Abigail A. Fraeman

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EDUCATION

Ph.D. Washington University in St. Louis, Earth & Planetary Science 2014
A.M. Washington University in St. Louis, Earth & Planetary Science 2011
B.S. Yale University, Geology & Geophysics with honors, Physics 2009

RESEARCH EXPERIENCE

Jet Propulsion Laboratory, research scientist, 2016 - present
California Institute of Technology, visiting associate, 2016 - present
California Institute of Technology, supervisor B. Ehlmann, 2014 - 2016
Texaco Prize Postdoctoral Scholar & Keck Institute for Space Studies Postdoctoral Scholar
Washington University in St. Louis, supervisor R. Arvidson, 2009 - 2014
Graduate researcher analyzing visible/near infrared spectra of Mars and its moons
National Academies of Science, supervisor D. Smith, 2009, 2007
Space Studies Board summer intern studying civil space research policy
Brown University, supervisor J. Mustard, 2008
Summer research student analyzing CRISM orbital data over Tyrrhena Terra, Mars
Cornell University, supervisor J. Bell, 2006
Summer research student analyzing Pancam multispectral data from Gusev Crater, Mars
Carnegie Institute of Washington, supervisor N. Haghigipour and K.E.S. Ford, 2005, 2004
High school summer research student performing dynamical modeling of exoplanet system

PLANETARY MISSION PARTICIPATION

Mars Science Laboratory, Deputy Project Scientist (2019-), Participating Scientist (2016-2022)
Mars Exploration Rover Mission, Deputy Project Scientist (2016-2019)
Compact Reconnaissance Imaging Spectrometer for Mars (CRISM), Co-I (2016-2023)

FELLOWSHIPS AND AWARDS

NASA Group Achievement Award, 2021, 2017, 2015, 2013
NASA Early Career Award, 2021
JPL Team Award, 2021
JPL Voyager Awards, 2018, 2019 (x2)
NASA Early Career Public Achievement Medal, 2018
Keck Institute for Space Studies Prize Postdoctoral Fellowship, 2014-2016
Caltech Geological & Planetary Science Div. Texaco Prize Postdoctoral Fellowship, 2014-2016
Washington University in St. Louis Graduate School of Arts & Science Student Marshal, 2014
Honor given to two outstanding graduates across all graduate degrees in physical sciences

P.E.O. Scholar Award, 2013
Mr. and Mrs. Spencer T. Olin Fellowship for Women in Graduate Study, 2012 - 2014
American Geophysics Union Fall Meeting Outstanding Student Paper Award, 2012
National Science Foundation Graduate Research Fellowship, 2009-2012
Samuel Lewis Penfield Prize, Excellence in Mineralogy, 2009
Yale Richter Fellowship for Summer Research, 2008
Planetary Geology & Geophysics Undergraduate Research Program grant, 2006
Intel Science Talent Search Finalist, 2005

PUBLICATIONS

PEER REVIEWED JOURNAL PUBLICATIONS

* = Directly advised student or postdoc

50. *Manelski, H.T., R.Y. Sheppard, **A.A. Fraeman,** R.C. Wiens, J.R. Johnson, E.B. Rampe, J. Frydenvang, N.L. Lanza, and O. Gasnault, 2023. "Compositional Variations in Sedimentary Deposits in Gale Crater as Observed by ChemCam Passive and Active Spectra," *JGR: Planets,* 128(3), doi: 10.1029/2022JE007706.
49. Barge, L.M, E. Flores, J.M. Weber, **A.A. Fraeman,** Y.L. Yung, D. VanderVelde, E. Martinez, A. Castonguay, K. Billings, and, M.M. Baum, 2022. "Prebiotic reactions in a Mars analog iron mineral system: Effects of nitrate, nitrite, and ammonia on amino acid formation," *Geochimica et Cosmochimica Acta,* 336, doi: 10.1016/j.gca.2022.08.038.
48. Haber, J.T., B. Horgan, **A.A. Fraeman,** J.R. Johnson, J.F. Bell III, M.S. Rice, C. Seeger, N. Mangold, L. Thompson, D. Wellington, E. Cloutis, and S. Jacob, 2022. "Mineralogy of a possible ancient lakeshore in the Sutton Island member of Mt. Sharp, Gale crater, Mars, from Mastcam multispectral images," *JGR: Planets,* 127(10), doi: 10.1029/2022JE007357.
47. Fedo, C.M., A.B. Bryk, L.A. Edgar, K.A. Bennett, V.K. Fox, W.E. Dietrich, S.G. Banham, S. Gupta, K.M. Stack, R.M.E. Williams, J.P. Grotzinger, N.T. Stein, D.M. Rubin, G. Caravaca, R.E. Arvidson, M.N. Huges, **A.A. Fraeman,** A. R. Vasavada, J. Schieber, and B. Sutter, 2022. "Geology and stratigraphic correlation of the Murray and Carolyn Shoemaker formations across the Glen Torridon region, Gale crater, Mars," *JGR: Planets,* 127(9), doi: 10.1029/2022JE007408.
46. Rice, M.S., C. Seeger, J. Bell, F. Calef, M. St. Clair, A. Eng, **A. A. Fraeman,** C. Hughes, B. Horgan, S. Jacob, J. Johnson, H. Kerner, K. Kinch, M. Lemmon, C. Million, M. Starr, and D. Wellington, 2022. "Spectral diversity of rocks and soils in Mastcam observations along the Curiosity rover's traverse in Gale crater, Mars," *JGR: Planets,* 127(8), doi: 10.1029/2021JE007134.
45. Stack, K.M., W.E. Dietrich, M.P. Lamb, R.J. Sullivan, J.R. Christian, C.E. Newman, C. D. O'Connell-Cooper, J.W. Sneed, M. Day, M. Baker, R.E. Arvidson, C.M. Fedo, S. Kahn, R.M.E. Williams, K.A. Bennett, A.B. Bryk, S. Cofield, L.A. Edgar, V.K. Fox, **A.A. Fraeman,** C.H. House, D.M. Rubin, V.Z. Sun, and J.K. Van Beek, 2022. "Orbital and In-Situ Investigation of Periodic Bedrock Ridges in Glen Torridon, Gale Crater, Mars," *JGR: Planets*, 127(6), doi: 10.1029/2021JE007096.
44. Bennett, K. A., F. Rivera-Hernández, C. Tinker, B. Horgan, D. M. Fey, C. Edwards, L. A. Edgar, R. Kronyak, K. S. Edgett, **A. Fraeman**, L. C. Kah, M. Henderson, N. Stein, E. Dehouck,

and A. J. Williams, 2021, "Diagenesis revealed by fine-scale features at Vera Rubin ridge, Gale crater, Mars," *JGR: Planets,* 126(5), doi:10.1029/2019JE006311/

43. Bristow, T.F., J. P. Grotzinger, E. B. Rampe, J. Cuadros, S. J. Chipera, G. W. Downs, C. M. Fedo, J. Frydenvang, A. C. McAdam, R. V. Morris, C. N. Achilles, D. F. Blake, N. Castle, P. Craig, D. J. Des Marais, R. T. Downs, R. M. Hazen, D. W. Ming, S. M. Morrison, M. T. Thorpe, A. H. Treiman, V. Tu, D. T. Vaniman, A. S. Yen, R. Gellert, P. R. Mahaffy, R. C. Wiens, A. B. Bryk, K. A. Bennett, V. K. Fox, R. E. Millken, **A. A. Fraeman**, and A. R. Vasavada, 2021, "Brine-driven destruction of clay minerals in Gale crater, Mars," *Science*, 373(6551), doi:10.1126/science.abg5449.
42. *Sheppard, R.Y., M.T. Thorpe, **A.A. Fraeman**, V.K. Fox, and R.E. Milliken, 2021, "Merging Perspectives on Secondary Minerals on Mars: A Review of Ancient Water-Rock Interactions in Gale Crater Inferred from Orbital and In-Situ Observations," *Minerals,* 11(9), doi:10.3390/min11090986.
41. Tu, V.M., E.B. Rampe, T.F. Bristow, M.T. Thorpe, J.V. Clark, N. Castle, **A.A. Fraeman**, L.A. Edgar, A. McAdam, C. Bedford, C.N. Achilles, D. Blake, S.J. Chipera, P.I. Craig, D.J. Des Marais, G.W. Downs, R.T. Downs, V. Fox, J.P. Grotzginer, R.M. Hazen, D.W. Ming, R.V. Morris, S.M. Morrison, B. Pavri, J. Eigenbrode, T.S. Peretyazhko, P.C. Sarrazin, B. Sutter, A.H. Treiman, D.T. Vaniman, A.R. Vasavada, A.S. Yen, and J.C. Bridges, 2021, "A Review of the Phyllosilicates in Gale Crater as Detected by the CheMin Instrument on the Mars Science Laboratory, Curiosity Rover," *Minerals*, 11(8), doi:10.3390/min11080847.
40. Turner, S.M.R., S.P. Schwenzer, J.C. Bridges, E.B. Rampe, C.C. Bedford, C.N. Achilles, A.C. McAdam, N. Mangold, L.J. Hicks, J. Parnell, **A.A. Fraeman**, and M.H. Reed, 2021, "Early diagenesis at and below Vera Rubin ridge, Gale crater, Mars," *Meteoritics & Planetary Science*, 56(10), doi:10.1111/maps.13748.
39. Edgar, L.A., Fedo, C.M., Gupta, S., Banham, S.G., **Fraeman, A.A.,** Grotzinger, J.P., Stack, K.M., Stein, N.T., Bennett, K.A., Rivera-Hernández, F., Sun, V.Z., Edgett, K.S., Rubin, D.M., House, C., Van Beek, J. 2020. "A Lacustrine Paleoenvironment Recorded at Vera Rubin Ridge, Gale Crater: Overview of the Sedimentology and Stratigraphy Observed by the Mars Science Laboratory Curiosity Rover," *Journal of Geophysical Research: Planets*, 125(3).
38. **Fraeman, A.A.,** L.A. Edgar, E.B. Rampe, L. M. Thompson J. Frydenvang , C. M. Fedo, J. G. Catalano, W. E. Dietrich, T. S. J. Gabriel, A. R. Vasavada, J. P. Grotzinger, J. L'Haridon, N. Mangold, V. Z. Sun, C. H. House, A. B. Bryk, C. Hardgrove, S. Czarnecki , K. M. Stack, R. V. Morris, R. E. Arvidson, S. G. Banham, K. A. Bennett, J. C. Bridges, C. S. Edwards, W. W. Fischer, V. K. Fox, S. Gupta, B. H. N. Horgan, S. R. Jacob, J. R. Johnson, S. S. Johnson, D. M. Rubin, M. R. Salvatore, S. P. Schwenzer, K. L. Siebach, N. T. Stein, S. Turner, D. F. Wellington, R. C. Wiens, A. J. Williams, G. David, and G. M. Wong, 2020. "Evidence for a Diagenetic Origin of Vera Rubin Ridge, Gale Crater, Mars: Summary and Synthesis of Curiosity's Exploration Campaign," *Journal of Geophysical Research: Planets*, 125(12).
37. **Fraeman, A.A.,** Johnson, J.R., Arvidson, R.E., Rice, M.S., Jacob, S.R., Sun, V.Z., Wellington, D.F., Bell III, J.F., Horgan, B.H., Fox, V.K., Morris, R.V., Salvatore, M.R., Pinet, P., Wiens, R.C., Vasavada, A.R. 2020. "Synergistic ground and orbital observations of iron oxides on Mt. Sharp and Vera Rubin ridge," *Journal of Geophysical Research: Planets*, 125(9).
36. Frydenvang, J., Mangold, N., Wiens, R., **Fraeman, A.A.,** Edgar, L.A., Fedo, C., L'Haridon, J., Bedford, C., Gupta, S., and 24 others. 2020. "The chemostratigraphy of the Murray formation and role of diagenesis at Vera Rubin ridge in Gale crater, Mars, as observed by the ChemCam instrument," *Journal of Geophysical Research: Planets,* 125(9).

35. Horgan, B.H.N., Johnson, J.R., **Fraeman, A.A.,** Rice, M.S., Seeger, C., Bell, J.F., Bennett, K.A., Cloutis, E.A., Edgar, L.A., Frydenvang, J., Grotzinger, J.P., L'Haridon, J., Jacob, S.R., Mangold, N., Rampe, E.B., Rivera-Hernandez, F., Sun, V.Z., Thompson, L.N., Wellington, D., 2020. "Diagenesis of Vera Rubin Ridge, Gale Crater, Mars, From Mastcam Multispectral Images," *JGR: Planets,* 125(11).
34. Li, S., Lucey, P.G., **Fraeman, A.A.,** Poppe, A.R., Sun, V.Z., Hurley, D.M., Schultz, P.H. 2020. "Widespread hematite at high latitudes of the Moon," *Science Advances,* 6(36), eaba1940.
33. Jacob, S., Wellington, D., Bell III, J., Achilles, C., **Fraeman, A.A.,** Peters, G., Johnson, J., Horgan, B., Rampe, E., Thompson, L., Wiens, R., Maurice, S. 2020. "Spectral, Compositional, and Physical Properties of the Upper Murray Formation and Vera Rubin Ridge, Gale Crater, Mars," *Journal of Geophysical Research: Planets*, 125(11), doi: 10.1029/2019JE006290.
32. L'Haridon, J., Mangold, N., **Fraeman, A.A.,** Johnson, J.R., Cousin, A., Rapin, W., David, G., Dehouck, E., Sun, V., and 13 others. 2020. "Iron Mobility during Diagenesis as Observed by ChemCam at Vera Rubin Ridge, Gale Crater, Mars," *Journal of Geophysical Research: Planets*, 125(11).
31. Morris, R.V., Rampe, E., Vaniman, D., Christoffersen, R. Yen, A., Morrison, S., Ming, D., Achilles, C., **Fraeman, A.A.,** and 20 others. "Hydrothermal Precipitation of Sanidine (Adularia) Having Full Al,Si Structural Disorder and Specular Hematite at Maunakea Volcano (Hawai'i) and at Gale Crater (Mars)," *Journal of Geophysical Research: Planets*, 125(9).
30. Rampe, E., Bristow, T., Morris, R., Morrison, S., Achilles, C., Ming, D., Vaniman, D., Blake, D., Tu, V., Chipera, S. Yen, A., Peretyazkho, T., Downs, R., Hazen, R., Treiman, A., Grotzinger, J., Castle, N., Craig, P., Des Marais, D., Thorpe, M., Walroth, R., Downs, G., **Fraeman, A.A.,** Siebach, K., Gellert, R., McAdam, A., Meslin, P-Y., Sutter, B., Salvatore, M. 2020. "Mineralogy of Vera Rubin Ridge from the Mars Science Laboratory CheMin Instrument," *Journal of Geophysical Research: Planets*, 125(9).
29. Rasmussen, B.P., Calvin, W.M., Ehlmann, B.L., Bristow, T.F., Lautze, N., **Fraeman, A.A.,** DesOrmeau, J.W. 2020. "Characterizing Low-Temperature Aqueous Alteration of Mars-Analog Basalts from Mauna Kea at Multiple Scales," *American Mineralogist,* 105(9).
28. Stein, N.T., Quinn, D.P., Grotzinger, J.P., Fedo, C., Ehlmann, B.L., Stack, K.M., Edgar, L.A., **Fraeman, A.A.,** Deen, R. 2020. "Regional structural orientation of the Mt. Sharp group revealed by in-situ dip measurements and stratigraphic correlations on the Vera Rubin ridge," *Journal of Geophysical Research: Planets*, 125(5).
26. **Fraeman, A.A.** 2018. "Commentary: Unraveling the history of Meridiani Planum, Mars: New chemical clues from the rim of Endeavour Crater," *Journal of Geophysical Research: Planets*, 123(3), 690-694.
25. Johnson, J.R., Bell III, J.F., Bender, S., Cloutis, E., Ehlmann, B., **Fraeman**, **A.,** Gasnault, O., Maurice, S., Pinet, P., Thompson, L., Wellington, D., Wiens, R.C. 2018. "Bagnold Dunes campaign Phase 2: Visible/near-infrared reflectance spectroscopy of longitudinal ripple sands," *Geophysical Research Letters*, 45(18):9480-9487.
24. McMahon, S., Bosak, T., Grotzinger, J.P., Milliken, R.E., Summons, R.E., Daye, M., Newman, S.A., **Fraeman, A.A.,** Williford, K.H., Briggs, D.E.G. 2018. "A Field Guide to Finding Fossils on Mars," *Journal of Geophysical Research: Planets,* 123(5), 1012-1040.
23. Lapotre, M., Ehlmann, B., Minson, S., Arvidson, R., Ayoub, F., **Fraeman, A.,** Ewing, R., Bridges, N. 2017. "Compositional Variations in Sands of the Bagnold Dunes at Gale Crater,

Mars, from Visible-Shortwave Infrared Spectroscopy and Comparison to Ground-Truth from the Curiosity Rover," *Journal of Geophysical Research: Planets, 122, 12.*

22. Ehlmann, B., Edgett, K., Sutter, B., Achilles, C., Litvak, M., Lapotre, M., Sullivan, R., **Fraeman, A.,** Arvidson, R., Blake, D., Bridges, N., Conrad, P., Cousin, A., Downs, R., Cabriel, T., Gellert, R., Hamilton, V., Hardgrove, C., Johnson, J., Kuhn, S., Mahaffy, P., Maurice, S., McHenry, M., Meslin, P., Ming, D., Minitti, M., Morookian, J., Morris, R., O'Connell-Cooper, C., Pinet, P., Rowland, S., Schroder, S., Siebach, K., Stein, N., Thompson, L., Vaniman, D., Vasavada, A., Wellington, D., Wiens, R., Yen, A. 2017. "Chemistry, mineralogy, and grain properties of Namib and High dunes, Bagnold dune field, Gale crater, Mars: A synthesis of Curiosity rover observations," *Journal of Geophysical Research: Planets, 122, 12*.
21. Johnson, J., Achielles, C., Bell, J., Bender, S., Cloutis, E., Ehlmann, B., **Fraeman, A.,** Gasnault, O., Hamilton, V., Le Mouelic, S., Maurice, S., Pinet, P., Thompson, L., Wellington, D., Wiens, R. 2017. "Visible/near-infrared spectral diversity from in situ observations of the Bagnold Dune Field sands in Gale Crater, Mars," *Journal of Geophysical Research: Planets, 122, 12.*
20. Arvidson, R., DeGrosse, P., Grotzinger, J., Heverly, M., Shechet, J., Moreland, S., Newby, M., Stein, N., Steffy, A., Zhou, F., Zastrow, A., Vasavada, A., **Fraeman, A.,** Stilly, E. 2017. "Relating geologic units and mobility system kinematics contributing to Curiosity wheel damage at Gale Crater, Mars," *Journal of Terramechanics, 73, SI.*
19. Wellington, D., Bell, J., Johnson, J., Kinch, K., Rice, M., Godber, A., Ehlmann, B., **Fraeman, A.,** Hardgrove, C., Le Mouelic, S. 2016, "Visible to Near-Infrared MSL/Mastcam Multispectral Imaging: Initial Results from Select High-Interest Science Targets within Gale Crater, Mars," *American Mineralogist, 102, 6*.
18. Frydenvang, J., Gasda, P., Hurowitz, J., Grotzinger, J., Wiens, R., Newsom, H., Edgett, K., Watkins, J., Bridges, J., Maurice, S., Fisk, M., Ehlmann, B., Johnson, J., Rapin, W., Stein, N., Clegg, S., Schwenzer, S., Bedford, C., Edwards, P., Mangold, N., Cousin, A., Anderson, R., Payre, V., Vaniman, D., Blake, D., Lanza, N., Gupta, S., Van Beek, J., Sautter, V., Meslin, P., Rice, M., Milliken, R., Gellert, R., Thompson, L., Clark, B., Sumner, D., **Fraeman, A.,** Kinch, K., Madsen, M., Mitrofanov, I., Jun, I., Calef, F., Vasavada, A. 2017. "Diagenetic silica enrichment and late-stage groundwater activity in Gale Crater, Mars," GRL, 44, 10.
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16. **Fraeman, A.,** Ehlmann, B., Arvidson, R., Edwards, C., Grotzinger, J., Milliken, R., Quinn, D., and Rice, M. 2016. "The Stratigraphy and Evolution of Lower Mt. Sharp from Spectral, Morphological, and Thermophysical Orbital Datasets," *Journal of Geophysical Research: Planets, 121, 9.*
15. Arvidson, R., Iagnemma, K., Maimone, M., **Fraeman, A.,** Zhou, F., Heverly, M., Bellutta, P., Rubin, D., Stein, N., Grotzinger, J., Vasavada, A. 2015. "Mars Science Laboratory Curiosity Rover Megaripple Crossings up to Sol 710 in Gale Crater," *Journal of Field Robotics,* 34, 3.

14. Stack, K., Edwards, C., Grotzinger, J., Gupta, S., Sumner, D., Calef, F., Edgar, L., Edgett, K., **Fraeman, A.,** Jacob, S., Le Deit, L., Lewis, K., Rice, M., Rubin, D., Williams, R., Williford, K. 2015. "Comparing orbiter and rover image-based mapping of an ancient sedimentary environment, Aeolis Palus, Gale crater, Mars," *Icarus,* 280.

13. Johnson, J., Bell, J. F., Bender, S., Blaney, D., Cloutis, E., Ehlmann, B., **Fraeman, A.,** Gasnault, O., Kinch, K., Le Mouélic, S., Maurice, S., Rampe, E., Vaniman, D., Wiens, R. 2015. "Constraints on iron sulfate and iron oxide mineralogy from ChemCam visible/nearinfrared reflectance spectroscopy of Mt. Sharp basal units, Gale Crater, Mars," *American Mineralogist, 101, 7-8.*

12. Lapotre, M., Ewing, R., Lamb, M., Fischer, W., Grotzinger, J., Rubin, D., Lewis, K., Ballard, M., Day, M., Gupta, S., Banham, S., Bridges, N., De Marais, D., **Fraeman, A.,** Grant, J., Herkenhoff, K., Ming, D., Mischna, M., Rice, M., Sumner, D., Vasavada, A., Yingst, R. 2016. "Large wind ripples on Mars: A record of atmospheric evolution," *Science*, 353, 6294.

11. Greenberger, R., Mustard, J., Ehlmann, B., Blaney, D., Cloutis, E., Wilson, J., Green, R., **Fraeman, A.** 2015. "Imaging spectroscopy of geological samples and outcrops: novel insights from microns to meters," *GSA today,* 25, 12, doi: 10.1130/GSATG252A.1

10. Seelos, K., Seelos, F., Vivano-Beck, C., Murchie, S., Arvidson, R., Ehlmann, B., **Fraeman, A.** 2014. "Mineralogy of the MSL Curiosity landing site in Gale crater as observed by MRO/CRISM," *Geophysical Research Letters,* 41, 14.

9. Arvidson, R., Bellutta, P., Calef, F., **Fraeman, A.,** Garvin, J., Gasnault, O., Grant, J., Grotzinger, J., Hamilton, V., Heverly, M., Iagnemma, K., Johnson, J., Lanza, N., Le Mouelic, S., Mangold, N., Ming, D., Mehta, M., Morris, R., Newsom, H., Renno, N., Rubin, D., Schieber, J., Sletten, R., Vasavada, A., Vizcaino, J., Wiens, R. 2014. "Terrain physical properties derived from orbital data and the first 360 sols of Mars Science Laboratory Curiosity rover operations in Gale Crater," *Journal Geophysical Research: Planets,* 119, doi: 10.1002/2013JE004605.

8. **Fraeman, A.,** Murchie, S., Arvidson, R., Clark, R., Morris, R., Rivkin, A., Vilas, F. 2014. "Spectral absorptions on Phobos and Deimos in the visible/near infrared wavelengths and their compositional constraints," *Icarus,* 229, 196-205, doi: 10.1016/j.icarus.2013.11.021

7. Grotzinger, J., Sumner, D., Kah, L., Stack, K., Gupta, S., Edgar, L., Rubin, D., Lewis, K. Schieber, J., Mangold, N., Milliken, R., Conrad, P., DesMarais, D., Farmer, J., Siebach, K., Calef III, F., Hurowitz, J., McClennan, S., Ming, D., Vaniman, D., Crisp, J., Vasavada, A., Edgett, K., Malin, M., Blake, D., Gellert, R., Mahaffy, P., Wiens, R., Maurice, S., Grant, J., Wilson, S., Anderson, R., Beegle, L., Arvidson R., Hallet, B., Sletten, R., Rice, M., Bell III, J., Griffes, J., Ehlmann, B., Anderson, R., Bristow, T., Dietrich, W., Dromart, G., Eigenbrode, J., **Fraeman, A.,** Hardgrove, C., Herkenhoff, K., Jandura, L., Kocurek, G., Lee, S., Leshin, L., Leveille, R., Limonadi, D., Maki, J., McCloskey, S., Meyer, M., Minitti, Newsom, H., M., Oehler, D., Okon, A., Palucis, M., Parker, T., Rowland, S., Squyers, S., Steele, A., Stolper, E., Summons, R., Treiman, A., Williams, R, Yingst, A. 2013. "A habitable fluvio-lacustrine environment at Yellowknife Bay, Gale Crater, Mars," *Science*, doi:10.1126/science.1242777.

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CRISM spectral observations of Phobos and Deimos," *Journal of Geophysical Research: Planets*, 117, doi:10.1029/2012JE004137.

4. Diniega, S., Sayanagi, K., Balcerski, J., Carande, B., Diaz-Silva, R., **Fraeman, A.**, Guzewich, S., Hudson, J., Nahm, A., Potter-McIntyre, S., Route, M., Urban, K., Vasisht, S., Benneke, B., Gil, S., Livi, R., Williams, B., Budney, C., Lowes, L. 2012. "Mission to the Trojan Asteroids: lessons learned during a JPL Planetary Science Summer School mission design exercise," *Planetary and Space Science,* 76, 68-82. doi:10.1016/j.pss.2012.11.011.
3. Ehlmann, B., Mustard, J., Murchie, S., Bibring, J-P., Meunier, A., **Fraeman, A.**, Langevin, Y. 2011. "Clay formation environments and potential habitats on early Mars," *Nature*, 497, 53-60. doi:10.1038/nature10582
2. **Fraeman, A.** and Korenaga, J. 2010. "The influence of mantle melting on the evolution of Mars," *Icarus*, 210, 43-57. doi:10.1016/j.icaurs.2010.06.030
1. McGuire, P., Bishop, J., Brown, A., **Fraeman, A.,** Marzo, G., Morgan, M., Murchie, S., Mustard, J., Parente, M., Pelkey, S., Roush, T., Seelos, F., Smith, M., Wendt, L., Wolff, M. 2009. "An improvement to the volcano-scan algorithm for atmospheric correction of CRISM and OMEGA spectral data," *Planetary and Space Sciences*, 57, 809-815. doi:10.1016/j.pss.2009.03.007

BOOK CHAPTERS

1. **Fraeman, A.A.,** 2021. "Chapter 1 – Resolving Martian enigmas, discovering new ones: the case of Curiosity and Gale crater," in: R.J. Soare, S.J. Conway, J-P. Williams and D.Z. Oehler (Eds.), *Mars Geological Enigmas: From the Late Noachian Epoch to the Present Day*, pp. 1-10, doi:10.1016/B978-0-12-820245-6.00001-X, Elsevier.

PEER-REVIWED CONFERENCE PAPERS

8. Vinckier, Q., R.O. Green, O. Mouroulis, P. Sullivan, C. Smith, T. Lin, M. Mok, D. Preston, C. Meyers, H.A. Bender, Z. Small, B.L. Ehlmann, and **A.A. Fraeman,** 2022. "The visible mid-wave Dyson imaging spectrometer (VMDIS)," Imaging Spectrometry XXV: Applications, Sensors, and Processing; 1223504, https://doi.org/10.1117/12.2632315.
7. Matthies, L.M., Kennett, A., Kerber, L., **Fraeman, A.,** Anderson, R.C. 2022. "Prospects for Very Long-Range Mars Rover Missions," Proceedings of the IEEE Aerospace conference.
6. Haag, J.M., Gibson, M.S., Chen, W., McKinley, I.M., **Fraeman, A.A.,** Mourouslis, P. 2020. "Ultra-Compact Imaging Spectrometer Moon (UCIS-Moon) for lunar surface missions: Optical, optomechanical, and thermal design," Imaging Spectrometry XXIV: Applications, Sensors, and Processing, 1150403.
5. Frez, C.F., Coskkun, M.B., Scott, V.J., Wu, Y-H., **Fraeman, A.,** Rais-Zadeh, M. 2020. "Frequency Tunable Surface Acoustic Wave Actuators for Adjustable Pitch Diffraction Grating," Journal of Microelectromechanical Systems, in press and available online, doi: 10.1109/JMEMS.2020.3000151.
4. Wyatt, E.J., Castillo-Rogez, J., Chien, S., **Fraeman, A.,** Gao, J., Herzig, S., T. J. Lazio, T. Vaquero. 2018. "Autonomous Networking for Robotic Deep Space Exploration," International Symposium on Artificial Intelligence, Robotics and Automation in Space (*iSAIRAS).*

3. **Fraeman, A.,** Ehlmann, B., Northwood-Smith, G., Liu, Y., Wadhwa, M., Greenberger, R. "Using VSWIR Microimaging Spectroscopy to Explore the Mineralogical Diversity of HED Meteorites," 2016. *IEEE Workshop on Hyperspectral Image and Signal Processing*.

2. **Fraeman, A.,** Arvidson, R., Grotzinger, J. "Curiosity's Traverse from the Kimberley to the Base of Mt. Sharp: An Orbital Data Perspective", 2014 *14th ASCE International Conference on Engineering, Sccience, Construction and Operations in Challenging Environments.*

1. Bosanac, N., Diaz, A., Dang, V., Ebersohn, F., Gonzalez, S., Qi, J., Sweet, N., Tie, N., Valentino, G., **Fraeman, A.,** Gibbings, A., Maddox, T., Nie, C., Rankin, J., Rebelo, T., and Taylor, G. "Manned sample return mission to Phobos: a technology demonstration for human exploration of Mars", 2014 *IEEE Aerospace Conference Paper*.

STUDY REPORTS

5. Keck Institute for Space Studies (KISS), Revolutionizing Access to the Mars Surface. Culbert, C.J., Ehlmann, B.L., Fraeman, A.A., editors. Final Workshop Report for the W.M. Keck Institute for Space Studies, Pasadena, CA. doi:10.7907/d1sm-mj77. 2022.
4. Committee on Planetary Protection Requirements for Sample Return Missions from Martian Moons, "Planetary Protection Classification of Sample Return Missions from the Martian Moons," National Academies Press, 2019.
3. Committee on the Planetary Science Decadal Survey, National Academy of Sciences, Space Studies Board, "Visions and Voyages for Planetary Science in the Decade 2013 – 2022," National Academies Press, 2011. *(Intern contributor)*
2. Committee on Assessing the Solar System Exploration Program, National Academy of Sciences, Space Studies Board, "Grading NASA's Solar System Exploration Program: A Midterm Review," National Academies Press, 2008. *(Intern contributor)*
1. Assessment of the NASA Astrobiology Institute Panel, National Academy of Sciences, Space Studies Board, "Assessment of the NASA Astrobiology Institute," National Academies Press, 2007. *(Intern contributor)*

PRESENTATIONS

INVITED SCIENTIFIC TALKS

19. Fraeman, A.A., "Unlocking Clues to Mars' Habitable Past with Curiosity and Orbital Data," Rice University. (2022).

18. Fraeman, A.A., "Characterizing Solar System Materials with Novel Hyperspectral Imaging Techniques," LPSC Early Career Award Plenary Session. (2022)

17. Fraeman, A.A., Culbert, C., Ehlmann, B.L., "An Outbrief from the 2021 KISS Workshop: 'Revolutionizing Access to the Martian Surface," Low-Cost Missions to Mars Conference. (2022).

16. Fraeman, A.A., "Exploring Mars' Habitable Past with the Curiosity Rover," Stanford University. (2021).

15. Fraeman, A.A., Ehlmann, B.L., Grotzinger, J.P., Milliken, R.E., Rampe, E.B., Arvidson, R.E., "Compositional fingerprints of past environments in the Martian rock record: Recent *in situ* discoveries and links to orbital data," COSPAR keynote talk. (2020).

14. Panel, Michael Meyer moderator, (Lead Scientist, Mars Exploration Program), "Mars Exploration Science: Mars Sample Return and Beyond," IEEE Aerospace Conference. (2020).
13. **Fraeman, A.,** "Exploring the sedimentary rock record of Mars: Clues to past environments and habitability," University of San Diego/Scripps Institute of Oceanography Gustaf Arrheniusm Symposium. (2019)
12. **Fraeman, A.,** "Exploration Vera Rubin Ridge, Mars with the Curiosity Rover," George Washington University Symposium in Honor of the Legacy of Vera Rubin, Keynote lecture. (2019)
11. **Fraeman, A.,** "Curiosity's Exploration of Vera Rubin Ridge," Space Science Institute (SSI) Journal Club talk. (2019)
10. **Fraeman, A.,** "Curiosity Results from Vera Rubin Ridge," UCLA Planetary Science Seminar. (2019)
9. Panel, Michael Meyer moderator, (Lead Scientist, Mars Exploration Program), "What's next in Mars Exploration Science," IEEE Aerospace Conference. (2019).
8. **Fraeman, A.,** Sun, V., Edgar, L., Fedo, C., Fox, V., Grotzinger, J., Hardgrove, C., Horgan, B., House, C., et al. "Curiosity at Vera Rubin Ridge: Major Findings and Implications for Habitability," oral presentation at AGU Fall Meeting (2018).
7. **Fraeman, A.,** "Mapping Mineralogy at Gale Crater with Reflectance Spectroscopy," SciX Conference. (2016).
6. **Fraeman, A.,** "Near Infrared Spectroscopy of Phobos and Deimos," Tohoku University Forum for Creativity. (2016)
5. **Fraeman, A.,** "Phobos and Deimos: What we know, what we don't know, and why we care," UCLA iPLEX lunch seminar. (2016).
4. **Fraeman, A.,** "Materials and Surface Processes at Gale Crater and the Moons of Mars Derived from High Spatial and Spectral Resolution Orbital Datasets," Caltech GeoClub speaker. (2014)
3. **Fraeman, A.,** "Phobos: A summary of current knowledge of its origin and evolution and key questions for future exploration," oral presentation at LPSC Microsymposium 55: Scientific Destinations for Human Exploration. (2014)
2. **Fraeman, A.,** Arvidson, R., Catalano, J., Morris, R., Murchie, S., Seelos, F., Seelos, K., McGovern, J., Viviano, C. "Hematite Bearing Ridge as Evidence for Anoxic Water Discharge in Gale Crater," oral presentation at GSA Fall Meeting. (2012)
1. **Fraeman, A.,** "New Techniques for Working with CRISM Data in Support of Opportunity and Curiosity Operations," NASA Jet Propulsion Laboratory Mars Seminar. (2012)

PROFESSIONAL WORKSHOPS & SERVICE

Discipline Program Manager, JPL, 2022 -
Program Committee, 2023 LPSC Meeting
Program Committee, 2022 COSPAR Meeting
NASA Proposal Evaluation Panels, Various
PDS Geosciences Node Advisory Committee, 2020-
Guest Associate Editor, *JGR Planets special issue on Curiosity's exploration of Vera Rubin ridge*

Peer Reviewer, *Icarus, JGR Planets, Planetary & Space Sciences, Astronomy & Astrophysics Letters, PDS, Oxford Research Encyclopedia of Planetary Science*

Scientific Organizing Committee, *9th International Conference on Mars Exploration* 2019

Program Committee, 2018 COSPAR Meeting

New Leaders in Space Studies Delegate, Joint workshop sponsored by the National Academy of Sciences and Chinese Academy of Sciences – 10/15, 5/16

Keck Institute for Space Studies Workshop, Mapping and Assaying the Near Earth Object Population Affordably on a Decadal Timescale – 8/14

Caltech Space Challenge, Human Mission Design Activity, selected participant - 3/13

Keck Institute for Space Studies Workshop, *In Situ* Science and Instrumentation for Primitive Bodies, invited participant - 5/12 and 2/13

Planetary Science Summer School, JPL TeamX Mission Design**,** selected participant - 8/11

TEACHING EXPERIENCE

Postdoc Advisor, Rachel Sheppard, 2020-2022
Summer student co-mentor, Macey Sandford, JPL Summer Internship Program, Summer 2019
Summer student mentor, Christopher Yen, JPL SURF Program, Summer 2018
Field Assistant, Bridge to Geosciences Citrus College Catalina Ocean Science Module, 2017-2019
Guest Lecturer, Dartmouth Remote Sensing Class, Spring 2018
Summer student mentor, Ethan Putnam, JPL SURF Program, Summer 2017
Summer student mentor, Geraint Northwood-Smith, Caltech SURF Program, Summer 2015
Guest Lecturer, WUSTL E&PS 567: Planetary Materials, Fall 2013
Guest Lecturer, WUSTL E&PS 106: Exploring Planets: Current Missions- Freshman Seminar, Spring 2012
Teaching Assistant, WUSTL Path 202: Case Study: Southwestern United States, Spring 2012
Teaching Assistant, WUSTL Path 201: Land Dynamics and the Environment**,** Fall 2011

RELEVANT COMPUTER SKILLS

Proficient in IDL, ENVI, Matlab, ArcMap. Microsoft Word, Excel, and PowerPoint. Some limited experience with Geochemist's Workbench.