Bethany L. Ehlmann

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RESEARCH INTERESTS

Broadly speaking, I am interested in environmental sustainability and the interaction of climate, geology, and biology in generating and sustaining habitable environments. My current research uses infrared remote sensing as a tool to investigate the earliest geologic history of Mars, in particular, establishing the nature, timing, and geologic occurrence of minerals formed in the presence of liquid water.

EDUCATION

Ph.D. (anticipated 2011), Brown University, Planetary Sciences (Thesis advisor: John Mustard)
Sc. M., Brown University, Geological Sciences, 2008
M.Sc. by research, University of Oxford, Physical Geography, 2007 (Thesis advisor: Heather Viles)
M.Sc. *with distinction*, University of Oxford, Environmental Change and Management, 2005
A.B. *Summa Cum Laude,* Washington University in St. Louis, 2004 (Thesis advisor: Raymond Arvidson)
Majors: Earth & Planetary Sciences, Environmental Studies; Minor: Mathematics
International Baccalaureate Diploma, Rickards H.S., Tallahassee, Florida, 2000

Additional Training:
Vatican Observatory Summer School in Astronomy and Astrophysics, Castel Gandolfo, Italy, June-July 2005
Rainforest to Reef Program: Marine Geology, James Cook University, Townsville, Australia, July 2004
School for International Training, Development and Conservation Program, Panamá, Sept-Dec 2002

AWARDS AND FELLOWSHIPS

NASA Group Achievement Award, Mars Exploration Rover Science Operations Team (2005)
National Science Foundation Graduate Research Fellowship (2004)
Rhodes Scholar (Missouri and Keble/Hertford, 2004)
USA Today All-USA Academic First Team (2004)
Morris K. Udall Scholar in Environmental Studies (2002, 2003)
Barry M. Goldwater Scholar in Science, Mathematics, and Engineering (2002)
Varney Prize in Introductory Undergraduate Physics, Washington University (2001)
Compton Scholar in Physical Sciences and Mathematics, Washington University (2000)

WORK AND RESEARCH EXPERIENCE

Compact Reconnaissance Imaging Spectrometer for Mars, science team collaborator
--Targeting, image and spectral analysis focusing on phyllosilicates (composition, stratigraphy, and probable environment of deposition)

School of Geography and Environment/Environmental Change Institute, University of Oxford, Postrgraduate Researcher
--Experimental physical weathering of basalt under Mars environmental conditions
--Parameterizing boulder form: inferring infer environmental history from quantitative morphology, Channeled Scablands
--Assessing Missouri River hydrologic change in response to 200 years of human management

Student Collaborator, NASA Mars Exploration Rover Athena Science Team
Jet Propulsion Laboratory, Pasadena, California (on-site full-time for mission operations, Jan-Sept '04)
Soil and Rock Physical Properties Theme Group Member, Microscopic Imager/Engineering Cameras Payload Uplink Lead, Science Operations Working Group Documentarian, and substitute SOWG chair

Undergraduate Researcher, Remote Sensing Laboratory, Washington University
- Terrain Modeling Using Mars Pathfinder and MER Telemetry Data
- Hydrologic Modeling of Lake Waiau, Mauna Kea, Hawaii
- Weathering Mechanisms of Kilauea lava flows from Infrared and Thermal Spectroscopy

Space Studies Board Intern, National Research Council, National Academy of Sci., Washington, DC, 2003
Assisted with preparation of the decadal solar system exploration strategy, preparation of congressional testimony, and creation of a web library of space policy reports.

Student Science Consultant, Interdisciplinary Environmental Law Clinic, Washington University School of Law, 2003

Analyzed air pollution impact and Clean Air Act control techonologies for a proposed cement plant

Research Associate, NASA Astrobiology Academy, Ames Research Center, 2002

Research assistant to Dr. Chris McKay on Remote Sensing of Axel Heiberg Springs, Canadian Arctic. Editor-in-chief, 2002 Academy project assessing the feasibility of a human mission to Mars

PEER-REVIEWED PUBLICATIONS

Viles, HA, BL Ehlmann, T Cebula, CF Wilson, M Bourke. **Simulating physical weathering of basalt on Earth and Mars.** in prep

EHLMANN, BL, JF Mustard, SL Murchie, F Poulet, JL Bishop, AJ Brown, WM Calvin, RN Clark, DJ Des Marais, RE Milliken, LH Roach, TL Roush, GA Swayze, JJ Wray. **Orbital Identification of Carbonate-Bearing Rocks on Mars**. under review, *Science*

Milliken, RE, G Swayze, R Arvidson, J Bishop, R Clark, B EHLMANN, R Green, J Grotzinger, R Morris, S Murchie, J Mustard, C Weitz. **Opaline silica in (geologically?) young deposits on Mars.** *Geology*, in press.

Bishop, JL, EZ Noe Dobrea, NK McKeown, M Parente, BL EHLMANN, JR Michalski, RE Milliken, F Poulet, GA Swayze, JF Mustard, SL Murchie, J-P Bibring. **Phyllosilicate Diversity and Past Aqueous Activity Revealed at Mawrth Vallis, Mars**. 2008. *Science* 321, 830-833.

Wray, J.J., BL EHLMANN, SW Squyres, JF Mustard, RL Kirk. **Compositional Stratigraphy of Clay-Bearing Layered Deposits at Mawrth Vallis, Mars.** 2008. *Geophysical Research Letters* 35, L12202, doi:10.1029/2008GL034385.

Mustard JF, SL Murchie, SL, SM Pelkey, BL EHLMANN, RE Milliken, JA Grant, J-P Bibring, F Poulet, J Bishop, E Noe Dobrea, L Roach, F Seelos, RE Arvidson, S Wiseman, R Green, C Hash, D Humm, E Malaret, JA McGovern, K Seelos, T Clancy, R Clark, D Des Marais, N Izenberg, A Knudson, Y Langevin, T Martin, P McGuire, R Morris, M Robinson, T Roush, M Smith, G Swayze, H Taylor, T Titus, M Wolff. **Hydrated Silicate Minerals on Mars Observed by the CRISM Instrument on MRO**. 2008. *Nature* 454, 305-309.

EHLMANN, BL, JF Mustard, CI Fassett, SC Schon, JW Head, DJ Des Marais, JA Grant, SL Murchie, CRISM team. **Clay mineralogy and organic preservation potential of lacustrine sediments from a Martian delta environment, Jezero Crater, Nili Fossae, Mars**. 2008. *Nature Geoscience*

EHLMANN, B. L., H. A. Viles, and M. C. Bourke. 2008. **Quantitative morphologic analysis of boulder shape and surface texture to infer environmental history: A case study of rock breakdown at the Ephrata Fan, Channeled Scabland, Washington,** *J. Geophys. Res*., 113, F02012, doi:10.1029/2007JF000872.

EHLMANN, BL and RE Criss, 2006. **Enhanced Stage and Stage Variability on the Lower Missouri River benchmarked by Lewis and Clark,** *Geology* 34(11), 977-980.

Arvidson, RE, F Poulet, RV Morris, J-P Bibring, JF Bell III, SW Squyres, PR Chistensen, G Belluci, B Gondet, BL EHLMANN, WH Farrand, RL Fergason, M Golombek, JL Griffes, J Grotzinger, EA Guinness, KE Herkenhoff, JR Johnson, G Klingelhoefer, Y Langevin, D Ming, K Seelos, RJ Sullivan, JG Ward, SM Wiseman, M Wolff. 2006, **Nature and Origin of the Hematite-Bearing Plains of Meridiani Based on Analyses of Orbital and Opportunity Data Sets**, *JGR* 111(E12), E12S08, doi:10.1029/2006JE002728

Herkenhoff, KE, SW Squyres, R Anderson, BA Archinal, RE Arvidson, JM Barrett, KJ Becker, JF Bell III, C Budney, NA Cabrol, MG Chapman, D Cook, BL EHLMANN, J Farmer, B Franklin, LR Gaddis, DM Galuszka, PA Garcia, TM Hare, E Howington-Kraus, JR Johnson, S Johnson, K Kinch, RL Kirk, EM Lee, C Leff, M Lemmon, MB Madsen, JN Maki, KF Mullins, BL Redding, L Richter, MR Rosiek, MH Sims, LA Soderblom, N Spanovich, R Springer, RM Sucharski, T Sucharski, R Sullivan, JM Torson, A Yen, 2006. **Overview of the Microscopic Imager Investigation during Spirit's first 450 sols in Gusev crater.** *JGR* 111, doi: 10.1029/2005JE002574.

EHLMANN, BL, et al, 2005, **Hydrologic and Isotopic Modeling of Alpine Lake Waiau, Mauna Kea, Hawaii.** *Pacific Science* 59 (1), p1-15.

EHLMANN, BL, et al., 2005. **Humans to Mars: A Feasibility and Cost-Benefit Analysis**. *Acta Astronautica* 56 (9-12), p851-858.

Golombek, MP, RE Arvidson, JF Bell III, PR Christensen, JA Crisp, LS Crumpler, BL EHLMANN, RL Fergason, JA Grant, R Greeley, AFC. Haldemann, DM Kass, TJ Parker, JT Schofield, SW Squyres, RW Zurek, 2005. **Assessment of Mars Exploration Rover Landing Site Predictions and Implications for Climate Change**. *Nature*, 436, 43-46.

Arvidson, RE, RC Anderson, P Bartlett, JF Bell III, PR Christensen, P Chu, K Davis, BL EHLMANN, MP Golombek, S Gorevan, EA Guinness, AFC. Haldemann, KE Herkenhoff, G Landis, R Li, R Lindemann, DW Ming, T Myrick, T Parker, L Richter, FP Seelos IV, LA Soderblom, SW Squyres, RJ Sullivan, J Wilson, 2004. **Localization and Physical Properties Experiments Conducted by Opportunity at Meridiani Planum**. *Science* 306, 1730-1733.

Arvidson, RE , RC Anderson, P Bartlett, JF Bell III, D Blaney, PR Christensen, P Chu, L Crumpler, K Davis, BL EHLMANN, R Fergason, MP Golombek, S Gorevan, JA. Grant, R Greeley, EA Guinness, AFC. Haldemann, KE

Herkenhoff, J Johnson, G Landis, R Li, R Lindemann, H McSween, DW Ming, T Myrick, L Richter, FP Seelos IV, SW Squyres, R Sullivan, A Wang, J Wilson, 2004. **Localization and physical properties experiments conducted by Spirit at Gusev crater**. *Science* 305, 821-824.

Grant, JA , R Arvidson, JF Bell, III, NA Cabrol, MH Carr, P Christensen, L Crumpler, DJ Des Marais, BL EHLMANN, J Farmer, M Golombek, FD Grant, R Greeley, K Herkenhoff, R Li, HY McSween, DW Ming, J Moersch, JW Rice, Jr., S Ruff, L Richter, S Squyres, R Sullivan, C Weitz, 2004. **Surficial Deposits at Gusev Crater Along Spirit Rover Traverses**. *Science* 305, 807-810.

Herkenhoff, KE, SW Squyres, R Arvidson, DS Bass, JF Bell III, P Bertelsen, BL EHLMANN, W Farrand, L Gaddis, R Greeley, J Grotzinger, AG Hayes, SF Hviid, JR Johnson, B Jolliff, KM Kinch, AH Knoll, MB Madsen, JN Maki, SM McLennan, HY McSween, JW Rice, Jr., L Richter, M Sims, PH Smith, LA Soderblom, N Spanovich, R Sullivan, S Thompson, T Wdowiak, C Weitz, P Whelley, 2004. **Evidence from Opportunity's Microscopic Imager for Ancient Water on Meridiani Planum**. *Science* 306, 1727-1730.

Soderblom, LA, RC Anderson, RE Arvidson, JF Bell III, NA Cabrol, W Calvin, PR Christensen, BC Clark, T Economou, BL EHLMANN, WH Farrand, D Fike, R Gellert, TD Glotch, MP Golombek, R Greeley, JP Grotzinger, KE Herkenhoff , DJ Jerolmack, JR Johnson, B Jolliff , G Klingelhöfer, AH Knoll, ZA Learner, R Li, MC Malin, SM McLennan, HY McSween, DW Ming, RV Morris, JW Rice Jr., L Richter, R Rieder, D Rodionov, C Schröder, FP Seelos IV, JM Soderblom, SW Squyres, R Sullivan, WA Watters, CM Weitz, MB Wyatt, A Yen, J Zipfel, 2004. **Soils of Eagle Crater and Meridiani Planum at the Opportunity Rover Landing Site**. *Science* 306, 1723-1726.

Solar System Exploration Survey, National Academy of Sciences, Space Studies Board, 2003. (Brian Dewhurst, BETHANY EHLMANN, and David Smith, text ed.), ***New Frontiers in Solar System Exploration*.** National Academies Press. <http://www.nap.edu/openbook/NI000529/html/index.html>

FIRST-AUTHOR CONFERENCE PUBLICATIONS AND PRESENTATIONS

(invited) EHLMANN, BL et al. "Orbital Identification of Carbonate-Bearing Rocks on Mars**"** AGU Fall Mtg. 2008

(invited) EHLMANN, BL et al. "Diverse Alteration Minerals Around Martian Impact Craters Revealed by MRO-CRISM: Indicators of Hydrothermal Activity or Subsurface Aqueous Alteration?" AGU Fall Mtg. 2008

EHLMANN, BL et al. "Phyllosilicates, zeolites, and carbonate near Nili Fossae: evidence for distinct environments of aqueous alteration. Workshop on Martian Phyllosilicates, Paris, October 2008.

EHLMANN, BL, et al. "Distinct provinces of aqueous alteration in the western Isidis region identified with MRO-CRISM" LPSC 38, Houston, Texas, March 10-14, 2008, Abstract #2326

EHLMANN, BL, et al. "Infrared spectra of impact products from Lonar Crater: the effects of weathering and implications for Mars." LPSC 38, Houston, Texas, March 10-14, 2008, Abstract #2437

EHLMANN, BL, et al. "Mineralogic diversity and geomorphology of CRISM-detected phyllosilicate bearing materials in Nili Fossae, Mars: Implications for aqueous alteration." Eos Trans. AGU 88(52), 2007 Fall Meet. Suppl., Abstract H43H-01 (talk).

EHLMANN, BL, et al. "New secondary minerals detected by MRO CRISM and their geologic settings: kaolinite, chlorite, illite/muscovite, and the possibility of serpentine or carbonate in Nili Fossae" Seventh International Conference on Mars, Pasadena, California, July 9-13, 2007, Abstract #3270. (talk)

EHLMANN, BL, et al. "New phyllosilicate mineral signatures from west of Nili Fossae, Mars through combined OMEGA-CRISM analysis" LPSC 38, Houston, Texas, March 12-15, 2007, Abstract #2078. (poster)

EHLMANN, BL, et al. "Quantifying boulder shape and surface texture: A case study using geomorphology to infer environmental history at the Ephrata Fan, Channeled Scablands, Washington" LPSC 38, Houston, Texas, March 12-15, 2007, Abstract #1325. (poster)

EHLMANN, BL and RE Criss. "Enhanced Stage Variability on the Lower Missouri River as benchmarked by Lewis and Clark: Implications for Ecosystem Restoration" Eos Trans. AGU 87(52), 2006 Fall Meet. Suppl., Abstract H43H-01 (talk).

EHLMANN, BL and HA Viles. "Fluvial feature persistence and lichen weathering rates on basalt boulders, Ephrata Fan, Washington" Geomorphology & Earth Systems Science, BGRG International Conference, Loughborough, UK, June 28-30, 2006 (poster).

EHLMANN, BL et al., "Terrain Roughness from MER Traverse Profiles at Gusev Crater and Meridiani Planum" *Eos Trans. AGU, 85*(47), 2004 Fall Meet. Suppl., Abstract P21A-0201. (poster)

Sullivan, R. et al., 2004. (talk by B. EHLMANN) "Rock and Soil Physical Properties at the MER Terra Meridiani Landing Site". European Geophysical Union Meeting, Nice, France, April 25-30, 2004

EHLMANN, BL and RE Criss. "Stage Variability of the Missouri River as recorded by Lewis and Clark." *Geological Society of America Abstracts with Programs*, Vol. 36, No. 3, p. 7, GSA Regional Meeting, St. Louis, April 1-2, 2004. (talk)

EHLMANN, BL et al., 2002. "Hydrology of Lake Waiau" *Eos. Trans. AGU, 83*(19), 2002 Spring Meet. Suppl., Abstract H51E-06. (talk)

TEACHING EXPERIENCE

Teaching assistant, geosciences undergraduate spring break field trip, Brown University 2008

Tutor for Remote Sensing-GIS, Oxford University Hilary and Trinity terms 2005, Michaelmas term 2006. Hired by colleges to teach seminar courses in remote sensing (term-long and revision) for first-year Geography students (Mansfield, Worchester, St. Hilda's, Christ Church, Merton, Wadham, St. Edmond's Hall Colleges)

Teaching Assistant for EPSc 407 Remote Sensing, Washington University, 2003

Academic Tutor, Earth & Planetary Sci. Courses, Student Educational Services, Washington Univ., 2001-2002

TALKS AND PUBLIC OUTREACH

9/06-present bi-semesterly Earth science lessons for 2nd & 4th graders at Vartan Gregorian Elementary School
9/07-4/08 Mentor for JHU-APL's Mars Exploration Student Data Team, Kickapoo H.S., Missouri
2/08 Planetary Sciences Institute invited talk, "Composition and stratigraphy of altered Noachian crust: new results from MRO CRISM for phyllosilicates on Mars"
3/08 Planetary Society guest blogger for the Lunar and Planetary Sciences Conference 2008
8/07 Docent for RI Museum of Natural History "Mars 3-D" exhibit
7/06 NASA Ames Academy for Exploration talk "New Insights into Water on Mars: First results from CRISM"
5/06 Rickards High School International Baccalaureate Class Senior Celebration keynote speaker "The importance of breadth and internationalism in education"
2/05 Oxford University Space and Astronomical Society talk "First Year on Mars: Science Results from the NASA Mars Exploration Rovers"
9/05 Edwardsville Middle School "NASA Mars Exploration Rover Mission"
8/04 Macquarie University, Australian Centre for Astrobiology invited talk "First Results from the Mars Exploration Rovers at Gusev Crater and Meridiani Planum"
3/04 Panelist in two live, televised weekly JPL Mars Exploration Rover press conferences
1/04 Guest on Fox 2 News in the Morning, live (KTVI-St. Louis); Mars Rovers Landings

PROFESSIONAL ASSOCIATIONS AND SERVICE

Reviewer for the *Journal of Geophysical Research*

American Geophysical Union (since 2001)

Geological Society of America (since 2003)

NASA Academy Alumni Association (since 2002)
Phone Interviewer, 2004, 2007; Executive Selection Board, 2005-8; Soffen Grant Committee, 2006-8

UNIVERSITY COMMITTEES AND SERVICE

University Resources Committee, Brown University, 2008-present

Rhodes/Marshall Scholarship Nominating Committee, Brown University, 2006-present

Geoclub (geoscience graduate student group), Treasurer, 2007; Rep. to Grad Student Council, 2008

Rhodes Scholar Southern Africa Forum, executive committee member (2005-6)

Committee on Environmental Quality, Washington University, student rep. and co-chair (2002-4)

Student Union, Washington University, Senator, Academic Affairs committee co-chair (2001-4)

TECHNICAL SKILLS

Computer:
Proficient in ENVI, IDL programming, ArcGIS, Adobe Illustrator and Photoshop, MS Word, MS Excel, MS PowerPoint, MS Publisher, CorelDraw. Comfortable in Unix or Windows OS

Field techniques:
Proficient in use of portable ASD spectrometer, thermal emission spectrometer,, thermal camera, GPS. Experienced in GTS/theodolite surveying (both land and shallow water). Experienced in transect and grid ecological surveys. Skilled in sediment core acquisition and marine grab sample acquisition and vibracoring.

LANGUAGE SKILLS

English (native), Spanish (highly proficient), French (beginner)

ATHLETICS

SCUBA: PADI Advanced Open Water Diver

Rowing: Keble College Boat Club, Women's 1st VIII (2004), Hertford College Boat Club Women's 2nd VIII

Ultimate Frisbee: Washington Univ. Women's Ultimate club team (2000-4); Oxford Women's Team (2005- 7)

Soccer: Keble College Women's Football Club, Oxford (2000); Rickards H.S. Women's Varsity ('96-2000)