

## **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 (neutron, gamma-ray, infrared, visible) of terrestrial and other planetary surfaces; small spacecraft instrument development (high resolution orbital neutron detectors for CubeSats, next-generation pulsed neutron detector systems for landed spacecraft and CubeSats); imaging of terrestrial analogs with thermal infrared imaging systems; autonomous science planning and visual recognition systems; planetary geomorphology; commercial spaceflight and academic partnerships

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

*Personal Interests:* Science journalism and communication (<http://shar.es/deMiN>); Science in video games (<http://www.astrumterra.com/blog>); Electronic music <http://www.themarathonmusic.com>; Podcasting (<http://www.astrumterra.com/thisisstrauss>)

*Activities/Awards:*

- Mars 2020 rover Co-Investigator, Mastcam-Z
- Mars Science Laboratory (MSL) Participating Scientist Collaborator - DAN and Mastcam team collaborator
- 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*, *SSW*
- Reviewer: *JGR - Planets*, *JGR - Atmospheres*, *Meteoritics and Planetary Science*, *Icarus*
- AGU Session Chair: *Planetary Sciences Section*, 2011 and 2013
- Stony Brook University Postdoctoral Working Group, Committee Member
- NASA Graduate Student Research Program Fellowship Awardee, NASA Goddard Space Flight Center

*Outreach*

- Invited geology lectures to video game developer Bungie Studios (Jan. 2013, May 2014)
- Phoenix Comicon Science Panelist (June 2014)
- San Diego Air and Space Museum Space Day, MSSS Organizer and Volunteer (2013)
- San Diego Festival of Science and Engineering, Volunteer (2013)
- New York Academy of Sciences, Writing Associate (2012-2013)
- National Academy of Sciences: Science and Entertainment Exchange, Consultant (2012 - present)

*Spacecraft Missions:* **Mars 2020** Co-I, Mastcam-Z; **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 management (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 (H-index = 5)

### I. First-Authored Peer-Reviewed Journal Articles

1. [Thermal Emission Spectroscopy of Microcrystalline Sediment Phases: Effects of Natural Surface Roughness on Spectral Feature Shape](#), **Craig Hardgrove**, A. Deanne Rogers, Tim Glotch, and J. A. Arnold, *in prep*, (2015).
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. [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).
5. [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).

### II. Peer-Reviewed Journal Articles with Significant Contribution

1. [Transient Liquid Water and Water Activity at Gale Crater on Mars](#), F. Javier Martin-Torres, Maria-Paz Zorzano, Patricia Valentin-Serrano, Ari-Matti Harri, Maria Genzer, Osku Kempainen, Edgard G. Rivera-Valentin, Insoo Jun, James Wray, Morten Bo Madsen, Walter Goetz, Alfred S. McEwen, **Craig Hardgrove**, Nilton Renno, Vincent F. Chevrier, Michael Mischna, Rafael Navarro-Gonzalez, Jesus Martinez-Frias, Pamela Conrad, Tim McConnochie, Charles Cockell, Gilles Berger, Ashwin R. Vasavada, Dawn Sumner and David Vaniman, *Nature - Geoscience*, Vol. 8, 357-361 doi:10.1038/ngeo2412 (2015)
2. [Water and chlorine content in the Martian soil along the first 1900 m of the Curiosity rover traverse as estimated by the DAN instrument](#), I.G. Mitrofanov, M.L. Litvak, A. Sanin, R. Starr, D.I. Lisov, R.O. Kuzmin, A. Behar, W.V. Boynton, **C. Hardgrove**, K. Harshman, I. Jun, R.E. Milliken, M.A. Mischna, J.E Moersch, C.G. Tate, *Journal of Geophysical Research - Planets*, Vol. 119, 7, 1579-1596 (2014).
3. [Local Variations of Bulk Hydrogen and Chlorine-Equivalent Neutron Absorption Content Measured at the Contact Between the Sheepbed and Gillespie Lake Units in Yellowknife Bay, Gale Crater, Using the DAN Instrument Onboard Curiosity](#), M.L. Litvak, I.G. Mitrofanov, A.B. Sanin, D. Lisov, A. Behar, W.V. Boynton, L. Deflores, F. Fedosov, D. Golovin, **C. Hardgrove**, K. Harshman, I. Jun, A.S. Kozyrev, R.O. Kuzmin, A. Malakhov, R. Milliken, M. Mischna, J. Moersch, M. Mokrousov, S. Nikiforov, V.N. Shvetsov, K. Stack, R. Starr, C. Tate, V.I. Tret'yakov, A. Vostrukhin and the MSL Team, *Journal of Geophysical Research - Planets*, Vol. 119 (2014).

4. [A martian case study of segmenting images automatically for granulometry and sedimentology, Part 1: Algorithm](#), Suniti Karunatillake, Scott M. McLennan, Kenneth E. Herkenhoff, Jonathan M. Husch, **Craig Hardgrove**, J.R. Skok, *Icarus*, Vol. 229, pp. 400-407, (2014).
5. [A martian case study of segmenting images automatically for granulometry and sedimentology, Part 2: Assessment](#), Suniti Karunatillake, Scott M. McLennan, Kenneth E. Herkenhoff, Jonathan M. Husch, **Craig Hardgrove**, J.R. Skok, *Icarus*, Vol. 229, pp. 408-417, (2014).
6. [A Habitable Fluvio-Lacustrine Environment at Yellowknife Bay, Gale Crater, Mars](#), J. P. Grotzinger, D. Y. Sumner, L. C. Kah, K. Stack, S. Gupta, L. Edgar, D. Rubin, K. Lewis, J. Schieber, N. Mangold, R. Milliken, P. G. Conrad, D. DesMarais, J. Farmer, K. Siebach, F. Calef III, J. Hurowitz, S. M. McLennan, D. Ming, D. Vaniman, J. Crisp, A. Vasavada, K. S. Edgett, M. Malin, D. Blake, R. Gellert, P. Mahaffy, R. C. Wiens, S. Maurice, J. A. Grant, S. Wilson, R. C. Anderson, L. Beegle, R. Arvidson, B. Hallet, R. S. Sletten, M. Rice, J. Bell III, J. Griffes, B. Ehlmann, R. B. Anderson, T. F. Bristow, W. E. Dietrich, G. Dromart, J. Eigenbrode, A. Fraeman, **C. Hardgrove**, K. Herkenhoff, L. Jandura, G. Kocurek, S. Lee, L. A. Leshin, R. Leveille, D. Limonadi, J. Maki, S. McCloskey, M. Meyer, M. Minitti, H. Newsom, D. Oehler, A. Okon, M. Palucis, T. Parker, S. Rowland, M. Schmidt, S. Squyres, A. Steele, E. Stolper, R. Summons, A. Treiman, R. Williams, A. Yingst, MSL Science Team, *Science*, Vol. 343, no. 6169, (2014).
7. [Neutron background environment measured by the Mars Science Laboratory's Dynamic Albedo of Neutrons instrument during the first 100 sols](#), I. Jun, I. Mitrofanov, M. L. Litvak, A. B. Sanin, W. Kim, A. Behar, W. V. Boynton, L. DeFlores, F. Fedosov, D. Golovin, **C. Hardgrove**, K. Harshman, A. S. Kozyrev, R. O. Kuzmin, A. Malakhov, M. Mischna, J. Moersch, M. Mokrousov, S. Nikiforov, V. N. Shvetsov, C. Tate, V. I. Tret'yakov and A. Vostrukhin, *Journal of Geophysical Research - Planets*, Vol. 118, 11, pp. 2400-2412, (2013).
8. [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, (2013).
9. [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).
10. [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).

11. [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).

12. [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).

13. [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. [The Lunar Polar Hydrogen Mapper \(LunaH-Map\) Mission: Revealing Hydrogen Distributions at the Moon's Pole with a 6U CubeSat](#), **C. Hardgrove**, J. Bell, J. Thangavelautham, A. Klesh, R. Starr, T. Colaprete, M. Robinson, D. Drake, E. Johnson, J. Christian, A. Genova, D. Dunham, B. Williams, D. Nelson, A. Babuscia, P. Scowen, K.M. Cheung, M. Beasley, T. McKinney, A. Taits, V. Hernandez, P. Wren, A. Thoesen, A. Godber, *21st Improving Space Operations Workshop, Exploring Space Using Game-Changing Approaches (2015)*.

2. [Lunar Polar Hydrogen Mapper \(LunaH-Map\)](#), **C. Hardgrove**, J. Bell, J. Thangavelautham, A. Klesh, R. Starr, T. Colaprete, M. Robinson, D. Drake, E. Johnson, J. Christian, A. Genova, D. Dunham, B. Williams, D. Nelson, A. Babuscia, P. Scowen, K.M. Cheung, M. Beasley, T. McKinney, A. Taits, V. Hernandez, P. Wren, A. Thoesen, A. Godber, *International Small Satellite Conference (2015), Abstract A3*.

3. [Detecting High Manganese Phases in Curiosity Mastcam Multispectral Images and Chemcam Passive Visible to Near Infrared Spectra](#), **C. Hardgrove**, J. Johnson, N. Lanza, M. Rice, J. Bell, K. Kinch, D. Wellington, R. Arvidson, A. Godber, *46th Lunar and Planetary Science Conference (2015), Abstract #2748*

4. [Modeling of Mars Science Laboratory Curiosity's Dynamic Albedo of Neutrons Instrument Data Using Elemental Geochemistry](#), **C. Hardgrove**, J. Moersch, I. Mitrofanov, M. Litvak, A. Behar, W. V. Boynton, L. Deflores, D. Drake, 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, *45th Lunar and Planetary Science Conference (2014)*, Abstract #1664

5. Visible and near-infrared spectra of manganese oxides: Detecting high manganese phases in Curiosity Mastcam multispectral images, **Craig Hardgrove**, Nina Lanza, James Bell, Melissa Rice, Roger Wiens, Jeffrey Johnson, Richard Morris, MSL Science Team (2014) *Eos Trans. AGU, Fall Meet. Suppl.*, Abstract P34A-07

6. DAN Active Parameters and Mastcam Hydration Survey Imaging: Comparisons Across Yellowknife Bay, Gale Crater, Mars, **Craig J. Hardgrove**, Melissa S. Rice, Jeffrey Moersch, Igor G. Mitrofanov, Maxim Litvak, Danika F. Wellington, Alberto Behar, James F. Bell, William V. Boynton, Lauren DeFlores, Darrell Drake, Fedor Fedosov, Dmitry Golovin, Insoo Jun, Karl Harshman, Alexander Kozyrev, Alexey Malakhov, Ralph Milliken, Ruslan Kuzmin, Michael A. Mischna, Maxim Mokrousov, Sergey Nikiforov, Anton Sanin, Christopher Tate, MSL Science Team (2013) *Eos Trans. AGU, 89(53)*, Fall Meet. Suppl., Abstract P23B

7. 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

8. 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

9. 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

10. 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

11. 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

12. Laboratory Spectral Analyses of Microcrystalline Silica, **C. Hardgrove** and D. Rogers (2011) *Eos Trans. AGU*, 89(53), *Fall Meet. Suppl.*, Abstract P43-1684
13. 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
14. 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
15. 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
16. 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
17. 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.
18. 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
19. 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
20. 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.
21. 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.
22. 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.

23. [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.
24. [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.
25. [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.
26. [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.
27. [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. Fahnstock, 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*
28. [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. Fahnstock, 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.
29. [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*