

# Curriculum Vitae

John Fraser Mustard

Professor of Earth, Environmental and Planetary Sciences and  
Environment and Society

## **Education**

B.Sc. Geological Sciences (Honors), May 1983, University of  
British Columbia, Vancouver, B.C. CANADA  
M.Sc. Geological Sciences, May 1986, Brown University, Providence RI.  
Ph.D. Geological Sciences, May 1990, Brown University, Providence RI.

## **Professional Appointments**

7/2007-present Professor of Geological Sciences and Professor of Environmental Studies, Brown  
University  
7/2000-6/2007 Associate Professor of Geological Sciences and Associate Professor of Environmental  
Studies, Brown University  
7/1998-6/2000 Steven Robert Assistant Professor, Assistant Professor of Geological Sciences, Brown  
University  
7/1996-6/1998 Assistant Professor, Department of Geological Sciences, Brown University  
7/1991-6/1996 Assistant Professor for Research, Department of Geological Sciences, Brown  
University  
1/1990-6/1991 Post-doctoral research associate in the Department of Geological Sciences at Brown  
University

## **Completed Research and Scholarship**

### **Edited Book**

Gutman G., C. Justice, D. Skole, R. Rindfuss, J. Mustard, W. Turner, T. Janetos, and E. Moran (eds) *Land  
Change Science: Observing, Monitoring, and Understanding Trajectories of Change on the Earth's  
Surface* Kluwer Netherlands (2004).

### *Book Chapters*

Mustard, J. F., R. Defries, T. Fisher and E. Moran, Land Use and Land Cover Change Pathways and  
Impacts. Chapter 26 in Gutman G. et al (eds) *Land Change Science: Observing, Monitoring, and  
Understanding Trajectories of Change on the Earth's Surface* Kluwer Netherlands (2004).

Mustard, J. F. and T. Fisher, Land Use and Land Cover Change and Hydrology. Chapter 15 in Gutman G. et  
al (eds) *Land Change Science: Observing, Monitoring, and Understanding Trajectories of Change on  
the Earth's Surface* Kluwer Netherlands (2004).

Mustard, J. F., and J. M. Sunshine, Spectral Analysis for Earth Science: Investigations Using Remote  
Sensing Data, in *Remote Sensing for the Earth Sciences, Manual of Remote Sensing 3<sup>rd</sup> Ed. Vol.  
3*, (Andrew Rencz, Editor), J. Wiley and Sons Inc., New York, Chapter 5, pg. 251-307, 1999.

Pieters, C. M., J. F. Mustard, J. M. Sunshine, Quantitative mineral analyses of planetary surfaces using  
reflectance spectroscopy, in *Mineral Spectroscopy: A tribute to Roger G. Burns*, (M. D. Dyar, C.  
McCammon, and M. W. Schaefer, eds.), The Geochemical Society, Houston TX, pp. 307-326, 1996.

## Refereed Publications

Submitted and in review:

Publications in peer-reviewed journals:

### 2015

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- Cannon, K.M., and J.F. Mustard(2015), Preserved glass-rich impactites on Mars, *Geology*, 43(7), 635-638, doi: 10.1130/G36953.1.
- Cannon, K.M., J.F. Mustard, and C.B. Agee(2015), Evidence for a widespread basaltic breccia component in the martian low-albedo regions from the reflectance spectrum of Northwest Africa 7034, *Icarus*, 252, 150-153, doi: 10.1016/j.epsl.2015.02.002.
- Cannon, K.M., J.F. Mustard, and M.R. Salvatore(2015), Alteration of immature sedimentary rocks on Earth and Mars: Recording aqueous and surface-atmosphere processes, *Earth and Planetary Science Letters*, 417, 78-86, doi: 10.1016/j.epsl.2015.02.017.
- Goudge, T.A., K.L. Aureli, J.W. Head, C.I. Fassett, and J.F. Mustard(2015), Classification and analysis of candidate impact crater-hosted closed-basin lakes on Mars, *Icarus*, 260, 346-367, doi: 10.1016/j.icarus.2015.07.026.
- Goudge, T.A., J.F. Mustard, J.W. Head, C.I. Fassett, and S.M. Wiseman(2015), Assessing the Mineralogy of the Watershed and Fan Deposits of the Jezero Crater Paleolake System, Mars, *Journal of Geophysical Research: Planets*, 120, doi: 10.1002/2014JE004782.
- Goudge, T.A., J.F. Mustard, J.W. Head, M.R. Salvatore, and S.M. Wiseman(2015), Integrating CRISM and TES hyperspectral data to characterize a halloysite-bearing deposit in Kashira crater, Mars, *Icarus*, 250, 165-187, doi: 10.1016/j.icarus.2014.11.034.
- Greenberger, R.N., J.F. Mustard, E.A. Cloutis, P. Mann, J.H. Wilson, R.L. Flemming, K.M. Robertson, M.R. Salvatore, and C.S. Edwards(2015), Hydrothermal alteration and diagenesis of terrestrial lacustrine pillow basalts: Coordination of hyperspectral imaging with laboratory measurements, *Geochim Cosmochim Acta*, 171, 174-200, doi: 10.1016/j.gca.2015.08.024.
- Greenberger, R.N., J.F. Mustard, E.A. Cloutis, L.M. Pratt, P.E. Sauer, P. Mann, K. Turner, M.D. Dyar, and D.L. Bish(2015), Serpentinization, iron oxidation, and aqueous conditions in an ophiolite: Implications for hydrogen production and habitability on Mars, *Earth and Planetary Science Letters*, 416, 21-34, doi: 10.1016/j.epsl.2015.02.002.
- Greenberger, R.N., J.F. Mustard, B.E. Ehlman, D.L. Blaney, E.A. Cloutis, J.H. Wilson, R.O. Green, and A.A. Fraeman(2015), Imaging spectroscopy of geological samples and outcrops: Novel insights from microns to meters, *GSA Today*, 25(12), 4-10, doi: 10.1130/GSATG252A.1.
- Mayes, M.T., J.F. Mustard, and J.M. Melillo(2015), Forest cover change in Miombo Woodlands: modeling land cover of African dry tropical forests with linear spectral mixture analysis, *Remote Sensing of Environment*, 165, 203-215, doi: 10.1016/j.rse.2015.05.006.
- Weber, A., J. Russell, T. Goudge, M. Salvatore, J. Mustard, and S. Bijaksana(2015), Characterizing clay mineralogy in Lake Towuti, Indonesia, with reflectance spectroscopy, *J Paleolimnol*, 54(2-3), 253-261, doi: 10.1007/s10933-015-9844-4.
- Yang, X., J. Tang, J.F. Mustard, J.-E. Lee, M. Rossini, J. Joiner, J.W. Munger, A. Kornfeld, and A.D. Richardson(2015), Solar-induced chlorophyll fluorescence that correlates with canopy photosynthesis on diurnal and seasonal scales in a temperate deciduous forest, *Geophysical Research Letters*, 42(8), 2977-2987, doi: 10.1002/2015GL063201.

## 2014

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- Donaldson Hanna, K., L. Cheek, C. Pieters, J. Mustard, B. Greenhagen, I. Thomas, and N. Bowles(2014), Global assessment of pure crystalline plagioclase across the Moon and implications for the evolution of the primary crust, *Journal of Geophysical Research: Planets*, 119(7), 1516-1545, doi: 10.1002/2013JE004476.
- Salvatore, M.R., J.F. Mustard, J.W. Head, D.R. Marchant, and M.B. Wyatt(2014), Characterization of spectral and geochemical variability within the Ferrar Dolerite of the McMurdo Dry Valleys, Antarctica: weathering, alteration, and magmatic processes, *Antarct Sci*, 26(1), 49-68, doi: 10.1017/S0954102013000254.
- Salvatore, M.R., J.F. Mustard, J.W. Head, III, A.D. Rogers, and R.F. Cooper(2014), The dominance of cold and dry alteration processes on recent Mars, as revealed through pan-spectral orbital analyses, *Earth and Planetary Science Letters*, 404, 261-272, doi: 10.1016/j.epsl.2014.08.006.
- Spera, S.A., A.S. Cohn, L.K. VanWey, J.F. Mustard, B.F. Rudorff, J. Risso, and M. Adami(2014), Recent cropping frequency, expansion, and abandonment in Mato Grosso, Brazil had selective land characteristics, *Environmental Research Letters*, 9(6), 4010, doi: 10.1088/1748-9326/9/6/064010.
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- Yang, X., J. Tang, and J.F. Mustard(2014), Beyond leaf color: Comparing camera-based phenological metrics with leaf biochemical, biophysical, and spectral properties throughout the growing season of a temperate deciduous forest, *Journal of Geophysical Research-Biogeosciences*, 119(3), 181-191, doi: 10.1002/2013jg002460.

## 2013

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- Saper, L.M., and J.F. Mustard(2013), Extensive linear ridge networks in Nili Fossae and Nilosyrtris, Mars: implications for fluid flow in the ancient crust, *Geophysical Research Letters*, 40(2), 245-249, doi: 10.1002/Grl.50106.
- VanWey, L.K., S. Spera, R. de Sa, D. Mahr, and J.F. Mustard(2013), Socioeconomic development and agricultural intensification in Mato Grosso, *Philos T R Soc B*, 368(1619), doi: 10.1098/Rstb.2012.0168.
- Wilson, J.H., and J.F. Mustard(2013), Exposures of olivine-rich rocks in the vicinity of Ares Vallis: Implications for Noachian and Hesperian volcanism, *Journal of Geophysical Research-Planets*, 118(5), 916-929, doi: 10.1002/Jgre.20067.

## 2012

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- Ehlmann, B. L., & Mustard, J. F. (2012). An in-situ record of major environmental transitions on early Mars at Northeast Syrtis Major. *Geophysical Research Letters*, 39. doi:10.1029/2012gl051594
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- Greenberger, R. N., Mustard, J. F., Kumar, P. S., Dyar, M. D., Breves, E. A., & Sklute, E. C. (2012). Low temperature aqueous alteration of basalt: Mineral assemblages of Deccan basalts and implications for Mars. *Journal of Geophysical Research-Planets*, 117. doi:10.1029/2012je004127
- Skok, J. R., Mustard, J. F., Tornabene, L. L., Pan, C., Rogers, D., & Murchie, S. L. (2012). A spectroscopic analysis of Martian crater central peaks: Formation of the ancient crust. *Journal of Geophysical Research-Planets*, 117. doi:10.1029/2012je004148
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- Yang, X., Mustard, J. F., Tang, J. W., & Xu, H. (2012). Regional-scale phenology modeling based on meteorological records and remote sensing observations. *Journal of Geophysical Research-Biogeosciences*, 117. doi:10.1029/2012jg001977

## 2011

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- Besse, S., J.M. Sunshine, M.I. Staid, N.E. Petro, J.W. Boardman, R.O. Green, J.W. Head, P.J. Isaacson, J.F. Mustard, and C.M. Pieters(2011), Compositional variability of the Marius Hills volcanic complex from the Moon Mineralogy Mapper (M-3), *Journal of Geophysical Research-Planets*, 116, doi: 10.1029/2010je003725.
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- Whitten, J., J.W. Head, M. Staid, C.M. Pieters, J. Mustard, R. Clark, J. Nettles, R.L. Klima, and L. Taylor(2011), Lunar mare deposits associated with the Orientale impact basin: New insights into mineralogy, history, mode of emplacement, and relation to Orientale Basin evolution from Moon Mineralogy Mapper (M-3) data from Chandrayaan-1, *Journal of Geophysical Research-Planets*, 116, doi: 10.1029/2010je003736.

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- Greenberger, R., J.F. Mustard, P.S. Kumar, M.D. Dyar, E.A. Speicher, and E.C. Skulte (2011) A Vertical section of Deccan basalts as a spectroscopic and mineral assemblage analog to phyllosilicate stratigraphies on Mars, *GSA Annual Meeting*, Abstract 100-111.
- Greenberger, R.N., J.F. Mustard, P.S. Kumar, M.D. Dyar, E.A. Speicher, and E.C. Skulte (2011) Weathering Products of Deccan Basalts and Implications for Mars, *42nd Lunar and Planetary Science Conference*, Abstract #2548.
- Head, J.W., J.F. Mustard, M.A. Kreslavsky, R.E. Milliken, D.R. Marchant, F. Forget, S.C. Schon, and J.S. Levy (2011) Mars in the Current Glacial-Interglacial Cycle: Exploring an Anomalous Period in Mars Climate History, *42nd Lunar and Planetary Science Conference*, Abstract #1315.

- Isaacson, P.J., J. Nettles, S. Besse, J. Boardman, L. Cheek, R. Clark, D. Dhingra, K. Donaldson Hanna, J. Head, R. Klima, G. Kramer, U. Mall, D. Moriarty, J. Mustard, N. Petro, C. Pieters, J. Sunshine, L. Taylor, S. Tompkins, and J. Whitten (2011) A Mineralogical Survey of Lunar Crater Central Peaks with Moon Mineralogy Mapper Data: First Results, *42nd Lunar and Planetary Science Conference*, Abstract #2556.
- Morgan, F., J.F. Mustard, S.M. Wiseman, F.P. Seelos, S.L. Murchie, P.C. McGuire, and C. Team (2011) Improved Algorithm for CRISM Volcano Scan Atmospheric Correction, *42nd Lunar and Planetary Science Conference*, Abstract #2453.
- Murchie, S., J.F. Mustard, R. Arvidson, B. Ehlmann, J.-P. Bibring, J. Bishop, J.J. Wray, and C. Team (2011) The Diversity of Aqueous Mineral-Bearing Deposits on Mars (Invited), *AGU Fall Meeting*, Abstract P22A-06.
- Mustard, J.F., B. Ehlmann, F. Poulet, A. Fraeman, and J. Carter (2011) Sequestration of volatiles in the martian crust through hydrated minerals, *AGU Fall Meeting*, Abstract P33H-05.
- Mustard, J.F., and B.L. Ehlmann (2011) A Stratigraphic Section that Traverses the Noachian-Hesperian Capturing Diverse Habitable Environments, *42nd Lunar and Planetary Science Conference*, Abstract #2355.
- Mustard, J.F., R. Greenberger, M.R. Salvatore, and B.E. Ehlman (2011) Traversing the aqueous history of Mars through analogs, *GSA Annual Meeting*, Abstract 284-281.
- Parente, M., J.F. Mustard, S. Murchie, and F. Seelos (2011), Robust unmixing of hyperspectral images: Application to Mars, paper presented at Geoscience and Remote Sensing Symposium (IGARSS), 2011 IEEE International, 24-29 July 2011.
- Parente, M., J.F. Mustard, S. Murchie, and F.P. Seelos (2011) Summarizing the Spectral Variability of CRISM Images with Endmember Extraction, *42nd Lunar and Planetary Science Conference*, Abstract #2622.
- Parente, M., J.R. Skok, J.F. Mustard, and I. Baarstad (2011) Simulating a Mars mission for the identification of samples of high mineralogical interest using a portable imaging spectrometer, *AGU Fall Meeting*, Abstract P33D-1784.
- Salvatore, M.R., J.F. Mustard, J. Head, R.F. Cooper, and D. Marchant (2011) Widespread, Juvenile Alteration of the Ferrar Dolerite in Beacon Valley, Antarctica, *AGU Fall Meeting*, Abstract P31C-1717.
- Salvatore, M.R., J.F. Mustard, J. Head, and J. Seeley (2011) Verification of spectral mapping of the McMurdo dry valleys using in situ and laboratory techniques, *GSA Annual Meeting*, Abstract 284-287.
- Salvatore, M.R., M.B. Wyatt, J.F. Mustard, and J.W.I. Head (2011) Development of Alteration Rinds on the Ferrar Dolerite of the Antarctic Dry Valleys: Initial Characterization, *42nd Lunar and Planetary Science Conference*, Abstract #1479.
- Seelos, K., J.F. Mustard, B. Ehlmann, A. Fraeman, and J.J. Wray (2011) Phyllosilicates in Tyrrhena Terra, Mars: A systematic evaluation using CRISM data, *GSA Annual Meeting*, Abstract 100-112.
- Skok, J.R., J. Mustard, L.L. Tornabene, and S.L. Murchie (2011) Composition of the Primary Crust of Mars: Observations of Deeply Excavated Crater Central Peaks, *AGU Fall Meeting*, Abstract P11A-1583.
- Skok, J.R., J.F. Mustard, B. Ehlmann, and S. Murchie (2011) Martian Hot Springs? Silica deposits in the Nili Patera Caldera. (Invited), *AGU Fall Meeting*, Abstract P31G-03.
- Skok, J.R., J.F. Mustard, and L.L. Tornabene (2011) Spectroscopic and Morphological Analysis of Alga Crater's Central Peak: Implications for Mars Primary Crust Formation, *42nd Lunar and Planetary Science Conference*, Abstract #1959.
- Thollot, P., N. Mangold, S. Lemouélic, R.E. Milliken, L.H. Roach, and J.F. Mustard (2011) A large diversity of hydrated minerals formed from interaction with hydrothermal fluids in Noctis Labyrinthus, Mars, *EPSC-DPS Joint Meeting 2011*, 1067.
- Whitten, J.L., J.W. Head, C.M. Pieters, J.F. Mustard, and M. Team (2011) Maunder and Kopff Craters: Windows into the Upper Lunar Crust, *42nd Lunar and Planetary Science Conference*, Abstract

#2168.

- Wilson, J.H., and J.F. Mustard (2011) Igneous Compositions in Ares Vallis: Timing and Importance of Volcanics and Fluvial Processes at the Noachian-Hesperian Boundary, *42nd Lunar and Planetary Science Conference*, Abstract #2507.
- Wiseman, S., J.F. Mustard, K. Donaldson Hanna, P. Isaacson, B. Jolliff, S. Besse, M. Staid, and C. Pieters (2011) Origin of Aristarchus Olivine Deposits Based on M3, WAC, and Diviner Analyses, *AGU Fall Meeting*, Abstract P13D-1697.
- Wiseman, S.M., J.C. Andrews-Hanna, R.E. Arvidson, J.F. Mustard, and K.J. Zabrucky (2011) Distribution of Hydrated Sulfates Across Arabia Terra Using CRISM Data: Implications for Martian Hydrology, *42nd Lunar and Planetary Science Conference*, Abstract #2133.
- Wray, J.J., S.L. Murchie, B.L. Ehlmann, R.E. Milliken, J.L. Bishop, K.D. Seelos, E.Z. Noe Dobrea, J.F. Mustard, and S.W. Squyres (2011) Orbital evidence for iron or calcium carbonates on Mars, *EPSC-DPS Joint Meeting 2011*, 1719.
- Wray, J.J., S.L. Murchie, B.L. Ehlmann, R.E. Milliken, K.D. Seelos, E.Z. Noe Dobrea, J.F. Mustard, and S.W. Squyres (2011) Evidence for Regional Deeply Buried Carbonate-Bearing Rocks on Mars, *42nd Lunar and Planetary Science Conference*, Abstract #2635.

## Theses

- Mustard, J. F., The geology of the Mount Brew area, Lillooet, British Columbia, unpublished B.Sc. Thesis, University of British Columbia, Vancouver, B.C. Canada, pp. 33, 1983.
- Mustard, J. F., Methods of quantitative analysis of reflectance spectra and application to imaging spectrometer data, Ph.D. Thesis, Brown University, Providence RI, USA, pp. 231 1990.

## Invited Lectures

- *Composition of the Martian Surface*, Spectroscopy from Space, The Spectroscopy Society of Pittsburgh, 10/27/90
- *Considerations of Non-linear Mixing Analysis*, Sub-pixel Analysis Workshop, 20th Applied Imagery Pattern Recognition (AIPR) Workshop, SPIE, Washington D.C., 10/15/91
- Invited Attendee and Panel Member, National Academy of Sciences' Fourth Annual Symposium on Frontiers of Science, Beckman Center, Irvine CA 11/5-11/7 1992
- *Composition of the Martian Crust: Clues from ISM Imaging Spectrometer Data*, Lunar and Planetary Institute, Houston TX, 6/10/93.
- *Scientific Visualization in Earth and Planetary Science: It looks good but will it publish*, North American Serial Interest Group, Brown University, 6/11/93.
- *Lithologic Mapping in the Cape Smith Fold and Thrust Belt with TM and Airborne Radar Data*, Institute for Space and Terrestrial Studies, York University, Toronto, Ont, 9/15/93
- Invited Attendee, National Academy of Sciences' Third Annual Symposium on Frontiers of Science, Beckman Center, Irvine CA 11/4-11/6 1993.
- *Understanding Processes on Mars: Rocks to Dust*, Massachusetts Institute of Technology, May 3, 1995.
- *Planetary Contributions to Environmental Remote Sensing*, GSA Annual Meeting, Nov. 1995.
- *New Insights into Crustal Heterogeneity and Chemical Alteration on Mars*, Geologic Survey of Canada, 2/21/96.
- *Quantitative Methods for Determining Surface Composition with Application to Geologic Mapping and Global Change*, Canadian Center for Remote Sensing, 2/20/96.

- *The Dynamics of Thermal Effluent from the Brayton Point Power Plant*, Mt. Hope Bay Research Forum, Mass. Coastal Zone Management, Executive Office of Environmental Affairs, 6/24/97
- *Seasonal and Tidal Dynamics of Thermal Effluent in the Mt. Hope Bay Estuary*, Environmental Protection Agency, Atlantic Ecology Division, Narragansett RI, 8/97
- *Application of Remotely Sensed Data to Environmental Problems in Narragansett Bay*, Dept. Ecology and Evolutionary Biology, Brown University, 9/97.
- *The Composition of the Martian Crust and Implications for the Mantle*, Department of Geological Sciences, RPI, New York, November, 1997.
- *Impact of Brayton Point thermal effluent on the Mt. Hope Bay estuary*, Environmental Protection Agency, Boston MA, December, 1998.
- *Impact of Brayton Point thermal effluent on the Mt. Hope Bay estuary*, Rhode Island Department of Environmental Management, December, 1998.
- *Quantifying Thermal Impacts of Effluent with Remotely Sensed Data*, Environmental Protection Agency, Research Division, Lexington MA, January, 1999.
- *Mineralogy and Mixing on Mars and the Moon*, invited talk for AGU Fall Meeting special session "Spectroscopy of Solar System Objects: A Session Celebrating the Contribution of John Adams," December, 1998.
- *Remote Sensing of the Narragansett Bay Waters: Progress and Promise*, invited talk to the symposium "Integrating science in the decision making process: Managing estuarine habitats in Narragansett Bay, Northeast Regional GSA Meeting, March, 1999
- *Hyperspectral Remote Sensing of Estuarine Waters*, University of Rhode Island, Graduate School of Oceanography Biological Oceanography colloquium, April, 1999.
- *Water Quality Information from Remotely Sensed Data*, invited speaker for the 1999 Environmental Expo special session on advances in hydrodynamic analyses, May, 1999.
- *Review of the ISM Instrument and Results*, Spectroscopy of the Martian Surface, What Next?, Lunar and Planetary Institute, Houston, June, 1999.
- *Recent Results from the Mars Missions*, Geology Department Colloquium, University of Vermont, 2/2000.
- *Impact of Water Use on Semi-Arid Ecosystems, Owens Valley CA.*, Geology Department Noon Seminar, University of Vermont, 2/2000.
- *Land Use and Land Cover Change in Semi-Arid Ecosystems*, Geography Department, Boston University, 9/2000.
- *Remote Sensing for Monitoring Estuarine Dynamics*, EMAP Symposium 2001, 4/2001.
- *Recent climate change on Mars*, University of Nantes, November, 2001
- *Remote sensing of water optical properties*, University of Nantes, October, 2001
- *The composition of the martian surface from infrared remote sensing*, University of Nantes, October 2001.
- *Ground ice and the evidence for climate change on Mars*, CNRS Toulouse, November, 2001
- *Cemented sulfates and ground ice on Mars: Evidence for recent climate change*, Institute d'Astrophysique Spatial, University of Paris, November 2001
- *New Observations of Narragansett Bay with Remote Sensing*, University of Rhode Island, April, 2002.

- *Remotely Sensed Environmental Parameters of Mt. Hope Bay, Narragansett Bay, and the New England Coastal Ocean* School of Marine Science and Technology, University of Massachusetts , Dartmouth, September 11, 2002
- *Recent Near Surface Ground Ice and Periodic Climate Change on Mars*, Woods Hole Oceanographic Institution, November 1, 2002
- *Beyond Red: The Composition of the Martian Surface*, Invited, presentation to the Fall AGU meeting special session in honor of Tom McCord, 2002.
- *Water, Fish, and Electricity, a Hot Topic in Mt. Hope Bay*, Massachusetts Institute of Technology, January, 2003.
- *Periodic Climate Change on Mars*, California Institute of Technology, March, 2003
- *The Temperature of Mt. Hope Bay*, New England Estuarine Research Society Meeting, May 2003.
- *Mars Exploration Astro Assembly*, Rhode Island, October 2003.
- *Ice Ages on Mars*, MIT EAPS Department, October 2003
- *Geomorphic Indicators of ground Ice on Mars and Evidence for Climate Change*, 2003 AGU, Fall Meeting.
- *Mars Surface Composition Through Pan-spectral Analysis: Mafic Mineralogy, Alteration, And Hydration*, 2003 AGU, Fall Meeting.
- *Mars Composition Diversity from the OMEGA Experiment*, Geological Society of America Annual Meeting, Denver, November 2004
- *Climate Change on Mars*, Rhode Island College Sigma Xi Inauguration Dinner, May, 2005
- *Multi-Instrument Sulfate Detection and Mineral Stability on Mars, Martian Sulfates as Recorders of Atmospheric-Fluid-Rock Interactions*, Houston TX (2006)
- *Mineralogic Evolution of Mars*, Penn State Department of Geological Sciences Colloquium, 2006
- *Blue, White and Red Mars: The mineralogic evolution of the Mars*, Brown University Colloquium, 2007
- *Hydrated Silicate Mineralogy of Mars from the CRISM Investigation*, Institute d'Astrophysique Spatial, University de Paris-Sud, Paris, France June 2008
- *Exploring Mars and Prospects for Habitability* Space Exploration Symposium, University of Alberta and Tellis World of Science, 2008
- *Hydrated Minerals on Mars: Implications for the History of Water*, Brown University Colloquium, 2008
- *Hydrated minerals on Mars and their geologic environments*;, Boston University, 2009
- *Hydrated minerals on Mars and their geologic environments: Implications for the history of water*, Lunar and Planetary Institute, Houston TX, 2009
- *Hydrated minerals on Mars and their geologic environments: Implications for the history of water*, University of Colorado, 2009
- *Hydrated minerals on Mars and their geologic environments: Implications for the history of water*, California Institute of Technology, April 2009.
- *Hydrated minerals on Mars and their geologic environments: Implications for the history of water*, Jet Propulsion Laboratory, April 2009.
- *Skyscappers Astroassembly, Smithfield Rhode Island: What's next for Mars Exploration* October 1, 2011
- *Presentation to the American Meteorological Society Annual Meeting of Broadcast Meteorologist: Mars: Understanding the Red Planet* August 2012

- *Evolving Concepts of Mars Habitability, Origins Institute, McMaster University September 2012.*
- *Invited Keynote, Canadian Space Summit, Evolving Concepts of Mars Habitability, November 2012*
- *Georgia Institute of Technology, School for Earth and Atmospheric Science , Evolving Concepts of Mars Habitability, November 2012*
- *Talk to the Boston Museum of Science, August, 2013*
- *Talk to the Department of Geography, Clark University Sept. 2013*
- *Invited SCUGOG Keynote, Western University of London, Ontario, February 2015*
- *Talk to the Brown Club of New Mexico, October 2015*
- *Talk to the Brown Club of San Diego, October 2015*

## **Service**

### University:

Under the Elms (Development Office) Speaker, 1991, 1994, 1995  
 Brown Summer Science Adventure, workshop on remote sensing, 1993.  
 Brown Parents Council participant  
 MacMillan Hall Dedication, seminar and video, 1998  
 Member of the Environmental Science Committee  
 Parents Leadership Weekend, Speaker and Workshop, Water in the Environment, March 2000  
 Freshman Advising, 2000-2001, 2003-2004, 2004-2005, 2005-2006  
 Co-developed the Environmental Change Initiative  
 Speaker, Parents Weekend, October 2003  
 Alumni Office, Meeting of the Minds:  
     Dallas, May 2004  
     Tuscon, November, 2004  
     Washington DC, April 2005  
     Greenwich, CT, April 2009  
 Boldly Brown Celebration  
 San Francisco October 2009  
 Seattle, October 2009  
 Naples FL Brown Club 2012  
 Parents Weekend 2012  
 Development Office, Denver gathering, November 2004.  
 Spoke at the President's Leadership Council Dinner, February 2004  
 Presentation to Corporation Members, February 2004  
 A Day on College Hill Presentation to Parents, April 2005  
 Brown University Staff Development Day Presentation, June 2005  
 Brown- Marine Biological Laboratory Oversight Committee 2004-present  
 Brown University Environmental Change Advisory Board, 2004-present  
 Chair of Search, Director, Center for Environmental Studies 2007-2008.  
 Committee to Review the Environmental Studies Concentration-2012-2013  
 Member of the Search Committee for Brown University Provost 2014  
 Member of the Academic Priorities Committee 2013-2015  
 Member of the Deficit Reduction Working Group 2014-2015

### Department:

Departmental Computer Committee, 1993-1995, 1997-1999  
 Department Undergraduate Field Trip, Organized and Lead, 1992; Assisted 1994, 1995

Chair, Planetary Geoscience Group Computer Committee  
 Search Committee, Geochemistry of Environmental Change, 1998  
 Undergraduate Program, Geology concentration advisor, 1997-2001  
 Chair's Advisory Committee, 2000-2001, 2005-2008  
 Search Committee, Physics and Chemistry of Magma Processes, 2000-2001  
 Department Curricular Committee 2002-2003  
 Department Colloquium Committee 2003-2004  
 Search Committee, Director, CES and Environmental Change Initiative, 2003-2004  
 Search Committee, ESH Faculty position, 2004-2005.  
 Search Committee, Planetary Faculty position, 2006.  
 Search Committee, ECI Faculty Position, 2005-2006.  
 Chair Search Committee, Planetary Faculty position, 2010-11.  
 Chair Search Committee, Planetary Faculty position, 2011-12.  
 Chair Search Committee, ECI Faculty Position in remote sensing, 2012-2013.  
 Chair Search Committee, Planetary Faculty position, 2013-2014.  
 Chair Search Committee, Planetary Faculty position, 2014-2015.

Professional Community:

Associate Editor, Proceedings of Lunar and Planetary Science, Volume 21, 1990  
 Associate Editor, Proceedings of Lunar and Planetary Science, Volume 22, 1991  
 Associate Editor, Journal of Geophysical Research-Planets, 1/96-12/98  
 Planetary Astronomy Mars Watch Review Panel, 1992  
 Organized and Convened AGU Special Session "Why Mars is Red", for Fall AGU 1994.  
 Member of NASA's Lunar and Planetary Geoscience Review Panel 1993-1995  
 (Remote Sensing Group Chief, 1994-1995)  
 Member, Management and Operations Working Group for the NASA Planetary Geology and Geophysics Program (S. Solomon, Chair), 1994-1996.  
 Executive Secretary, NASA's Terrestrial Planets Science Working Group (TePSWG), 1994-1996.  
 Member of the Mars Surveyor '98 Instrument Selection Panel, for NASA's division of Solar System Exploration, Oct. 1995.  
 Member of EOS-AM1 panel to evaluate the algorithms and scientific yield from the Earth Observing System, May 1996  
 Invited Participant, EPA-NASA Workshop on Water Monitoring, Remote Sensing, and Advanced Technologies, Dec. 1996  
 Chair of Optics Panel, NASA Planetary Instrument Definition and Development Program Panel Review, fall, 1996 and 1997.  
 Member, NASA Science Definition Team for Mars Surveyor 2001 Orbiter, 1996-1997.  
 Member of Earth System Science Pathfinder Step 1 review panel, 1998.  
 Member of Review Panel for NASA's Land Use Land Cover Change program, 2000.  
 Member, NASA Science Definition Team for Mars'05 Mars Reconnaissance Orbiter, 2000-2001  
 Elected Secretary for the Planetary Sciences Section of AGU and member of the AGU Fall Program Planning Committee, 2000-2002.  
 Presentations on Liberal Arts Undergraduate Science Curricula to the Aga Khan University Planning Committee, 2001-2002  
 Member of the Space Studies Board Committee on Planetary and Lunar Exploration (COMPLEX), 9/98-01/02  
 Member, Space Studies Board, Solar System Exploration Survey Committee for the study "A New Strategy for Solar System Exploration", 5/01-7/02  
 NASA Mars Exploration Program, Pathways Steering Group, member, 02/01-06/01

Organized and Convened Workshop, Infrared Spectroscopy of Mars: From Theory and the Laboratory to Field Observations, LPI, Houston, 2002

Member, NASA Science Concept Definition Team for Project Prometheus, 2003-2004

Member NASA Astrobiology Field Laboratory Science Definition Team, 2003-2004

Invited Participant: Applications of NASA's Land Cover/Land-Use Change (LCLUC) science results to NASA's national priority areas, 2003

Invited Participant: Implementation planning process for the Land-Use/Land-Cover Change (LULCC) research element of the U.S. Climate Change Science Program strategic plan, 2003

Organized and Convened AGU Special Session Evidence for Recent Climate Change on Mars, December 2003

Development of Interdisciplinary Undergraduate Science Curriculum, Aga Khan University, Karachi Pakistan, June 2004.

Member, NASA Space Science Advisory Committee (SScAC), 2002-2005

Co-organized the 41<sup>st</sup> Brown-Vernadsky Microsymposium, Geological Evidence for Recent Climate Change on Mars, Houston, March, 2005

Co-organized the special session OMEGA@Mars for the 36<sup>th</sup> Lunar and Planetary Science Conference, Houston, March, 2005

Mars Science Laboratory 2009 Landing Site Steering Committee, 2006-2009.

Co-organized the 45<sup>st</sup> Brown-Vernadsky Microsymposium, Geological Evidence for Recent Climate Change on Mars, Houston, March, 2007

Chair of the Mars Exploration Program Assessment Group (MEPAG), 2007-2010

Co-organized the special session The Noachian Mars for the Fall Meeting of the American Geophysical Union, 2007

Member of the Planetary Science Subcommittee of the NASA Advisory Council 2007-2010

Co-organized Phyllosilicate Workshop, Paris, 2008

Co-organized the 47<sup>st</sup> Brown-Vernadsky Microsymposium, Geological Evidence for Recent Climate Change on Mars, Houston, March, 2008

Co-organized the special session The Noachian Mars for the Fall Meeting of the American Geophysical Union, 2008

Aga Khan University planning committee for Interdisciplinary Undergraduate Education, Babson College, 2009.

Member of the Space Studies Board 2010-present

Chair of the Mars 2020 Science Definition Team 2014

Member of the Mars 2020 Standing Review Board 2014-present

## **Spacecraft Involvement**

- CRISM on Mars Reconnaissance Orbiter, Deputy PI, 2001-2016
- OMEGA on Mars Express, Co-Investigator, 2002-2013
- Moon Mineralogy Mapper (M3) on Chandrayan, Co-Investigator 2006-2009
- Earth Observer 1, Science Team Member, 2000-2002

## **Academic Honors, Awards, etc**

- 5 awards for academic excellence at University of British Columbia (1979-1983)
- NSERC post-graduate scholarship (1986-1988)
- Named the Stephen Robert Assistant Professor by the Brown Corporation, 1/7/1998.
- Elected as a Fellow of the American Association for the Advancement of Science 2011.
- Awarded the NASA Medal for Exceptional Public Service 2012
- Elected fellow of the American Geophysical Union 2014

## Memberships

- Sigma Xi (1992)
- American Geophysical Union
- American Society for Photogrammetry and Remote Sensing
- American Association for the Advancement of Science

## Teaching

### Courses:

GEOL1330 Global Environmental Remote Sensing. Lecture course with lab developed for undergraduate and graduate students with environmental science interests. Spring semester, 1996/1997/1998/1999/2001/2003/2004/2005/2006/2007/2008/2009/2010/2011/2012/2013/2014/2015/2016 (Enrollment 20-25)

GE195 (21) Geographical Information Systems, Lecture and lab course centered around geographical information systems, Fall semester 2000 (Enrollment 10), joint with Lynn Carlson  
GE0016 (21) Global Environmental Change. Freshman Seminar, Fall Semester 2003/2004  
2004/2005, 2006/2007. (Enrollment 20)

GEOL2330 Advanced Remote Sensing and GIS, New lecture and lab course for advanced topics in remote sensing, Fall semester 1997/2002/2005/2007 (Enrollment 4-8)

GEOL2910 Planetary Crusts. Lecture course for advanced topics in the development and characteristics of Planetary Crusts. Fall Semester 2015 (Enrollment 10-15)

### Independent Study:

Jasper Oshun, fall 2005/2006

### Undergraduate Advising:

6 students/year for the past 3 years

### Graduate Advising:

#### Master's

J. Hays	M.Sc. 1995.	
A. Sen	MSc, Environmental Studies 1997, (Joint with S. Hamburg)	
H. Chen	M.Sc. 2001	
L. Kanner	M.Sc. 2006	
T. Garcia	M.Sc. 2008	
J. Wilson	M.Sc. 2012	

#### Ph.D.

S. Tompkins (joint with C. M. Pieters),		Ph.D. 1996.
L. Lin,	began 9/1995 M.Sc. 1998	Ph.D. 2002
C. Cooper	began 9/1996 M.Sc. 1998	Ph.D. 2004
A. Elmore	began 9/1997 M.Sc. 1999	Ph.D. 2003

B. Bradley	began 9/2001	M.Sc. 2003	Ph.D. 2006
J. Fisher	began 9/2001	M.Sc. 2003	Ph.D. 2006
R. Milliken	began 9/2001	M.Sc. 2003	Ph.D. 2006
L. Roach	began 9/2004	M.Sc. 2006	Ph.D. 2009
G. Galford	began 9/2004	M.Sc. 2006	Ph.D. 2010
B. Ehlmann	began 9/2006	M.Sc. 2008	Ph.D. 2010
J. Skok	began 9/2007	M.Sc. 2009	Ph.D. 2012
M. Salvatore	began 9/2008	M.Sc. 2010	Ph.D. 2013
X. Yang	began 9/2010	M.Sc. 2012	Ph.D. 2014
R. Greenberger	began 9/2010	M.Sc. 2012	Ph.D. 2015
T. Goudge	began 9/2010	M.Sc. 2012	Ph.D. 2015
M. Mayes	began 9/2011	M.Sc. 2014	
S. Spera	began 9/2011	M.Sc. 2013	
K. Cannon	began 9/2012	M.Sc. 2014	
V. Sun	began 9/2012	M.Sc. 2014	
M. Bramble	began 9/2014		
A. Pascuzzo	began 9/2015		

Post-Doctoral Advising:

Shannon Pelkey 2004-2007  
Aline Gendrin 2005-2008  
Mathieu Vincendon 2008-2010  
Mario Parente 2010-2012  
Sandra Wiseman 2010-

Undergraduate Student Theses:

N. Taylor '94 Senior Honors thesis in Biology (Ecology), (D. Murray and S. Gaines)  
E. Gonzales '94, Senior Honors thesis in geological sciences  
A. Holdsworth '95, Summer research fellowship from National Institute for Global Environmental Change (NIGEC)  
A. Ballantine '96, Senior thesis in geological sciences (UTRA Fellowship, 1995)  
A. Trueba '96, Senior thesis in geological sciences (joint with T. Herbert and D. Murray)  
A. Sen, '96, Senior Thesis in Environmental Science (with S. Hamburg)  
G. Proctor, Senior Thesis, Geological Sciences, '97 (Prell)  
D. Wexler, Senior Thesis, Geological Sciences, '97 (joint with T. Herbert)  
M. Carney, Senior Thesis Environmental Science, '97 (Hamburg, Prell)  
E. Wolf, Senior Thesis, Geological Sciences, '98.5 (Prell)  
V. Gokaldos, Senior Thesis, Environmental Science, '99 (UTRA 1998, Hamburg)  
D. Lobell, Independent Study and Research, Applied Math '00  
L. Firestone, Senior Thesis, Environmental Science, '00 (A. Foster)  
G. Bulman, Senior Thesis, Geological Sciences, '00 (T. Herbert).  
M. Rifkin, Senior Thesis, Geological Science, '01  
C. Balazs, Senior Thesis, Environmental Science '01.  
A. Bashkar, Geological Sciences, '08  
J. Oshun, Geological Sciences, '09  
L. Saper, Geological Sciences, '12  
M Swaann, Geological Sciences, '14

## External Funding

### Active Grants

<u>Agency</u>	<u>Project Title</u>	<u>Award Amount</u>	<u>Period Support</u>
JPL	CRISM Extended Mission 2 (EM2)	401,996	01/23/13 - 9/30/16
JPL	CRISM-OMEGA Liason Scientist	480,254	9/30/02-9/25/16
NASA	Mineralogy and Lithologies of Rock Units Traversing the Noachian-Hesperian Boundary in Nili Fossae	448,571	7/1/13 - 6/30/16
NASA	Evolution and Environment of Exploration Destinations: Science and Engineering Synergism (Co-PI)	4,171,576	3/7/14 - 2/14/19
NASA	Impact - Generated Glass on Mars: Laboratory Characterization and Remote Detection	60,000	9/14/14 - 8/31/16
<b>Total</b>		<b>\$ 5,562,397</b>	

### Completed Grants

<u>Agency</u>	<u>Project Title</u>	<u>Award Amount</u>	<u>Period Support</u>
NASA/AMES	The Moon as a Cornerstone to the Terrestrial Planets: The Formative Years (Carle Pieters, PI)	3,587,703	4/9/09-6/30/15
NASA	Evaluation of Major Spectral Surface types on Mars across multiple wavelengths: Combining Thermal-Infrared and Near-Infrared datasets to constrain surface compositions	225,000	4/2/08 - 4/17/12
NASA	Mineral Abundance from Reflectance Spectroscopy	95,000	8/11/11 - 8/10/12
NASA	Geologic Characterization of Phyllosilicate Desposition on Mars	282,680	7/13/06-9/30/10
NASA	Hydration and Mineral Abundance from Reflectance Spectroscopy	170,000	7/18/07-7/17/10
NSF	Disaster, Resilience and the Built Environment on the Gulf Coast (John Logan, PI)	750,000	8/30/06-12/31/09
MBL	From Early Biospheric Metabolisms to the Evolutions of Complex Systems	191,993	7/1/03-10/31/09
MBL	Biogeochemical Consequences of Land-use Transitions long Brazil's Agricultural Fields	78,000	9/1/06-8/31/09
NASA	Compact Reconnaissance Imaging Spectrometer for Mars (CRISM)	1,900,000	12/1/01-6/28/09
NASA	Moon Mineralogy Mapper for Chandrayaan-1 (Carle Pieters, PI)	3,215,455	3/1/05-5/31/09
NASA	Hydration of Geological Materials from Reflectance Spectroscopy	72,181	7/11/06 - 7/10/08
NASA	MDAP Program: Investigation of Martian surface Composition and the record for recent climate change	245,000	6/01/03-5/31/07
JPL	Mineralogy Maps of OMEGA Data to Support Mars Exploration	69,617	2/17/05-4/30/07

NASA	Hydration of Geological Materials from Reflectance Spectroscopy	292,000	4/1/03-3/31/07
NSF	Resistance and Resilience of the Natural and Build Environments In Response to Disaster: Impacts of Katrina	100,000	11/3/05-11/2/06
NASA	Salt Marsh Assessment and Restoration Tool	46,027	6/01/05-5/31/06
NASA	Landscape dynamics and Land Use Land Cover Change in the Great Basin-Mojave Desert Region	350,000	8/1/01-9/1/04
NASA	NOPP Application of an Integrated Monitoring and Modeling System to Narragansett Bay	54,000	8/01/02-8/01/03
NASA	Mineralogy of the Martian Surface: Crustal Composition to Surface Processes	211,000	3/1/00-2/03/03
NASA	MDAP Program: Reflectance and Thermal Infrared Spectroscopy of Mars: Relationship between ISM and TES for compositional determinations Data for Vegetation Monitoring	172,000	5/15/00-5/14/03
NASA	EO-1 Evaluation Precision and Accuracy of EO-1 ALI Data for Vegetation Monitoring	141,000	3/1/00-12/31/02
NASA	Brown University Affiliated Research Center for the Northeast	625,000	8/6/98-6/30/02
CMER	Optical Properties of Temperatures of Narragansett Bay from Remote Sensing for Environmental Monitoring	50,000	6/1/00-7/1/02
NASA	Mineralogy of the Martian Surface: Crustal Composition to Surface Processes	275,000	1/3/96-2/28/00
NASA	Environmental Remote Sensing of Narragansett Bay	640,000	6/96-12/00
NASA	Dynamics of a Semi-Arid Region in Response to Climate Change and Water-Use Policy	350,000	9/97-12/00
NASA	A Computer Learning Center for Remote Sensing and GIS	155,000	10/97-9/99
Desert	Spectral Mixture Modelling: Objective Research Determination of Image Endmembers and the Institute Effects of Nonlinear Mixture Systematics	291,400	7/95-6/98
NASA	Constraints on the Magnitude of Lateral Mass Transport on the Moon	100,000	2/01/96-1/1/98
RI DEM	Landsat Data for Environmental Monitoring	24,500	6/96-12/97
NASA	Composition, alteration, and redistribution of low albedo materials on Mars from ISM data.	112,370	1/3/93-2/28/96
NECUSE	Mission to Planet Earth: The Planetary Perspective, Laboratory Modules for Earth System Science	32,500	6/93-6/94
NECUSE	Field Modules for Remote Sensing	21,500	7/94-12/94
JPL	Science Applications of Advanced Sensor Development Using On-board Information Extraction Algorithms	71,487	1/15/92-6/30/94
<b>Total</b>		<b>\$ 14,827,413</b>	