

Curriculum Vita

William H. Farrand

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EDUCATION

Ph.D. in Geosciences at the University of Arizona, Tucson, AZ, Spring 1991.

Minor in Remote Sensing

Dissertation Title: Visible and Near Infrared Reflectance of Tuff Rings and Tuff Cones

Dissertation Advisor: Dr. Robert B. Singer

M.S. in Geosciences at the University of Arizona, Tucson, AZ, Spring, 1987.

Thesis Title: Highland contamination and minimum basalt thickness in northern Mare Fecunditatis

Thesis Advisor: Dr. John S. Lewis

B.S. in Geology at Franklin and Marshall College, Lancaster, PA, Spring 1984.

PROFESSIONAL and ACADEMIC EXPERIENCE

6/1999 – present Senior Research Scientist, Space Science Institute, Boulder, CO. Working on NASA Mars Data Analysis Program research projects; Participating Scientist on Mars Exploration Rover mission. Experience working with Mars Reconnaissance Orbiter CRISM and HiRISE data, MER Pancam and Mini-TES data, Mars Odyssey THEMIS data, Mars Global Surveyor MOC, MOLA, and TES data, and Mars Pathfinder IMP data.

1/1998 - present Periodic commercial remote sensing consulting work. Analysis of hyper- and multispectral datasets for commercial clients. Experience with ENVI, IDL, Matlab, and ArcGIS in a PC environment.

1996 - 1/1998 Senior Research Scientist, Applied Signal and Image Technology, Boulder, CO. Analyzed hyperspectral data sets for purposes of mineral exploration and environmental remediation, integrated remote sensing with other information sources, collected field reflectance spectra, and validated algorithms for hyperspectral data analysis. Worked with ENVI/IDL and Matlab on PCs

1995 - 1996 Senior Research Scientist, Analytical Imaging and Geophysics, Boulder, CO. Analyzed hyperspectral data sets for purposes of mineral exploration and environmental remediation. Worked primarily with ENVI/IDL on PCs.

1992 - 1995 Research Scientist, Science Applications International Corporation (SAIC), McLean, VA. Worked under contract to Naval Research Laboratory on the Hyperspectral Digital Imagery Collection Experiment (HYDICE). Engaged in analysis of hyperspectral data sets for purposes of identification of manmade and natural materials, assisted in planning and conduct of data collections (including collection of ground truth data), represented and gave presentations for program at numerous meetings. Experience with IDL and ENVI and C programming on a Sun SPARC workstation environment, also worked with radiative transfer codes for the atmospheric correction of remote sensing data.

- 1988 - 1991 Graduate Research Associate, Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ. Research centered on analysis of the visible and infrared reflectance of tuff rings and tuff cones as possible Mars analog materials using laboratory, field and airborne spectral measurements. Experience with C and FORTRAN working in a unix-based Sun workstation environment.
- 1985 - 1987 Graduate Research Assistant, Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ. Research focused on analysis of Apollo orbital X-ray and gamma ray data of lunar maria.

RESEARCH GRANTS

- Principal Investigator on NASA Mars Fundamental Research Program investigation “Field and laboratory studies of hydrovolcanic tephra and impact ejecta: Applications to Mars rover investigations”, total budget of \$196,000, 2012-2015.
- Principal Investigator on JPL funded Mars Landing Site investigation “Exploring Exposures of Multiple Phyllosilicate Minerals South of Mawrth Vallis”, total budget of \$25,000, 2011-2012.
- Co-Investigator on NASA Mars Data Analysis Program investigation “MEx HRSC color data analysis of the MER sites”, P.I., T.A. McCord, Columbia Technologies & Services, Inc., 2007-2010.
- Principal Investigator on NASA Mars Data Analysis Program investigation “Analysis of Layered Terrains near Mawrth Vallis: Comparisons with Meridiani Planum”, NNX06AD87G, total budget of \$200,530; 2007 – 2011.
- Principal Investigator on NASA Mars Data Analysis Program investigation “Mapping and Characterization of Surface Units and Landforms on the Northern Plains of Mars”, NNG05GQ53G, total budget of \$184,737; 2006 – 2010.
- Principal Investigator on NASA Mars Data Analysis Program investigation “Mapping and Analysis of Spectrally Unique Soils, Rocks, and Rock Coatings on Mars at Local and Regional Scales Using Imager for Mars Pathfinder and Mars Odyssey THEMIS”, NAG5-13294, total budget of \$167,266; 2003 – 2006.
- Participating Scientist on NASA Mars Exploration Rover mission on investigation “Major and Minor Components of the Surface Layer of Mars: An Investigation Using the MER Pancam and mini-TES Instruments”, original 2002-2005 budget of \$245,312.
- Co-Investigator on NASA Applied Information Systems Research investigation “Precision Mining of Large Spectral Data Volumes for Rapid Identification of Planetary Resources”, P.I., E. Merényi, Rice Univ. NNG05GA94G, Co-I portion of budget was \$25,117 for 2006-2009.
- Principal Investigator on NASA Mars Data Analysis Program investigation “Using a Pan-Spectral Approach to Identify Hydrovolcanic Landforms and Tephra on Mars”, NAG5-10577, total budget of \$172,118; 2001-2004.
- Co-Investigator on NASA Planetary Geology and Geophysics investigation “Mineralogy and Weathering History of the Martian Surface”, P.I., J.F. Bell III, Cornell Univ. Co-I portion of budget was \$13,516 for 2002-2004.
- Co-Investigator on NASA Applied Information Systems Research investigation “Precision Mining of Large Spectral Data Volumes for Rapid Identification of Planetary Resources”, P.I., E. Merényi, Rice Univ. NAG5-9405. Co-I portion of budget was \$23,883 for 2000 – 2003.

- Co-Investigator on NASA Mars Data Analysis investigation “Sub-pixel Detectability of Materials at the Pathfinder Landing Site”, P.I, J.F. Bell III, Cornell Univ. Co-I portion of budget was \$49,535 for 2000-2003.
- Co-Investigator on NASA Mars Data Analysis investigation “Multispectral Mapping of the Martian Polar Ice Caps”, NAG5-8259, P.I., A. Nolin, Univ. Colorado. 1999 – 2002.

PROFESSIONAL ACTIVITIES

- 2014 Co-convener of session on “Tectonics and Volcanism in the Solar System” at 2014 GSA meeting, Vancouver, BC, October 19, 2014.
- 2012 Chair of sub-panel of NASA Mars Fundamental Research Program review panel.
- 2012 Participant and presenter at Mars 2018 Landing Site workshop and participant in Mars Exploration Program Analysis Group (MEPAG) meeting, February 27-28, Washington, DC.
- 2009 NASA Stand Alone Missions of Opportunity Notice (SALMON) review panel member.
- 2008 Served on Travel Award Grants Committee for GSA Planetary Geology Division.
- 2008 Represented GSA Planetary Geology Division at the GSA Leadership Meeting, Boulder, CO, May 2-5, 2008.
- 2007 Co-convener of session on “Advanced Remote Sensing of the Earth, Moon, and Mars: Mars Reconnaissance Orbiter and Other Platforms” at 2007 GSA meeting, Denver, CO, October 31, 2007.
- 2004 Co-chairman of session on “Mars mineralogy: the view from MER” at 2004 GSA meeting, Denver, CO, November 10, 2004.
- 2004 Served on instrument review panel for MSL radiation environment instrument.
- 2002 Assisted in camera calibration activities for Mars Exploration Rovers cameras.
- 2002 Participated in August 2002 FIDO rover field experiment.
- 2002 Selected as Participating Scientist on NASA Mars Exploration Rover mission.
- 2001 Co-Investigator on commercial project for Saudi Aramco using Ikonos 4 meter multispectral data to map shallow water marine environments on the shoreline of the Arabian Gulf.
- 2001 NASA Mars Global Surveyor Data Analysis Program (MGSDAP) review panel member.
- 2000 Session co-chairman for plenary session on “New Airborne Hyperspectral Systems”, 14th International Conference on Applied Geologic Remote Sensing, Las Vegas, NV.
- 2000 Served on program committee for the 14th International Conference on Applied Geologic Remote Sensing, Las Vegas, NV.
- 1998-9 Invited participant in planning meetings for and analysis of data from EPA sponsored AVIRIS flights over abandoned mine lands in Utah.
- 1998 Participated with researchers from the Grand Canyon Monitoring and Research Center and the University of Arizona in a remote sensing field experiment over a portion of the Grand Canyon.
- 1997 Session co-chairman for poster session on “Hyperspectral Geology” at Twelfth International Conference on Applied Geologic Remote Sensing, Denver, Colorado, November 17-19, 1997.

- 1997 Served on host committee for the Twelfth International Conference on Applied Geologic Remote Sensing held in Denver, Colorado, November 17-19, 1997.
- 1997 Invited participant for EPA sponsored workshop on “Advanced measurement and site characterization for mining impacts on public health and the environment”.
- 1997 Participated in ground truth activities for a Department of Energy -sponsored remote sensing mission to Kazakstan.
- 1994 Invited participant in Spectral Mixture Analysis workshop at the University of Washington Department of Geological Sciences Keck Remote Sensing Laboratory.
- 1993 Member of doctoral committees for Joseph Harsanyi at Department of Computer Science and Electrical Engineering, University of Maryland, Baltimore County.
- 1992 Evaluator for NASA Office of Exploration in selection of an imaging spectrometer for proposed Lunar Resource Mapper.
- 1989 Invited participant in NASA-sponsored Geologic Remote Sensing Field Experiment (GRSFE).

EDUCATION AND PUBLIC OUTREACH ACTIVITIES

- 2016 Instructor of workshop at 2016 IGTF, Ft. Worth, TX on “Hyperspectral and Extended Multispectral Remote Sensing: Phenomenology, Sensor Systems, and Data Processing”.
- 2015 Instructor of workshop at 2015 IGTF, Tampa, FL on “Hyperspectral and Extended Multispectral Remote Sensing: Phenomenology, Sensor Systems, and Data Processing”.
- 2014 Instructor of ASPRS workshop at 2014 Fall Pecora Conference, Denver CO on “Extended Multispectral Satellite Remote Sensing in the VNIR and SWIR”
- 2013 Co-instructor of ASPRS sponsored workshops for National Geospatial Agency on “Hyperspectral Image Processing and Feature Extraction: Maximizing Geospatial Information Retrieval”, St. Louis, MO and Springfield, VA.
- 2012 Instructor of workshop at 2012 ASPRS Fall Pecora Conference, Tampa, FL on “Hyperspectral Remote Sensing Data Processing: Background and Approaches”.
- 2012 Invited panel participant for public event associated with landing of the Mars Science Laboratory Curiosity rover, Denver Museum of Nature and Science, August 5, 2012.
- 2012 Co-Instructor for workshop at 2012 ASPRS meeting, Sacramento, CA on “Hyperspectral Image Processing and Feature Extraction: Maximizing Geospatial Information Retrieval”.
- 2011 Instructor of workshop at 2011 ASPRS Fall Pecora Conference, Reston, VA on “Hyperspectral Remote Sensing Data Processing: Background and Approaches”.
- 2010 Invited instructor for short course on “Application of hyperspectral remote sensing for mineral detection, presented at the Korea Institute of Geoscience and Mineral Resources (KIGAM), Daejeon, South Korea, December 15-16, 2010.
- 2010 Instructor for workshop at 2010 ASPRS/CaGIS Fall Specialty Conference, Orlando, FL on “Hyperspectral remote sensing: Phenomenology and data processing”, November 15, 2010.
- 2010 Presenter of ASPRS webinar “Hyperspectral remote sensing: Phenomenology and data analysis”, March 11, 2010.

- 2008 Co-Instructor for workshop at 2008 Fall Pecora Conference, Denver, CO on “Hyperspectral Image Processing and Feature Extraction: Maximizing Geospatial Information Retrieval”.
- 2008 Co-Instructor for workshop at 2008 ASPRS meeting, Portland, OR on “Hyperspectral Image Processing and Feature Extraction: Maximizing Geospatial Information Retrieval”.
- 2007 Co-Instructor for workshop at 2007 ASPRS meeting, Tampa, FL on “Hyperspectral Image Processing and Feature Extraction: Maximizing Geospatial Information Retrieval”.
- 2006 Instructor for workshop at 2006 ASPRS meeting, Reno, NV on “Integrating Hyperspectral Data and Spatial Analyses in a Geographic Information System”.
- 2005 Co-Instructor for workshop at 2005 ASPRS meeting, Baltimore, MD on “Integrating Hyperspectral Data and Spatial Analyses in a Geographic Information System”.
- 2003-4 Served as mentor to two high school students through Mars Exploration Rover Athena Student Intern Program.
- 2004 Co-Instructor for workshop at 2004 ASPRS meeting, Denver, CO on “Integrating Hyperspectral Data and Spatial Analyses in a Geographic Information System”.
- 2003 Co-Instructor for workshop at 2003 ASPRS meeting, Anchorage, AK on “Integrating Hyperspectral Data and Spatial Analyses in a Geographic Information System”.
- 2002 Co-Instructor for workshop at ASPRS Pecora 15 conference, Denver, CO on “Integrating Hyperspectral Data and Spatial Analyses in a Geographic Information System.”
- 2001 Authored materials and led Geoscience Instruction Workshop for grade 2 - 9 teachers in association with Classroom Science, Inc. and New Hampshire schools, Nasua, NH, August, 2001.
- 2001 Co-Instructor for workshop at 2001 ASPRS meeting, St. Louis, MO on “Integrating Hyperspectral Data and Spatial Analyses in a Geographic Information System”.
- 2000 Workshop instructor at 14th International Conference on Applied Geologic Remote Sensing, Las Vegas, NV, “Hyperspectral Data Analysis: Methods and a GIS Perspective”.
- 2000 Co-Instructor for workshop at 2000 ASPRS meeting, Washington, DC on “Integrating Hyperspectral Data and Spatial Analyses in a Geographic Information System”.
- 1999 Instructor for workshop at ASPRS Pecora 12 conference, Denver, CO on “Integrating Hyperspectral Data and Spatial Analyses in a Geographic Information System.”
- 1999 Co-Instructor for workshop at 1999 ASPRS meeting, Portland, OR on “Integrating Hyperspectral Data and Spatial Analyses in a Geographic Information System.”
- 1996 Instructor for Analytical Imaging & Geophysics sponsored short courses on “Hyperspectral data analysis and image processing”.

INVITED PRESENTATIONS

- Invited speaker at the University of Utah, Salt Lake City, UT, Title: “Hydrothermal and acid sulfate alteration on Mars: Rover and orbital observations”, February 12, 2015.
- Invited speaker at Stony Brook University, Stony Brook, NY, Title: “Clays and sulfate minerals on the rim of Endeavour crater, Mars: Exploration by Opportunity and links to similar materials elsewhere on Mars”, November 15, 2012.

- Invited speaker at Lunar and Planetary Institute, Houston, TX, Title: “Acid sulfate minerals in Mawrth Vallis and related areas on Mars”, June 22, 2012.
- Invited speaker at Purdue University, Department of Earth and Atmospheric Sciences, Title: “Hyperspectral remote sensing evidence for volcano-ice interactions in the southern highlands and northern lowlands of Mars”, April 7, 2011.
- Invited lecturer on hyperspectral remote sensing for mineral exploration, December, 2010 at the Korea Institute of Geoscience and Mineral Resources, Daejeon, South Korea.
- Invited speaker at University of Cincinnati, Dept. of Geography, Title: “Remote sensing of ferric sulfates and other minerals associated with acid waters on the Earth and Mars”, April 1, 2010.
- Invited speaker at Denver Museum of Nature and Science for Phoenix landing event, Title: “The On-Going Explorations of Spirit & Opportunity: An update”, May 31, 2008.
- Invited speaker at University of Colorado Fiske Planetarium, Mars, “Mars Exploration Rovers Update”, Sept. 6 and 7, 2007.
- Invited speaker at University of Texas at El Paso, Dept. of Geological Sciences, Title: “Multi- and hyperspectral analysis of layered terrains on Mars”, March 1, 2007.
- Invited speaker for DaVinci Institute “Night with a Futurist” series, Westminster, CO, Title: “The past, present and future of Mars Exploration”, August 7, 2006.
- Invited speaker at 8th International Mars Society Convention, Boulder, CO, Title: “The colors of Mars as viewed by Pancam”, August 11, 2005.
- Invited speaker at University of Northern Colorado Earth Sciences Dept., Greeley, CO, Title: “The explorations of Spirit and Opportunity: Two robotic field geologists on Mars”, February 11, 2005.
- Keynote speaker at ESRI Southwest Users Group meeting, Title: “The explorations of Spirit and Opportunity: Two robotic field geologists on Mars”, Telluride, CO, October 20, 2004.
- Invited speaker at Rice University, Houston, TX, Title: “The Explorations of Spirit and Opportunity”, June 21, 2004.
- Invited speaker at Southwest Research Institute, Boulder, CO, Title: “Visible and near infrared spectral variability in Eagle crater, Meridiani Planum, Mars as revealed by the Mars Exploration Rover Opportunity”, May, 2004.
- Invited speaker at Ball Aerospace, Boulder, CO, Title: “The Explorations of Spirit and Opportunity”, March 26, 2004.
- Invited speaker at 2nd Conference on Early Mars, Title: “In situ and displaced rocks exposed on Meridiani Planum, Mars as observed by the Mars Exploration Rover Opportunity: Chemistry, mineralogy and physical properties”, Jackson, WY, October 11-14, 2004.
- Invited presenter for the Defense Landsat Program Office sponsored workshop on “Atmospheric correction of Landsat imagery”, Torrance, CA, June 29 – July 1, 1993.
- Invited speaker at 1991 AGU Spring Meeting, special session on the Geologic Remote Sensing Field Experiment.

AWARDS and HONORS

- Ten year service award, Space Science Institute, September 2009.
- Received Sigma Xi travel grant and corresponding award from International Association of Volcanology and Chemistry of the Earth's Interior (IAVCEI) to attend IAVCEI Volcanological Congress in Mainz, FRG, Sept. 1990.

- Graduated Cum Laude from Franklin & Marshall College, May 1987.

PROFESSIONAL MEMBERSHIPS

- Institute of Electrical and Electronics Engineers (IEEE), 2007 – present.
- Geological Society of America, 2004 – present.
- American Society of Photogrammetry and Remote Sensing, 1992 - present.
- American Geophysical Union, 1986 - present.

PUBLICATIONS: William H. Farrand

DISSERTATION

Visible and Near Infrared Reflectance of Tuff Rings and Tuff Cones. (1991) University of Arizona, 187 pp.

PEER REVIEWED PUBLICATIONS

- Farrand, W.H.**, J.R. Johnson, M.S. Rice, A. Wang, J.F. Bell III (2016) VNIR multispectral observations of aqueous alteration materials by the Pancams on the Spirit and Opportunity Mars Exploration Rovers, *American Mineralogist*, **101**, 2005-2019, doi:0.2138/am-2016-5627.
- Farrand, W.H.**, S.P. Wright, A.D. Rogers, and T.D. Glotch (2016) Basaltic glass formed from hydrovolcanism and impact processes: Characterization and clues for detection of mode of origin from VNIR through MWIR reflectance and emission spectroscopy, *Icarus*, **275**, 16-28
- Farrand, W.H.**, J.F. Bell III, J.R. Johnson, M.S. Rice, B.L. Jolliff, and R.E. Arvidson (2014) Observations of rock spectral classes by the Opportunity rover's Pancam on northern Cape York and on Matijevic Hill, Endeavour Crater, Mars, *J. Geophys. Res. Planets*, **119**, doi:[10.1002/2014JE004641](https://doi.org/10.1002/2014JE004641).
- Farrand, W.H.**, T.D. Glotch, and B. Horgan (2014) Detection of copiapite in the northern Mawrth Vallis region of Mars: Evidence of acid sulfate alteration, *Icarus*, **241**, 346-357.
- Arvidson, R.E. et al. (2014), Ancient aqueous environments at Endeavour Crater, Mars, *Science*, **343**, doi:10.1126/science.1248097.
- Merenyi, E., **W.H. Farrand**, J.V. Taranik, and T.B. Minor (2014) Classification of hyperspectral imagery with neural networks: Comparison to conventional tools, *EURASIP Journal on Advances in Signal Processing*, **71**, doi:10.1186/1687-6180-2014-71.
- Farrand, W.H.**, J.F. Bell III, J.R. Johnson, M.S. Rice, and J.A. Hurowitz (2013) VNIR multispectral observations of rocks at Cape York, Endeavour crater, Mars by the Opportunity rover's Pancam, *Icarus*, **225**, 709-725.
- Squyres, S.W., R.E. Arvidson, J.F. Bell III, F. Calef III, B.C. Clark, B.A. Cohen, L.A. Crumpler, P.A. de Souza Jr., **W.H. Farrand**, and 18 others (2012) Ancient impact and aqueous processes at Endeavour crater, Mars, *Science*, **336**, 570-576.
- Farrand, W.H.**, M.D. Lane, B.R. Edwards, and R.A. Yingst (2011) Spectral evidence of volcanic cryptodomes on the northern plains of Mars, *Icarus*, **211**, 139-156, doi: 10.1016/j.icarus.2010.09.006.
- Fleischer, I., **W.H. Farrand**, C. Schröder, B. Jolliff, J. Ashley, G. Klingelhöfer, R. Gellert, P.A. de Souza, R.V. Morris, C. Weitz, S. Squyres, J.R. Johnson, K. Herkenhoff, E. Treguier, J.

- Brückner, D. Mittlefehldt (2010) Cobbles at Meridiani Planum, Mars, *J. Geophys. Res.*, **115**, E00F05, doi:10.1029/2010JE003621.
- Schröder, C., J.W. Ashley, **W.H. Farrand**, I. Fleisher, R. Gellert, K.E. Herkenhoff, J.R., G. Klingelhöfer, R. Li, R.V. Morris, and W. Wang (2010) Properties and distribution of paired candidate stony meteorites at Meridiani Planum, Mars, *J. Geophys. Res.*, **115**, E00F09, doi:10.1029/2010JE003616.
- Weitz, C.M., **W.H. Farrand**, J.R. Johnson, I. Fleischer, C. Schröder, A. Yingst, B. Joliff, R. Gellert, J.F. Bell III, K. Herkenhoff, G. Klingelhöfer, B. Cohen, W. Calvin, and M. Rutherford (2010) Visible and near-infrared multispectral analysis of geochemically measured rock fragments at the Opportunity landing site in Meridiani Planum, *J. Geophys. Res.*, **115**, E00F10, doi:10.1029/2010JE003660.
- Rice, M.S., J.F. Bell III, E.A. Cloutis, A. Wang, S.W. Ruff, M.A. Craig, D.T. Baily, J.R. Johnson, P.A. de Souza Jr., and **W.H. Farrand** (2010) Silica-rich deposits and hydrated minerals at Gusev crater, Mars: Vis-NIR spectral characterization and regional mapping, *Icarus*, **205**, 375–395.
- Yingst, R.A., L. Crumpler, **W.H. Farrand**, R. Li, and P. de Souza (2010) Morphology and texture of particles at the Home Plate region along Spirit's traverse from sol 750 to 1889, *J. Geophys. Res.*, **115**, E00F13, doi:10.1029/2010JE003668.
- Farrand, W.H.**, T.D. Glotch, J.W. Rice, J.A. Hurowitz, and G.A. Swayze (2009) Discovery of Jarosite within the Mawrth Vallis region of Mars: Implications for the geologic history of the region, *Icarus*, **204**, 478-488 doi:10.1016/j.icarus.2009.07.014.
- Schmidt, M.E., **W.H. Farrand**, J.R. Johnson, C. Schröder, J.A. Hurowitz, T.J. McCoy, S.W. Ruff, R.E. Arvidson, D.J. Des Marais, K.W. Lewis, D.W. Ming, S.W. Squyres, and P.A. de Souza (2009) Spectral, mineralogical, and geochemical variations across Home Plate, Gusev Crater, Mars indicate high and low temperature alteration, *Earth Planet. Sci. Letters*, **281**, 258-266.
- Squyres, S.W. A.H. Knoll, R.E. Arvidson, J.W. Ashley, J.F. Bell, III, W.M. Calvin, P.R. Christensen, B.C. Clark, B.A. Cohen, P.A. de Souza, Jr., L. Edgar, **W.H. Farrand**, et al. (2009) Exploration of Victoria Crater by Mars Rover Opportunity, *Science*, **324**, 1058-1061.
- Farrand, W.H.**, J.F. Bell III, J.R. Johnson, R.E. Arvidson, L.S. Crumpler, J.A. Hurowitz, and C. Schröder (2008) Rock spectral classes observed by the Spirit rover's Pancam on the Gusev crater plains and in the Columbia Hills, *J. Geophys. Res.*, **113**, E12S38, doi:10.1029/2008JE003237.
- Farrand, W. H.**, E. Merenyi, J. R. Johnson and J.F. Bell III (2008) Comprehensive mapping of spectral classes in the imager for Mars Pathfinder Super Pan, *Mars*, **4**, 33.
- Farrand, W.H.**, J.F. Bell III, J.R. Johnson, J.L. Bishop, and R.V. Morris (2008) Multispectral imaging from Mars Pathfinder, In *The Martian Surface: Composition, Mineralogy, and Physical Properties* (J.F. Bell III, ed.), Cambridge University Press, pp. 265-280.
- Arvidson, R.E., S.W. Ruff, R.V. Morris, D.W. Ming, L.S. Crumpler, A.S. Yen, S.W. Squyres, R.J. Sullivan, J.F. Bell III, N.A. Cabrol, B.C. Clark, **W.H. Farrand**, et al. (2008), Spirit Mars Rover Mission to the Columbia Hills, Gusev Crater: Mission overview and selected results from the Cumberland Ridge to Home Plate, *J. Geophys. Res.*, **113**, E12S33, doi:10.1029/2008JE003183.
- Calvin, W.M., J.D. Shoffner, J.R. Johnson, A.H. Knoll, J.M. Pockock, S.W. Squyres, C.M. Weitz, R.E. Arvidson, J.F. Bell III, P.R. Christensen, P.A. de Souza Jr., **W.H. Farrand**, et al. (2008)

- Hematite spherules at Meridiani: Results from MI, Mini-TES, and Pancam, *J. Geophys. Res.*, **113**, E12S37, doi:10.1029/2007JE003048.
- Knoll, A.H., B.L. Jolliff, **W.H. Farrand**, J.F. Bell III, B.C. Clark, R. Gellert, M.P. Golombek, J.P. Grotzinger, K.E. Herkenhoff, J.R. Johnson, S.M. McLennan, R.V. Morris, S.W. Squyres, R. Sullivan, N.J. Tosca, A. Yen, and Z. Learner (2008), Veneers, rinds, and fracture fills: Relatively late alteration of sedimentary rocks at Meridiani Planum, Mars, *J. Geophys. Res.*, **113**, E06S16, doi:10.1029/2007JE002949.
- Schmidt, M.E., S.W. Ruff, T.J. McCoy, **W.H. Farrand**, J.R. Johnson, R. Gellert, D.W. Ming, R.V. Morris, N. Cabrol, K.W. Lewis, and C. Schroeder (2008) Hydrothermal origin of halogens at Home Plate, Gusev Crater, *J. Geophys. Res.*, **113**, E06S12, doi:10.1029/2007JE003027.
- Schröder, C., D. S. Rodionov, T. J. McCoy, B. L. Jolliff, R. Gellert, L. R. Nittler, **W. H. Farrand**, J. R. Johnson, S. W. Ruff, J. W. Ashley, D. W. Mittlefehldt, K. E. Herkenhoff, I. Fleischer, A. F. C. Haldemann, G. Klingelhöfer, D. W. Ming, R. V. Morris, P. A. de Souza, S. W. Squyres, C. Weitz, A. S. Yen, J. Zipfel, and T. Economou. (2008) Meteorites on Mars observed with the Mars Exploration Rovers, *J. Geophys. Res.*, **113**, E06S22, doi:10.1029/2007JE002990.
- Yingst, R.A., L. Crumpler, **W.H. Farrand**, R. Li, N.A. Cabrol, and L.D. Neakrase (2008), Morphology and texture of particles along the Spirit rover traverse from sol 450 to sol 745, *Jour. Geophys. Res.*, **113**, E12S41, doi:10.1029/2008JE003179.
- Farrand, W.H.**, J.F. Bell III, J.R. Johnson, B.L. Joliff, A.H. Knoll, S.M. McLennan, S.W. Squyres, W.M. Calvin, J.P. Grotzinger, R.V. Morris, J. Soderblom, S.D. Thompson, W.A. Watters, and A.S. Yen (2007) Visible and near-infrared multispectral analysis of rocks at Meridiani Planum, Mars by the Mars Exploration Rover Opportunity, *J. Geophys Res.: Planets*, **112**, E06S02, 10.1029/2006JE002773.
- Squyres, S.W., O. Aharonson, B.C. Clark, B.A. Cohen, L. Crumpler, P.A. de Souza, **W.H. Farrand**, and 21 others (2007) Pyroclastic activity at Home Plate in Gusev Crater, Mars, *Science*, **316**, 738-742.
- Johnson, J.R., J.F. Bell III, E. Cloutis, M. Staid, W.H. Farrand, T. McCoy, M. Rice, A. Wang, A. Yen (2007) Mineralogic constraints on sulfur-rich soils from Pancam spectra at Gusev crater, Mars, *Geophys. Res. Lett.*, **34**, L13202, doi:10.1029/2007GL9029894.
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