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Curriculum Vita

William H. Farrand

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EDUCATION

Ph.D. University of Arizona, Geosciences; minor in Remote Sensing, 1991
M.S. University of Arizona, Geosciences, 1987
B.S. Franklin and Marshall College, Geology, 1984

PROFESSIONAL and ACADEMIC EXPERIENCE

6/1999 – present	Research Scientist, Space Science Institute, Boulder, CO. Working on NASA Office of Space Science Mars Data Analysis Program research projects; Participating Scientist on Mars Exploration Rover mission. Experience working with Mars Global Surveyor MOC, MOLA, and TES data, Mars Pathfinder IMP data, Mars Odyssey THEMIS data, and MER Pancam and Mini-TES data.
1/1998 - present	President and Senior Remote Sensing Scientist of Far View Consulting, Thornton, CO. Analysis of hyper- and multispectral datasets for commercial clients. Experience with ENVI, IDL, Matlab, and ArcView 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
1996 - present	Adjunct Research Associate, Center for Study of Earth from Space, University of Colorado, Boulder, CO. Presented guest lectures on terrestrial and planetary remote sensing.
1995 - 1996	Senior Research Scientist, Analytical Imaging and Geophysics (AIG), 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 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 on 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.

AWARDS and HONORS

-- 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.

RESEARCH GRANTS

-- Principal Investigator on NASA Mars Data Analysis Program investigation "Analysis of Layered Terrains near Mawrth Vallis: Comparisons with Meridiani Planum", total budget 2006 – 2009 of $200,530. NASA grant # NNX06AD87G.

-- Principal Investigator on NASA Mars Data Analysis Program investigation "Mapping and Characterization of Surface Units and Landforms on the Northern Plains of Mars", total budget 2005 – 2008 of $184,737.

-- 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", total budget 2003 – 2006 of $167,266.

-- 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 budget 2002-2005 of $245,312; 2005-2007 extended mission budget of $179,418.

-- Principal Investigator on NASA Mars Data Analysis Program investigation "Using a Pan-Spectral Approach to Identify Hydrovolcanic Landforms and Tephras on Mars", NAG5-10577, total budget 2001-2004 of $172,118.

-- 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 for 2002-2004 was $13,516.

-- 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 for 2000 – 2003 was $23,883.

-- 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 for 2000-2003 was $49,535.

-- 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

2007 Co-chairman of session on "Advanced Remote Sensing of the Earth, Moon, and Mars" 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 Keynote speaker at ESRI Southwest Users Group meeting, Telluride, CO, October 20.

2004 Invited speaker at 2nd Conference on Early Mars, Jackson, WY, October 11-14, 2004.

2002 selected as Participating Scientist on NASA Mars Exploration Rover mission.

2002 Assisted in camera calibration activities for cameras on Mars Exploration Rovers.

2002 Participated in August 2002 FIDO rover field experiment.

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.

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 Invited presenter for the Defense Landsat Program Office sponsored workshop on "Atmospheric correction of Landsat imagery".

1993 Served on doctoral committees at University of Maryland, Baltimore County Campus.

1992 Evaluator for NASA Office of Exploration in selection of an imaging spectrometer for proposed Lunar Resource Mapper.

1991 Invited speaker at 1991 AGU Spring Meeting, special session on the Geologic Remote Sensing Field Experiment.

1989 Invited participant in NASA-sponsored Geologic Remote Sensing Field Experiment (GRSFE).

EDUCATION AND PUBLIC OUTREACH ACTIVITIES

2007 Instructor for workshop at 2007 ASPRS meeting in Tampa, FL on "Integrating Hyperspectral Data and Spatial Analyses in a Geographic Information System".

2006 Instructor for workshop at 2006 ASPRS meeting in Reno, NV on "Integrating Hyperspectral Data and Spatial Analyses in a Geographic Information System".

2005 Co-Instructor for workshop at 2005 ASPRS meeting in 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 in Denver, CO on "Integrating Hyperspectral Data and Spatial Analyses in a Geographic Information System".

2003 Co-Instructor for workshop at 2003 ASPRS meeting in 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 in 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 in 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 in 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".

PROFESSIONAL MEMBERSHIPS

Geological Society of America, 2004 – present.
American Astronomical Society, Division of Planetary Science, 2000 – 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.

PAPERS SUBMITTED OR IN PRESS

Farrand, W.H., L. Kirkland, A.W. Nolin, and K. Thome. "Principles of Hyperspectral Remote Sensing" chapter in *Hyperspectral Remote Sensing* (E.A. Cloutis, Ed.), a volume in the 3rd Edition of the *Manual of Remote Sensing*, To be published by ASPRS.

PEER REVIEWED PUBLICATIONS

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.

S.W. Squyres, 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.

S.W. Squyres, A. H. Knoll, R. E. Arvidson, B. C. Clark, J. P. Grotzinger, B. L. Jolliff, S. M. McLennan, N. Tosca, J. F. Bell, III, W. M. Calvin, **W. H. Farrand**, T. D. Glotch, M. P. Golombek, K. E. Herkenhoff, J. R. Johnson, G. Klingelhöfer, H. Y. McSween, A. S. Yen (2006) Two years at Meridiani Planum: Results from the Opportunity rover, *Science*, **313**, 1403-1407.

Farrand, W.H., J.F. Bell III, J.R. Johnson, S.W. Squyres, J. Soderblom, D.W. Ming (2006) Spectral variability among rocks in visible and near infrared multispectral Pancam data collected at Gusev Crater: Examinations using spectral mixture analysis and related techniques. *J. Geophys. Res.: Planets*, **111**, E02S15, 10.1029/2005JE002495.

Squyres, S. W.; Arvidson, R. E.; Bollen, D.; Bell, J. F., III; Brückner, J.; Cabrol, N. A.; Calvin, W. M.; Carr, M. H.; Christensen, P. R.; Clark, B. C.; Crumpler, L.; Des Marais, D. J.; d'Uston, C.; Economou, T.; Farmer, J.; **Farrand, W. H**. and 38 others. (2006) Overview of the Opportunity Mars Exploration Rover Mission to Meridiani Planum: Eagle Crater to Purgatory Ripple. *J. Geophys. Res*., Vol. 111, No. E12, E12S12, 10.1029/2006JE002771.

Ruff, S.W., P.R. Christensen, D.L. Blaney, **W.H. Farrand**, J.R. Johnson, J.E. Moersch, S.P. Wright, S.W. Squyres (2006) The rocks of Gusev Crater as viewed by the Mini-TES instrument. *J. Geophys. Res.: Planets*, **111**, E12S18, 10.1029/2006JE002747.

Johnson, J.R., W.M. Grundy, M.T. Lemmon, J.F. Bell III, M.J. Johnson, R. Deen, R.E. Arvidson, **W.H. Farrand**, E. Guinesss, A.G. Hayes, K.E. Herkenhoff, F. Seelos IV, J. Soderblom, S.W. Squyres (2006) Spectrophotometric properties of materials observed by Pancam on the Mars Exploration Rovers: 2. Opportunity. *J. Geophys. Res.: Planets*, **111**, E12S16, 10.1029/2006JE002762.

Arvidson, R. E.; F. Poulet; R.V. Morris; J.-P.Bibring; J.F. Bell III; S.W. Squyres; P.R. Christensen; G. Bellucci; B. Gondet; B.L. Ehlmann; **W.H. Farrand**; R.L. Fergason; M. Golombek; J.L. Griffes; J. Grotzinger; E.A. Guinness; K.E. Herkenhoff; J.R. Johnson; G.

Klingelhöfer; Y. Langevin; D. Ming; K. Seelos; R.J. Sullivan; J.G. Ward; S.M Wiseman; M. Wolff (2006) Nature and origin of the hematite-bearing plains of Terra Meridiani based on analyses of orbital and Mars Exploration rover data sets. *J. Geophys. Res.: Planets*, **111**, E12S08, 10.1029/2006JE002728.

Weitz, C.M., R.C. Anderson, J.F. Bell III, **W.H. Farrand**, K.E. Herkenhoff, J.R. Johnson, B.L. Joliff, R.V. Morris, S.W. Squyres, R.J. Sullivan (2006) Soil grain analyses at Meridiani Planum, Mars, *J. Geophys. Res.: Planets*, **111**, E12S04, 10.1029/2005JE002541.

Johnson, J.R., W.M. Grundy, M.T. Lemmon, J.F. Bell III, M.J. Johnson, R. Deen, R.E. Arvidson, **W.H. Farrand**, E. Guinness, A. G. Hayes, K.E. Herkenhoff, F. Seelos IV, J. Soderblom, S. Squyres (2005) Spectrophotometric Properties of Materials Observed by Pancam on the Mars Exploration Rovers: 1. Spirit. *J. Geophys. Res.: Planets*, **111**, E02S14, 10.1029/2005JE002494.

Squyres, S.W., R.E. Arvidson, D.L. Blaney, B.C. Clark, L. Crumpler, **W.H. Farrand**, S. Gorevan, K.E. Herkenhoff, J. Hurowitz, A. Kusack, H.Y. McSween, D.W. Ming, R.V. Morris, S.W. Ruff, A. Wang, and A. Yen (2005) The Rocks of the Columbia Hills. *J. Geophys. Res.: Planets*, **111**, E02S11, 10.1029/2005JE002562.

Ming, D.W., D.W. Mittlefehldt, R.V. Morris, D.C. Golden, R. Gellert, A.Yen, B.C. Clark, S.W. Squyres, **W.H. Farrand**, S.W. Ruff, R.E. Arvidson, G. Klingelhöfer, H.Y. McSween, D.S. Rodionov, C. Schröder, P.A. de Souza, A. Wang, A. (2006) Geochemical and mineralogical indicators for aqueous processes in the Columbia Hills of Gusev crater, Mars. *J. Geophys. Res.*, **111**, E02S12, 10.1029/2005JE002560.

Wang, A., R.L. Korotev, B.L. Jolliff, L.A. Haskin, L. Crumpler, **W.H. Farrand**, K.E. Herkenhoff, P. de Souza Jr., A.G. Kusack, J.A. Hurowitz, N.J.Tosca (2005) Evidence of Phyllosilicates in Wooly Patch, an Altered Rock Encountered at West Spur, Columbia Hills, by the Spirit Rover in Gusev Crater, Mars. *J. Geophys. Res.: Planets*, **111**, E02S16, 10.1029/2005JE002516.

Farrand, W.H., L.R. Gaddis, and L. Keszthelyi (2005) Pitted cones and domes on Mars: Observations in Acidalia Planitia and Cydonia Mensae with MOC, THEMIS and TES data, *J. Geophys. Res.: Planets*, **109**, 10.1029/2004JE002297.

Clark, B.C., R.V. Morris, S.M. McLennan, R. Gellert, B. Jolliff, A.H. Knoll, S.W. Squyres, T.K. Lowenstein, D.W. Ming, N.J. Tosca, A. Yen, P.R. Christensen, S. Gorevan, J. Brückner, W. Calvin, G. Dreibus, **W. Farrand**, et al. (2005) Chemistry and mineralogy of outcrops at Meridiani Planum, *Earth and Planetary Science Letters*, **240**, 73-94.

McLennan, S.M., J.F. Bell III, W.M. Calvin, P.R. Christensen, B.C. Clark, P.A. de Souza, J. Farmer, **W.H. Farrand**, et al. (2005) Provenance and diagenesis of evaporite-bearing Burns formation, Meridiani Planum, Mars, *Earth and Planetary Science Letters*, **240**, 95-121.

Farrand, W.H. (2004) Environmental measurements: Hyperspectral remote sensing of land and atmosphere, *Encyclopedia of Modern Optics* (R. Guenther, L. Bayvel, and D. Steel, Eds.), Oxford, ISBN 0-12-227600-0.

Squyres, S., J. Grotzinger, R. Arvidson, J. Bell, W. Calvin, P. Christensen, B. Clark, J. Crisp, **W. Farrand**, et al. (1994) In situ evidence for an ancient aqueous environment at Meridiani Planum, Mars, *Science*, **306**, 1709-1714

Squyres, S.W. et al. (2004) The Spirit rover's Athena science investigation at Gusev Crater, Mars. *Science*, **305**, 794-799.

Bell, J.F. et al. (2004) Pancam multispectral imaging results from the Spirit rover at Gusev Crater, *Science*, **305**, 800-806.

Greeley, R. et al. (2004) Wind-related processes detected by the Spirit rover at Gusev Crater, Mars. *Science*, **305**, 810-821.

Merényi, E., A. Jain, **W.H. Farrand** (2004) Applications of SOM magnification to data mining. *WSEAS Trans. on Systems*, 3(5), July, 2004, pp 2122-2128.

Bell, J.F., **W.H. Farrand**, J.R. Johnson, and R.V. Morris (2002) Low abundance materials at the Mars Pathfinder Landing Site: An investigation using spectral mixture analysis and related techniques. *Icarus*, **158**, 56-71.

Al-AbdulKader, K., J.S. Blundell, and **W.H. Farrand** (2002) Marine habitat mapping using high spatial resolution multispectral satellite data. *Saudi Aramco J. of Technology*, Fall 2002, 2-12.

Farrand, W.H. (1997) Identification and mapping of ferric oxide and oxyhydroxide minerals in imaging spectrometer data of Summitville, Colorado and the surrounding San Juan Mountains. *Int. J. of Rem. Sens.* **18**, 1543-1552.

Farrand, W.H. and J.C. Harsanyi (1997) Mapping the distribution of mine tailings in the Coeur d'Alene River Valley, Idaho through the use of a Constrained Energy Minimization technique. *Rem. Sens. of Env.* **59**, 64-76.

Farrand, W.H. and J.C. Harsanyi (1995) Discrimination of poorly exposed lithologies in imaging spectrometer data. *J. Geophys. Res.* **100**, 1565-1578.

Farrand, W.H., R.B. Singer and E. Merenyi (1994) Conversion of AVIRIS data to reflectance: A comparison of empirical line, radiative transfer and spectral mixture methods. *Rem. Sens. of Env.* **47**, 311-321.

Farrand, W.H. and R.B. Singer (1992) Alteration of hydrovolcanic basaltic ash: Observations with visible and near-infrared spectrometry. *J. Geophys. Res.* **97**, 17,393-17,408.

Farrand, W.H. and R.B. Singer (1991) Spectral analysis and mapping of palagonite tuffs of Pavant Butte, Millard County, Utah. *Geophys. Res. Letters* **18**, 2237-2240.

Farrand, W.H. (1987) Highland contamination and minimum basalt thickness in northern Mare Fecunditatis. *Proc. Lunar and Planet. Sci. Conf. 18th*, pp.319-329.

PAPERS FROM CONFERENCE PROCEEDINGS and EXTENDED ABSTRACTS

Farrand, W.H., J.W. Rice, T.D. Glotch, and J.A. Hurowitz (2007) Hyperspectral, multispectral and textural analysis of the Mawrth Vallis layered terrain, *Seventh International Conf. on Mars*, #3304.

Farrand, W.H., J.F. Bell III, J.R. Johnson, J.P. Grotzinger, S.W. Squyres, B.L. Jolliff (2007) Spectral stratigraphy of Victoria Crater, Meridiani Planum, Mars, *Seventh International Conf. on Mars*, #3250.

Farrand, W.H., J.F. Bell III, J.R. Johnson, and D.L. Blaney (2007) Multispectral reflectance of rocks in the Columbia Hills examined by the Mars Exploration Rover Spirit: Cumberland Ridge to Home Plate, *Lunar and Planeary. Science XXXVIII*, #1957.

Farrand, W.H. and M.D. Lane (2006) Multi-dataset analysis of surface units and landforms on the Northern Plains of Mars, *Lunar and Planetary Science XXXVII*, #1499.

Farrand, W.H., B.L. Jolliff, J.F. Bell III, and J.R. Johnson (2006) Visible/near infrared spectral trends between Meridiani Planum surface materials: Comparisons between spherules, basaltic sands, outcrop rinds and cobbles, *Lunar and Planetary Science XXXVII*, #1707.

Farrand, W.H., J.F. Bell III, J.R. Johnson (2005) Visible/Near Infrared spectral classes of rocks in the Columbia Hills, Gusev Crater, Mars as observed by the Mars Exploration Rover Spirit's Pancam, *Eos Trans. AGU*, 86(52), Fall Meet. Suppl., Abstract P21A-0129.

Wright, S.P., W.H. Farrand, D. Rogers, and E. Merényi (2005) The nature of the Mars Pathfinder "Black Rock" lithology: Comparisions with SNC meteorites and OMEGA spectral images of Chryse Planitia, *Eos Trans. AGU*, 86(52), Fall Meet. Suppl., Abstract P21B-0145.

Farrand, W.H., J.F. Bell III, J.R. Johnson, B.C. Clark, and B.L. Joliff (2005) Visible/Near Infrared spectral characterization of *in situ* rock outcrops at Meridiani Planum as observed by the Mars Exploration Rover Opportunity, *Lunar and Planetary Science XXXVI*, #2082.

Farrand, W.H, E. Merényi, S. Murchie, O.S. Barnouin-Jha (2005) Spectral class distinctions observed in the MPF IMP SuperPan using a self-organizing map, *Lunar and Planetary Science XXXVI*, #2009.

Farrand, W.H., B.L. Joliff, J.F. Bell III and the Athena Science Team (2004) In situ and displaced rocks exposed on Meridiani Planum, Mars as observed by the Mars Exploration Rover Opportunity: Chemistry, Mineralogy and Physical Properties, *2nd Conference on Early Mars*, #8079.

Seelos F.P. IV, J.M. Soderblom, W.H. Farrand, J.R. Johnson, et al. (2004) Mars Exploration Rover Panoramic Camera multidimensional analyses and surface spectral variability, *Lunar and Planetary Science XXXV*, #2166.

Farrand, W., E. Merényi, S. Murchie, O. Barnouin-Jha, and J. Johnson (2004) Mapping rock and soil units in the MPF Superpan using a Kohonen self-organizing map, *Lunar and Planetary Science XXXV*, #1916.

Farrand, W.H., L.R. Gaddis, and S. Blundell (2004) Variability in morphology and thermophysical properties of pitted cones in Acidalia Planitia and Cydonia Mensae, *Lunar and Planetary Science XXXIV*, #1928

Farrand, W.H. and L.R. Gaddis (2003) THEMIS Observations of Pitted Cones in Acidalia Planitia and Cydonia Mensae, Sixth International Conference on Mars, #3094.

Farrand, W.H. and L.R. Gaddis (2003) Analysis of MGS TES data over Acidalia Planitia and Cydonia Mensae: Compositional Evidence for Hydrovolcanic Activity?, *Lunar and Planetary Science XXXIII*, #1601.

Farrand, W.H. (2003) Using AVIRIS Data to Map and Characterize Subaerially and Subaqueously Erupted BasalticVolcanic Tephras: The Challenge of Mapping Low Albedo Materials, *Proceedings of the 12th JPL Airborne Geoscience Workshop*.

Farrand, W.H., L.R. Gaddis, and S. Blundell (2002) Hydrovolcanic landforms in Acidalia and Cydonia: Pan-spectral analysis with MGS MOC, MOLA, and TES, *Lunar and Planetary Science XXXIII*, #1820.

Farrand, W.H. and M.D. Lane (2002) Spectral differences between palagonite tuffs formed in sub-glacial versus liquid water environments: Relevance to Mars, *Lunar and Planetary Science XXXIII*, #1804.

Bell, J.F., III, W.H. Farrand, J.R. Johnson, and R.V. Morris (2002) Low abundance materials at the Mars Pathfinder landing site: An investigation using spectral mixture analysis and related techniques. *Lunar and Planetary Science XXXIII*, #1664.

Morris, R.V., J.F. Bell III, W.H. Farrand, and M.J. Wolff (2002) Constraints on Martian global surface mineralogical composition, albedo and thermal inertia from Hubble Space Telescope extended visible multispectral data. *Lunar and Planetary Science XXXIII*, #1913.

Farrand, W.H. (2001) Application of techniques from chemical factor analysis to airborne imaging spectrometer data. *Proc. ASPRS 2001 Annual Meeting*, (CD-ROM) paper 10.

Farrand, W.H. (2001) Analysis of AVIRIS Data: A Comparison of the Performance of Commercial Software with Published Algorithms. *Proceedings of the Tenth JPL Airborne Earth Science Workshop*. JPL Publication 02-1, (R.O. Green, ed.), 125-132.

Farrand, W.H., L.R. Gaddis, and S. Blundell (2001) Possible hydrovolcanic landforms observed in MOC NA imagery: A preliminary survey. *Lunar and Planetary Science XXXII*, #1664.

Farrand, W.H., J.R. Johnson, J.F. Bell III (2001) N-Dimensional visualization and spectral mixture analysis applied to Imager for Mars Pathfinder data: Detection and mapping of rocks and soils. *Lunar and Planetary Science XXXII*, #1656.

Bell, J.F., III, R.V. Morris, W.H. Farrand, and M.J. Wolff (2001) A re-assessment of global color units on Mars from Hubble Space Telescope visible to near-IR imageing and spectrocopy. *Lunar and Planetary Science XXXII*, #1484.

Dusenbery, P.B. and W.H. Farrand (2001) The MarsQuest traveling exhibition: The first year and beyond. *Lunar and Planetary Science XXXII*, #2018.

Farrand, W.H. (2000) Mapping alteration mineralogy in the Tushar Mountains and Marysvale mining district, Utah using AVIRIS data. *Proceedings of the Fourteenth International Conference on Applied Geologic Remote Sensing*, 62-69.

Merényi, E., W.H. Farrand, L.E. Stevens, T.S. Melis, and K. Chibber (2000) Mapping Colorado River ecosystem resources in Glen Canyon: Analysis of hyperspectral low-altitude AVIRIS imagery. *Proceedings of the Fourteenth International Conference on Applied Geologic Remote Sensing*, 44-51.

Farrand, W.H. (2000) Remotely sensed signatures of hydrovolcanism: Examples from the Earth and preliminary results from Mars. *Lunar and Planetary Science XXXI*, #1965.

Gaddis, L.R., W.H. Farrand, and L. Weller (2000) Compositional mapping of lunar pyroclastic deposits using Clementine UVVIS and NIR data. *Lunar and Planetary Science XXXI*, #1244.

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