during normal business hours. To reach interested users Beyond the Walls of building, the RPIF / Library has made efforts to utilize tools such as website development, social media, and Wikipedia to provide access to the rich resources within the facility. We have scanned and prepared key parts of the collection including the extensive map collection, books, documents, and imagery. Web resources such as the Lunar Map Catalog, Lunar Sample Atlas, and Lunar Orbiter Gallery are viewed and used by not only scientists but also educators, students, and media representatives.

In effort to expand our reach to the amateur science community and general public, we have established and added over 1200 images on the LPI Flickr site with over 68,000 views to date. As an interactive site, viewers can leave comments or tag an image with their keywords for easy retrieval. The tagging allows individual researchers, educators, or the curious to stumble upon planetary images in a new way. We have also worked with other social media sites such as Facebook and Twitter. Facebook, rated 2<sup>nd</sup> most popular site by web information company Alexa.Com, focuses on planetary science in general and LPI meetings and activities specifically. The LPI Facebook page has an international appeal reaching viewers from India, Turkey, Egypt, Philippines, Poland, and Argentina. Work will continue with various social media sites as the Beyond the Walls outreach project continues.

According to Alexa.Com, Wikipedia, an online free encyclopedia, is the 6<sup>th</sup> most popular site in the United States. Of all the people using Wikipedia, college students use it more than the general population as their first source for information. This fact alone makes it imperative that basic planetary science information within Wikipedia be accurate and up-to-date. However, within Wikipedia are assorted planetary science article with varying degrees of accuracy. Using the resources of the Library and its staff, we have made efforts to update articles, add references, and enhance biographies of planetary science investigators. To raise awareness within the planetary science community of this effort, LPI hosted a booth at LPSC to encourage student and scientist involvement in updating and developing good solid planetary science articles and biographies.

In order to provide the support for the Beyond the Walls efforts, the Library staff has evaluated the systems, space, and other resources to provide service for onsite patrons. With many of the new resources available through the Library in a digital format, the Library has provided new options for access and collaboration. After evaluation of the collection, new storage options have been added freeing areas for flexible usage. The new spaces feature interactive whiteboards, projectors, internet-enabled flat panel monitors, and tablets for e-journal access, portable walls, and displays.

As formats and dissemination methods of information change the LPI RPIF / Library is adapting to the needs of patrons both in-house and those in remote locations.

In response to the impending changes in library catalog standards, the staff evaluated our existing system as well as different options. A new library catalog system has been selected and is in the first stages of implementation. This new system will give increased flexibility to library users both distant and onsite. We will begin testing in the fall of 2011 with the final switch to the new system occurring by the end of the calendar year.

The RPIF/ Library facility will continue to serve a broad range of patrons, including funded scientists, educators, students, and the public. The collection, which contains over 60,000 items, is refreshed on a regular basis with the addition of books, journals, and data within the scope of the CAN. We are a member of OCLC, an international network of over 72,000 libraries and AMIGOS, a regional network of 750 libraries. These networks provide access to LPI library collections worldwide.

## **APPENDIX XI: Meeting and Publication Services - Conferences and Workshops**

**Annual Meeting of the Lunar Exploration Analysis Group;** November 16–19, 2009; Houston, Texas; Attendance: 159; Clive Neal (University of Notre Dame) and Stephen Mackwell (Lunar and Planetary Institute).

**NLSI Center for Lunar Science and Exploration Team Workshop;** January 11–12, 2010; Houston, Texas; Attendance: 30; David Kring (Lunar and Planetary Institute)

**Ground-Based Geophysics on the Moon;** January 21–22, 2010; Tempe, Arizona; Attendance: 60; Matthew Fouch (Arizona State University), Andrew Dombard (University of Illinois at Chicago), and Catherine Johnson (University of British Columbia).

**Next-Generation Suborbital Researchers Conference;** February 18–20, 2010; Boulder, Colorado; Attendance: 266; S. Alan Stern (Southwest Research Institute, Boulder), Daniel Durda (Southwest Research Institute, Boulder), John Gedmark (Commercial Spaceflight Federation), Stephen Mackwell (Lunar and Planetary Institute), Mark Sirangelo (Commercial Spaceflight Federation), and Fred Tarantino (Universities Space Research Association).

**41st Lunar and Planetary Science Conference;** March 1–5, 2010; The Woodlands, Texas; Attendance: 1626; Stephen Mackwell (Lunar and Planetary Institute) and Eileen Stansbery (NASA Johnson Space Center).

**Spring CAPTEM meeting;** March 6–7, 2010; Houston, Texas; Attendance 30; Chair: Meenakshi Wadhwa (Arizona State University)

**Spring Meteorite Working Group meeting;** March 5–6, 2010; The Woodlands, Texas; Attendance 15; Chair: Marc Caffee (Purdue University)

**First International Conference on Mars Sedimentology and Stratigraphy (with accompanying field trip);** April 19–23, 2010, El Paso, Texas; Attendance: 91; John Grotzinger (California Institute of Technology) and David Beaty (Mars Program Office, Jet Propulsion Laboratory).

**Astrobiology Science Conference 2010: Evolution and Life: Surviving Catastrophes and Extremes on Earth and Beyond;** April 26–29, 2010, League City, Texas; Attendance: 730; Mary Voytek (NASA Headquarters), Pamela Conrad (Jet Propulsion Laboratory), and Janet Siefert (Rice University).

**Second International Planetary Dunes Workshop: Planetary Analogs — Integrating Models, Remote Sensing, and Field Data;** May 18–21, 2010; Alamosa, Colorado; Attendance: 38; Timothy Titus (U.S. Geological Survey).

**Nördlingen 2010: The Ries Crater, the Moon, and the Future of Human Space Exploration;**

June 25–27, 2010; Nördlingen, Germany; Dieter Stöffler (Museum für Naturkunde, Berlin) and Wolf Uwe Reimold (Museum für Naturkunde, Berlin).

**LEAG Roadmapping Meeting**; July 7–9, 2010, Houston, Texas; Attendance: 10; Clive Neal (University of Notre Dame) and Charles Shearer (University of New Mexico).

**Workshop on Disks, Meteorites, and Planetesimals**, July 24–25, 2010; New York, New York; Attendance: 70; Marc Kuchner (NASA Goddard Space Flight Center), Mordecai-Mark Mac Low (American Museum of Natural History), and Edward Young (University of California, Los Angeles).

## **APPENDIX XII: Department of Education and Public Outreach**

The Lunar and Planetary Institute (LPI) Department of Education and Public Outreach (E/PO) focuses on preparing formal and informal educators, through materials development and training, to infuse Earth and planetary science into their programmatic efforts.

### **Personnel**

The Department is headed by Dr. Stephanie Shipp, with Education Specialists Ms. Heather Dalton, Ms. Brooke Hsu (located at Goddard Space Flight Center), Ms. Andrea Jones (located at Goddard Space Flight Center), Ms. Eve Halligan, Ms. Keliann LaConte, Mr. Andrew Shaner, Ms. Christine Shupla, Education Assistant Yolanda Ballard-Zimmerman, and NLSI Coordinator Ms. Julie Tygielski.

**Programs Planetary Science E/PO Forum** – LPI, in collaboration with NASA's Jet Propulsion Laboratory, Emily A. CoBabe and Associates, Sustainability Schools Consulting, LLC, and the Mid-continent Research for Education and Learning (McREL), supports the NASA Science Mission Directorate (SMD) in the coordination of the Planetary Science Division E/PO community efforts to increase the overall coherence of the SMD E/PO program leading to more effective, sustainable, and efficient utilization of SMD science discoveries and learning experiences. The community includes approximately 150 education specialists and scientists. LPI coordinates communications from NASA Headquarters and SMD, provides orientation and resources for new members, facilitates collaboration and leveraging of resources and efforts among community members, offers professional development based on community needs, and coordinates cross-community thematic efforts. FY2011 activities included participating in weekly planning calls with the SMD E/PO Lead and other Forum leads, hosting monthly community calls and the annual community meeting, organizing data calls for the SMD E/PO portfolio, managing the SMD E/PO community online workspace (<http://smdepo.org>), overseeing the Year of the Solar System (YSS) content development and marketing, offering online professional development training, coordinating conference participation, engaging scientists, supporting SMD E/PO portfolio analysis and participating in audience-based working groups. Presentations and posters about these efforts were presented at various conferences, including the American Geophysical Union Conference in San Francisco and the Lunar and Planetary Science Conference in Houston.

**NASA Lunar Science Institute E/PO Programs** – The Department is supporting three of the selected NASA Lunar Science Institute teams in their E/PO efforts: 1) Center for Lunar Science and Exploration / LPI and the Astromaterials Research and Exploration Science (ARES) of the Johnson Space Center (JSC); 2) Center for Lunar Origin and Evolution / Southwest Research Institute (SwRI); 3) Johns Hopkins Applied Physics Laboratory (JH/APL)

**Center for Lunar Science and Exploration / LPI and ARES High School Student Lunar Mentoring and Research Program** - Seven teams of four to five students and their teachers participated in the eight-month High School Lunar Mentoring and Research Program. The program is designed to expose high-school students to science and science careers, with an emphasis on lunar science and exploration. Each student team conducted an authentic lunar research project under the guidance of an online lunar scientist mentor. Based on research presentations presented to lunar scientists, the team from Kickapoo High School, Springfield, Missouri, presented their lunar research poster - *Using Boulder*

*Diameter / Crater Diameter Ratios to Differentiate Primary from Secondary Craters on the Lunar Surface* - at the NASA Lunar Science Institute Forum at NASA Ames Research Center (07/19-21/2011). The FY2012 program has expanded to 16 teams, 14 of which serve underserved / underrepresented populations, including rural communities.  
<http://www.lpi.usra.edu/nlsi/education/hsResearch/>

**Traveling Library Exhibit Program** - Five traveling exhibits, designed to engage the general public in lunar science and exploration, and to share NLSI research, are available for loan to libraries, science centers, planetariums and other informal learning institutions serving primarily underserved and under-represented audiences. The exhibits include how the Moon formed, the scientific relevance of lunar exploration, and lunar craters. Three more exhibits currently are in development. As of July, 2011, the exhibits have visited 17 locations and been viewed by 85,000 visitors. Two additional exhibits are ready for fabrication and four are in development. <http://www.lpi.usra.edu/nlsi/education/exhibits/>

**Center for Lunar Origin and Evolution / SwRI Librarian Training Program** - Twenty-two library, planetarium, observatory, and museum staff attended a two-day professional development workshop in Bismarck, North Dakota on April 13-14, 2011 to explore the formation and evolution of the Moon, and its influence on Earth and humans. The participants were trained in the use of the materials to engage children and families in lunar science in the informal learning environment through the use of the Marvel Moon module of approximately 17 hands-on activities. Training included live and virtual presentations by SwRI NLSI scientists, as well as implementation of the module activities and exploration of how the participants will integrate the content and materials into their own programs. This and future trainings target informal educators serving underserved and under-represented audiences. The 22 participants have the potential to reach a minimum of 6,500 children over a 5 year period.  
<http://www.lpi.usra.edu/education/explore/marvelMoon/>

**JH/APL High School Educator Lunar Workshops** – Twenty high school teachers spent a week at the Johns Hopkins University Applied Physics Lab, learning about current lunar science and exploration, including an in-depth examination of the environment of the lunar poles. Participants interacted with NLSI scientists in person and virtually, undertook hands-on activities, and planned for implementation of lunar investigations in their classrooms. An online workspace for continued networking and collaboration was utilized throughout the experience. Evaluations extremely positive; 100% reported the institute, activities, and presentations were very good to excellent, with 89% reporting all were excellent.  
<http://www.lpi.usra.edu/education/workshops/unknownMoon/>

**MyMoon** - LPI is collaborating with lunar scientists, educators, artists, and the public to engage a population of new lunar enthusiasts between 18 and 25 through an online educational new-media portal. The target audience is invited to interact with lunar content that informs them about NASA's lunar science research and missions, and engages them in future plans for lunar exploration through online webcasts, exhibits, events, contests, and opportunities for involvement. A distributed "street team" of seven members of the target audience has been created. The street team will use social media to engage the target audience in the conversation about Moon in culture, science and exploration. Efforts over the next year will focus on community development.  
<http://www.lpi.usra.edu/mymoon/>

**International Observe the Moon Night (InOMN)** - LPI partnered with NASA Goddard Space Flight Center (LPI Team member Brooke Hsu, project lead), NASA Ames Research Center, NASA Marshall Space Flight Center, and the NASA Lunar Science Institute to design, implement, and host the second annual InOMN, designed to engage the general public in lunar science and exploration. Almost 600 sites in 50 countries participated. LPI developed and maintained the 2011 interactive project website. LPI also hosted an InOMN event in partnership with the JSC Astronomical Society in conjunction with Astronomy Day. LPI staff interacted directly with over 400 parents and children at the George Observatory; more than 2000 people attended the Astronomy Day events.  
<http://www.lpi.usra.edu/observethemoonnight/>

**Explore! Program** – For over a decade Explore! programs have been sharing Earth and space science through informal venues such as libraries and after school programs. The program encompasses development of children’s activities and preparation of children’s program providers, with an emphasis on those serving underserved and underrepresented communities including rural areas. To date, over 700 librarians have been trained in 25 states. The LPI Education Team maintains contact with these trainers by sharing new resources and Earth and space science news and opportunities for involvement through online Explore! discussion boards. It is estimated that the trainers are reaching a minimum of 30,000 children per year through their Explore! programs.  
<http://www.lpi.usra.edu/education/explore/>

FY11 activity included:

- Delivery of a Jupiter’s Family Secrets (Juno Mission) workshop for 24 library, planetarium, museum, and science center staff in Grand Island, Nebraska on February 16-17;
- Delivery of the Center for Lunar Origin and Evolution / SwRI Librarian Training described above;
- Development of a Discover Earth module of hands-on activities and programming ideas to accompany a library exhibit for the NSF-funded STAR\_Net project (PI Paul Dusenbery of Space Science Institute);
- Design of a two-day Discover Earth training for STAR\_Net exhibit hosts;
- Development of a module of astrobiology activities with emphasis on engaging girls in science; this will be used in collaborations;
- Co-hosting of a Special Interest Group at the July 2011 Astronomical Society of the Pacific annual conference on partnering with libraries to bring NASA science into the library; and
- Collaboration on an NSF proposal with San Jacinto Community College and Space Center Houston to train librarians in the development and implementation of Earth and space science exhibits in their libraries (PI Scott Hairston, San Jacinto).

Beyond training new trainers and visiting new states, future program efforts will concentrate on developing strategies to increase collaboration among the extended Explore! community in ways that are meaningful to the community members. This strategy will be implemented in FY12 with Explore’s Juno Mission efforts.

**Educator Workshops** – The LPI Education Team continues to work closely with the JSC ARES Education Team and the Harris County Department of Education (HCDE) to provide deep training to classroom science teachers in the Houston area. Through the trainings participants experience standards-based, inquiry oriented classroom activities, and learned about available resources aligned with their teaching needs. The Education Team recently received a three-year grant through the NASA SMD E/PO Opportunities in Earth and Space Science to prepare middle-school science coordinators and lead teachers in Earth and space science content and pedagogy in collaboration with HCDE, ARES, the University of Houston, and Rice University. Other teacher preparation efforts

include the five LRO week-long summer institutes, the Mars Science Laboratory ChemCam instrument summer institute, and the JH/APL high school educator lunar workshops described above.

<http://www.lpi.usra.edu/education/workshops/workshops.shtml>

**Faculty Institutes for NASA Earth and Space Science Education (FINESSE)** – LPI leads a collaboration of scientists and science education specialists, in partnership with the Association for Science Teacher Education (ASTE) and the National Association of Community College Teacher Education Programs (NACCTEP), to provide faculty involved in teacher preparation with access to NASA Earth and space science content, data, and educational resources through two-day Institutes. FY11 activity included three two-day institutes for faculty at the AGU

- AGU fall meeting in San Francisco, CA (12/11-12/2011), 13 participants
- ASTE Annual Conference in Minneapolis, Minnesota (1/18-19/2011); 22 participants
- NACCTEP meeting in San Diego, California (2/24-25/2011), 22 participants

Participants explored best science education practices for teacher preparation, learned about curricular support resources for teacher educators that leverage NASA SMD content and data, and became part of a network of teacher education faculty.

**Family Space Day** - LPI's monthly Family Space Day, now in its eighth year, engaged 1400 children, ages 5 to 8, and their parents in Earth and space science. Each month explores a different topic through parent-led hands-on inquiry activities, crafts, reading and interactive games, and often partners with the JSC Astronomical Society. The focus of Family Space Day will be changing in FY12. In order to reach out to underserved audiences in our community, leverage other program strengths, and stay aligned with our mission to prepare educators to share science with their audiences, LPI will partner with two or three local libraries to offer training to parents in association with Family Space Day activities at that library. LPI will coordinate with library staff to visit these libraries three or four times a year and to offer a parent program that explore the importance of science and inquiry in their children's lives and ways to keep children engaged in science. During the training, LPI team members will conduct hands-on activities with the children; the parents will become facilitators in structured activities, guided by the LPI team as a conclusion to the training.

[http://www.lpi.usra.edu/education/space\\_days/](http://www.lpi.usra.edu/education/space_days/)

**Cosmic Lecture Series** - LPI offers an annual lecture series designed to engage inquisitive adult members of the general public in current relevant topics in space science. The FY12 series celebrates the Year of the Solar System and the new worlds and new discoveries that are fundamentally changing our relationship with and understanding of our solar system. Speakers include author Dava Sobel, *Humanity's Changing Relationship with the Solar System*, and Dr. William Bottke, *Planet Formation: What's New With the Oldest Events in the Solar System*.

<http://www.lpi.usra.edu/education/lectures/>

**Support of NASA Science Mission Directorate Missions** - The LPI E/PO team helped to support the GRAIL launch in September 2011 through logistics preparation and staffing of exhibits at the Kennedy Space Center during the launch window. Involvement in the activities surrounding the scheduled launch of the Mars Science Laboratory in November 2012 is more significant and includes design and implementation of a two-day workshop and launch experience for 40 librarians and participation in the K-12 educator workshop led by the Mars Exploration Public Engagement Program.