

Craig J. Hardgrove, Ph.D – Planetary Scientist

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Education: Doctor of Philosophy, Geology, University of Tennessee (2004-2011)
Bachelor of Science, Physics, Georgia Institute of Technology (1999-2004)

Website: <http://www.astrumterra.com/chardgrove>

Employment: Postdoctoral Research Scientist, Arizona State University (2013-present)

Assistant Staff Scientist, Malin Space Science Systems (2012-2013)

Postdoctoral Researcher, Stony Brook University (2011-2012)

NASA Graduate Research Program (GSRP), NASA Goddard Space Flight Center
& Department of Earth and Planetary Sciences, University of Tennessee
(2008-2011)

Graduate Teaching Assistant, Department of Earth and Planetary Sciences,
University of Tennessee (2004-2008)

Teaching Assistant, Department of Physics, Georgia Institute of Technology
(2002-2003)

Undergraduate Researcher, Department of Physics, Georgia Institute
of Technology (2003-2004)

Intern, Boeing Advanced Space Systems Division, Houston, TX (Spring, 2001)

Research Interests: Remote sensing (infrared, visible, gamma-ray, neutron) of terrestrial and other planetary surfaces; spacecraft instrument development; terrestrial analogs; planetary geomorphology

Personal Interests: Communicating science in video games (<http://www.astrumterra.com/blog>); science journalism (<http://shar.es/deMiN>); electronic music <http://www.themarathonmusic.com>

Computing Experience: Programming - Proficient in IDL, MCNPX, some Java, C++, FORTRAN, Unix bash script; Utilities - ENVI, Davinci, LaTeX

Activities/Awards:

- MSL Participating Scientist Collaborator - Jeff Moersch PI, Funded up to 0.25 FTE to work on DAN science analysis

- NASA GSRP, “Modeling and Characterization Studies of a Rover-Based Neutron Detector with Applications to Mars” NASA Goddard Space Flight Center - University of Tennessee, \$90K, (2008 - 2011)
- Interdisciplinary Research Award, Department of Earth and Planetary Sciences, University of Tennessee, (2010)
- NASA Group Achievement Award: for work on the Mars Exploration Rover mission (2007-2008)
- Graduate Student Award for Professional Promise, Department of Earth and Planetary Sciences, University of Tennessee, (2008)
- Excellence in Graduate Coursework, Department of Earth and Planetary Sciences, University of Tennessee, (2006, 2007)
- NASA/JPL Planetary Science Summer School, (summer 2006)

Service:

- Review Panels: NASA PG&G, MDAP, ASTID
- Reviewer: *JGR - Planets, JGR - Atmospheres, Meteoritics and Planetary Science, Icarus*
- AGU Session Chair: *Planetary Sciences Section*, 2011 and 2013
- San Diego Festival of Science and Engineering, Volunteer
- San Diego Air and Space Museum Space Day, MSSS Organizer and Volunteer
- New York Academy of Sciences, Writing Associate
- National Academy of Sciences: Science and Entertainment Exchange, Consultant
- Stony Brook University Postdoctoral Working Group, Committee Member
- NASA Graduate Student Research Program Fellowship Awardee, NASA Goddard Space Flight Center

Spacecraft Missions: **Mars Science Laboratory (MSL)**; Collaborator, Science Team Member, Geology Science Theme Lead, Mastcam/MAHLI/MARDI uplink (PUL-1 and PUL-2), downlink (PDL) and data managements (MDM) lead, member of DAN science team (2012-present); **Mars Exploration Rover (MER)** Mission, Mini-TES Payload Downlink Lead and Mineralogy/Geochemistry Science Theme Group (2005-present); **Mars Reconnaissance Orbiter (MRO)** Context Imager (CTX) targeting team

Publications

I. Peer-Reviewed Journal Articles

1. MAHLI (Mars Hand Lens Imager) at the Rocknest Sand Shadow: Science and Science-enabling Activities, Michelle Minitti, Linda Kah, R. Yingst, Kenneth Edgett, Robert Anderson, Luther Beegle, Joseph Carsten, Robert Deen, Walter Goetz, **Craig Hardgrove**, David Harker, Kenneth Herkenhoff, Joel Hurowitz, Louise Jandura, Megan Kennedy, Gary Kocurek, Gillian Krezoski, Stephen Kuhn, Daniel Limonadi, Leslie Lipkaman, Morten Madsen, Timothy Olson, Matthew Robinson, Scott Rowland, David Rubin, Calina Seybold, Juergen Schieber, Mariek Schmidt, Dawn Sumner, Vandana Tompkins, Jason Van Beek, Tessa Van Beek, *Journal of*

Geophysical Research - Planets, Results from the First 100 Sols of the Mars Science Laboratory Mission: Bradbury Landing Through Rocknest, Special Issue, (submitted).

2. [Thermal infrared and Raman microspectroscopy of moganite-bearing rocks](#), Craig Hardgrove and A. Deanne Rogers, *American Mineralogist*, Vol. 98, pp.78-84, (2013).

3. [Effects of geochemical composition on neutron die-away measurements: Implications for Mars Science Laboratory's Dynamic Albedo of Neutrons instrument](#). **Craig Hardgrove**, Jeff Moersch, Darrell Drake, *Nuclear Instruments and Methods in Physics Research A*, 659, pp. 442-455, (2011).

4. [Evidence for episodic alluvial fan formation in far western Terra Tyrrhena, Mars](#), Rebecca M.E. Williams, A. Deanne Rogers, Matthew Chojnacki, Joseph Boyce, Kimberly D. Seelos, **Craig Hardgrove**, Frank Chuang, *Icarus*, Vol. 221, pp. 222-237, (2011).

5. [Reexamining the relationship between Apollinaris Patera and the basalts of the Gusev crater plains, Mars](#), Nicholas Lang, Harry Y. McSween Jr., Livio L. Tornabene, **Craig J. Hardgrove**, *Journal of Geophysical Research*, Vol. 115, E04006, (2010).

6. [Thermal Imaging of Sedimentary Features on Alluvial Fans](#), **Craig Hardgrove**, Jeffrey E. Moersch, Stephen Whisner, *Planetary and Space Science*, Vol. 58, pp. 482-508, (2010).

7. [Thermal Imaging of Alluvial Fans; A New Technique for Remote Classification of Sedimentary Features](#), **Craig Hardgrove**, Jeffrey E. Moersch, Stephen Whisner, *Earth and Planetary Science Letters*, Vol. 285, pp. 124-130, (2009).

8. [Surface and subsurface composition of the Life in the Atacama Field Sites from Rover Data and Orbital Image Analysis](#), Jennifer L. Piatek, **Craig Hardgrove**, Jeffrey E. Moersch, Darrel M. Drake, Michael B. Wyatt, Michael Rampey, Orion Carlisle, Kim Warren-Rhodes, James M. Dohm, Andrew N. Hock, Nahalie A. Cabrol, David S. Wettergreen, Edmond A. Grin, Guillermo Chong Diaz, Peter Coppin, Shmuel Weinstein, Charles S. Cockell, Lucia Marinangeli, Gian Gabriele Ori, Trey Smith, Dominic Jonak, Michael Wagner, Kristen Stubbs, Geb Thomas, Erin Pudenz, and Justin Glasgow, *Journal of Geophysical Research*, Vol. 112, (2007).

9. [Life in the Atacama: Searching for life with rovers \(science overview\)](#), Nathalie A. Cabrol, David Wettergreen, Kim Warren-Rhodes, Edmond A. Grin, Jeffrey Moersch, Guillermo Chong Diaz, Charles S. Cockell, Peter Coppin, Cecilia Demergasso, James M. Dohm, Lauren Ernst, Gregory Fisher, Justin Glasgow, **Craig Hardgrove**, Andrew N. Hock, Dominic Jonak, Lucia Marinangeli, Edwin Minkley, Gian Gabriele Ori, Jennifer Piatek, Erin Pudenz, Trey Smith, Kristen Stubbs, Geb Thomas, David Thompson, Alan Waggoner, Michael Wagner, Shmuel Weinstein, Michael Wyatt *Journal of Geophysical Research*, Vol. 112, (2007).

10. [Life in the Atacama: A scoring system for habitability and the robotic exploration for life](#), Andrew N. Hock, Nathalie A. Cabrol, James M. Dohm, Jennifer Piatek, Kim Warren-Rhodes, Shmuel Weinstein, David S. Wettergreen, Edmond A. Grin, Jeffrey Moersch, Charles S. Cockell, Peter Coppin, Lauren Ernst, Gregory Fisher, **Craig Hardgrove**, Lucia Marinangeli, Edwin Minkley, Gian Gabriele Ori, Alan Waggoner, Mike Wyatt, Trey Smith, David Thompson, Michael Wagner, Dominic Jonak, Kristen Stubbs, Geb Thomas, Erin Pudenz, Justin Glasgow, *Journal of Geophysical Research*, Vol. 112, (2007).

II. Selected Conference Abstracts

1. [Chlorine and Hydrogen Contents from the First 90 Sols of MSL DAN Active Measurements](#), **C. J. Hardgrove**, J. Moersch, D. Drake, I. G. Mitrofanov, M. Litvak, A. Behar, W. V. Boynton, L. Deflores, F. Fedosov, D. Golovin, I. Jun, K. Harshman, A. S. Kozyrev, A. Malakhov, R. Milliken, R. O. Kuzmin, M. Mischna, M. Mokrousov, S. Nikiforov, A. B. Sanin, C. Tate, A. Varenikov, and the MSL Science Team (2013) *44th Lunar and Planetary Science Conference*, Abstract #1752

2. [Content of Hydrogen at Testing Spots of the Gale Crater: The First Data from DAN Onboard the Curiosity Mars Rover](#), I. G. Mitrofanov, M. Litvak, D. Lisov, A. Behar, W. V. Boynton, L. Deflores, F. Fedosov, D. Golovin, **C. J. Hardgrove**, K. Harshman, I. Jun, A. S. Kozyrev, R. Kuzmin, A. Malakhov, M. Mischna, J. Moersch, M. Mokrousov, S. Nikiforov, A. B. Sanin, V. Shvetsov, R. Starr, C. Tate, V. I. Tret'yakov, A. Varenikov, A. Vostrukhin, *44th Lunar and Planetary Science Conference* (2013), Abstract #1487

3. [Origin and Evolution of the Peace Vallis Fan System that Drains into the Curiosity Landing Area, Gale Crater](#), M. C. Palucis, W. E. Dietrich, A. G. Hayes, R. M. E. Williams, F. Calef, D. Y. Sumner, S. Gupta, **C. J. Hardgrove**, MSL Team (2013) *44th Lunar and Planetary Science Conference*, Abstract #1607

4. [Thermal Infrared Spectra of Microcrystalline Sedimentary Phases: Effects of Natural Surface Roughness on Spectral Feature Shape](#), **C. Hardgrove** and D. Rogers (2012) *43rd Lunar and Planetary Science Conference*, Abstract #1675

5. [Importance of Future Gamma and Neutron Spectrometers at Mars](#), S. Karunatillake, **C. Hardgrove**, J. J. Wray (2012) *Concepts and Approaches for Mars Exploration*, Abstract #4083

6. [Laboratory Spectral Analyses of Microcrystalline Silica](#), **C. Hardgrove** and D. Rogers (2011) *Eos Trans. AGU*, 89(53), *Fall Meet. Suppl.*, Abstract P43-1684

7. [Geochemical Effects on Neutron Die-Away: Implications for the Mars Science Laboratory Dynamic Albedo of Neutrons Experiment](#), **C. J. Hardgrove** and J. E. Moersch, (2011) *42nd Lunar and Planetary Sciences Conference*, Abstract #2135

8. Remote Thermophysical Observations of Terrestrial Inverted Relief Features, **C. J. Hardgrove**, S. C. Whisner, R. M. E. Williams, J. E. Moersch, M. Chojnacki, D. Rogers, (2010) *41st Lunar and Planetary Sciences Conference*, Abstract #2497
9. Simulations of Time-Dependent Neutron Scattering in Layered Materials Containing Hydrated Minerals, **C. J. Hardgrove**, J. E. Moersch, R. Starr, T. Mcclanahan, A. Parsons, (2010) *41st Lunar and Planetary Sciences Conference*, Abstract #2473
10. Ground-Based Thermal Imaging of An Inactive Rock Glacier as Analog to Martian Debris Aprons, J. Piatek, **C. J. Hardgrove** and J. E. Moersch, (2009) *GSA Annual Meeting*, Paper No. 20-9
11. Identification of Sedimentary Processes on Alluvial Fans using Thermal Images and Ground Truth, **C. J. Hardgrove**, J. E. Moersch and S. C. Whisner, (2009) *40th Lunar and Planetary Sciences Conference*, Abstract #1211.
12. Detection and Mapping of Sedimentary Features on Alluvial Fans Using High-Resolution Overhead Thermal Imaging, **C. J. Hardgrove**, J. E. Moersch, and S. Whisner, (2008) *Eos Trans. AGU*, 89(53), Fall Meet. Suppl., Abstract H33A-0985
13. Was Apollinaris Patera the source for the Gusev crater basalts?, N. P. Lang, H. Y. McSween, L. L. Tornabene, **C. J. Hardgrove**, P. R. Christensen, (2008) *Eos Trans. AGU*, 89(53), Fall Meet. Suppl., Abstract P52B-02
14. Thermophysical Signatures of Sedimentary Processes on Alluvial Fans, Jeffrey E. Moersch, **Craig J. Hardgrove**, and S. Christopher Whisner, (2008) *GSA Joint Annual Meeting*, Abstract 268-4.
15. Thermophysical Patterns In Terrestrial Alluvial Fans For Application to the Study of Martian Sedimentary Features, **C. Hardgrove**, S. C. Whisner, J. E. Moersch, (2008) *39th Lunar and Planetary Sciences Conference*, Abstract #1226.
16. Thermophysical Characterization of Terrestrial Analogs for Martian Sedimentary Features, J. E. Moersch, S. C. Whisner, **C. Hardgrove**, (2007) *Seventh International Conference on Mars*, Abstract #3355.
17. Potential Rock Glaciers on Mars: Comparison with Terrestrial Analogs, J. L. Piatek, **C. Hardgrove**, J. E. Moersch, (2007) *Seventh International Conference on Mars*, Abstract #3353.
18. Field Observations of Thermoclinometric Effects in Dumont Dunes, California, S.C. Whisner, J.E. Moersch and **C. J. Hardgrove**, (2007) *38th Lunar and Planetary Sciences Conference*, Abstract #2371.

19. [Simulations of Rover Based Neutron Remote Sensing of Periglacial Features on Mars](#), **C. J. Hardgrove**, J. E. Moersch, and D. M. Drake, (2007) *38th Lunar and Planetary Sciences Conference*, Abstract #1786.
20. [Field Tests and Ground Truthing of a Surface-Based Neutron Detector in the Atacama Desert, Chile](#), **C. Hardgrove**, J. Moersch, D. Drake, J. Piatek, D. Wettergreen, N. Cabrol, (2006) *37th Lunar and Planetary Sciences Conference*, Abstract #2320.
21. [SCREAM \(Subsurface Characterization Rover for Exobiology Assessment on Mars\)](#), A.M. Cook, M. Spencer, M. Avnet, J. Bonetti, K. Bryson, M. Busch, S. Cheng, Z. Crawford, J. Edmundson, E. Fahnestock, C. Fuse, **C. Hardgrove**, C. Hier-Majumder, N. Johnson, J. Mikucki, H. Smith, L. Son, S. Wilson, T. Balint, (2006) *EOS Trans. AGU*, 87(52), *Fall Meet. Suppl.* Abstract P51C-1205
22. [A PSSS Student-designed Alternative to Exomars](#), A.M. Cook, M. Spencer, A. Avnet, J. Bonetti, K. Bryson, M. Busch, S. Cheng, Z. Crawford, J. Edmundson, E. Fahnestock, C. Fuse, **C. Hardgrove**, C. Hier-Majumder, N. Johnson, J. Mikucki, H. Smith, L. Son, S. Wilson, T. Balint, (2006) *28th Meeting of the AAS Division for Planetary Sciences DPS*, Presentation Number: 45.22.
23. [Thermophysical Characterization of Terrestrial Alluvial Fans, With Applications to Mars](#), J.E. Moersch, S.C. Whisner, **C. Hardgrove**, (2005) *EOS Trans. AGU*, 86(52), *Fall Meet. Suppl.* Abstract P41B-0935

Courses taught:

The Dynamic Earth
 Introduction to Planetary Geology
 Geologic Applications of Remote Sensing
 Intro Physics

Courses taken:

Mineralogy
 Igneous/Metamorphic Petrology
 Earth Sedimentary Processes
 Earth Structure and Geophysics
 Applied Geophysics
 Geologic Applications of Remote Sensing Petrogenesis of Crystalline Rocks
 Data Analysis in Geological Sciences Seminar in Petrology
 Seminar in Geochemistry
 Atomic Physics Astrophysics and Cosmology
 Monte Carlo Analysis
 Geology Field Camp while in Residence at University of Tennessee
 Intro Physics I
 Intro Physics II
 Intro to Modern Physics Stellar Astrophysics Quantum Mechanics I Classical Mechanics I

Electro & Magnetostatics Electrodynamics Thermodynamics
Solid State Physics
Electronics I
Statistical Mechanics
Quantum Mechanics II
Advanced Lab I
Remote Sensing & Data Analysis
Circuits & Electronics
Principles & Applications - Engineering Materials Intro to Computing
General Chemistry
Calculus I
Calculus II
Calculus III Differential Equations
Intro to Aerospace Engineering Intro to Mechanics
Low Speed Aerodynamics Dynamics
Intro-Structural Analysis Thermodynamics and Compressible Flow Vibrations & System
Dynamics Astronautics