RACHEL Y. SHEPPARD

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CURRENT PROFESSIONAL APPOINTMENTS

Institut d'Astrophysique Spatiale (IAS), Université Paris-Saclay — Orsay, France
Marie Curie Postdoctoral Fellow — *2023 - present*

Planetary Science Institute (PSI) — Tucson, Arizona
Research Scientist — *2022 - present*

PAST PROFESSIONAL APPOINTMENTS

Jet Propulsion Laboratory (JPL), Caltech — Pasadena, California
Postdoctoral Fellow — *2020 - 2022*

Gemological Institute of America (GIA) — New York, New York
Research Laboratory Technician, Diamond Color Origin Group — *2013 - 2015*

EDUCATION

Brown University — Providence, Rhode Island

- ⋄ **2020 Ph.D.**, Earth, Environmental & Planetary Sciences
  Dissertation: Spatial and temporal variations in the chemistry and mineralogy of mafic lacustrine systems on Earth and Mars. Advisor: Ralph Milliken
- ⋄ **2017 M.Sc.**, Earth, Environmental & Planetary Sciences
  Thesis: Spectroscopic analysis of iron cycling in a terrestrial ultramafic lake and its implications for martian sedimentary systems. Advisor: Ralph Milliken

Columbia University — New York, New York

- ⋄ **2013 B.A.**, Earth Science
  Thesis: Extractable organic molecules are an effective thermometer of both naturally and artificially heated fault rocks. Advisors: Pratigya Polissar & Heather Savage

PEER-REVIEWED PUBLICATIONS (†STUDENT)

⋄Under review:

L. Nardelli†, R. Brunetto, C. Pilorget, K. Hatakeda, T. Jiang, **R. Sheppard**, T. Le Pivert-Jolivet, C. Lantz, D. Loizeau, M. Mahlke, T.Okada, R. Fukai, J.-P. Bibring, M. Abe, D. Baklouti, Z. Dionnet, Z. Djouadi, Y. Enokido, V. Hamm, S. Kawasaki, A. Miyazaki, A. Moussi-Soffys, M. Nishimura, F. Poulet, L. Riu, R. Tahara, T. Usui, T. Yada, K. Yogata. Alteration processes recorded in Bennu samples: evidence from NIR and MIR measurements at the ISAS/JAXA Curation Center and comparison to Ryugu. Under review, *Earth & Planetary Science Letters.*

R. Y. Sheppard, C. Pilorget, D. Baklouti, D. Loizeau, R. Brunetto, L. Nardelli†, Z. Djouadi, C. Lantz, K. Hatakeda, T. Okada, R. Fukai, M. Abe, Y. Enokido, S. Kawasaki, A. Aléon-Toppani, J.-P. Bibring, Z. Dionnet, T. Jiang, Y. Langevin, M. Mahlke, A. Moussi-Soffys, F. Poulet, L. Riu, A. Miyazaki, K. Nagashima, M. Nishimura, R. Sakurai, R. Shimonishi, R. Tahara, T. Usui, T. Yada, K.

Yogata. Contrasting hydrated phosphate assemblages on Bennu and Ryugu. Under review, *Nature Astronomy*.

W. Rapin, G. Dromart, G. Caravaca, J. Schieber, D. Rubin, L. Edgar, S. Gupta, A. Roberts†, T. Magnin, B. Clark, L. Kah, **R. Sheppard**, M. Loche, E. Dehouck, O. Gasnault, D. Burtt, E. Dehouck, S. Le Mouélic. Stratigraphic partitioning of evaporites through the clay-sulfate transition in Gale Crater, Mars. Under review, *Journal of Geophysical Research: Planets*.

T. Jiang, D. Baklouti, C. Pilorget, D. Loizeau, K. Hatakeda, M. Mahlke, L. Nardelli†, T. Le Pivert-Jolivet, J.-P. Bibring, **R. Y. Sheppard**, A. Aleon-Toppani, R. Brunetto, C. Lantz, F. Poulet, T. Okada, R. Fukai, T. Usui, M. Abe, Z. Dionnet, Z. Djouadi, Y. Enokido, V. Hamm, S. Kawasaki, Y. Langevin, A. Miyazaki, A. Moussi-Soffys, M. Nishimura, L. Riu, R. Tahara, T. Yada, K. Yogata. Ammonium (NH_4^+)-bearing phyllosilicate grains detected in Ryugu and Bennu samples via infrared spectroscopy. Under review, *Nature Communications*.

A. B. Bryk, W. E. Dietrich, K. A. Bennett, V. K. Fox, C. M. Fedo, A. R. Vasavada, A. A. Fraeman, M. P. Lamb, S. Le Mouélic, G. Caravaca, D. M. Joel, J. A. Grant, R. C. Wiens, R. M. E. Williams, O. Gasnault, K. M. Stack, R. E. Arvidson, L. A. Edgar, J. P. Grotzinger, S. G. Banham, S. Gupta, K. M. Lewis, M. Turner, W. Rapin, M. N. Hughes, E. S. Kite, S. W. Purdy, **R. Y. Sheppard**, D. M. Rubin, M. C. Malin. Curiosity meets the Gediz Vallis Ridge: Remnants of a late-stage debris-flow dominated fan in Gale Crater. Under review, *Icarus*.

A. Tsalickis†, R. S. Vachula, **R. Y. Sheppard**, T. M. Cullen, J. W. Campbell, M. N. Waters. Time-dependent mineral alteration in bat guano: Insights from a 12,000-year archive. Under review, *The Holocene*.

M. Mahlke, C. Lantz, C. Pilorget, D. Baklouti, R. Brunetto, K. Hatakeda, T. Jiang, D. Loizeau, **R. Sheppard**, A. Aléon-Toppani, M. Abe, J.-P. Bibring, Y. Enokido, R. Fukai, V. Hamm, S. Kawasaki, T. Le Pivert-Jolivet, A. Miyazaki, L. Nardelli†, M. Nishimura, T. Okada, F. Poulet, L. Riu, R. Tahara, T. Usui, K. Yogata, T. Yada. Carbonates in Ryugu and Bennu with MicrOmega: Insights into aqueous alteration on primitive asteroids. Under review, *Meteoritics & Planetary Science*.

J. M. Meusburger, T. F. Bristow, D. T. Vaniman, E. B. Rampe, **R. Y. Sheppard**, S. L. Simpson, S. J. Chipera, D. F. Blake, A. Yen, A. L. Roberts†, C. H. Seeger, J. P. Grotzinger, R. M. Hazen, V. M. Tu, T. S. Peretyazhko, G. Berlanga, N. Castle, J. V. Clark, P. Craig, R. T. Downs, D. J. Des Marais, R. Gellert, S. Gupta, E. M. Hausrath, E. B. Hughes, M. Litvak, D. W. Ming, R. V. Morris, S. M. Morrison, P. K. Najeeb, S. Nikiforov, A. Pandey, M. T. Thorpe, A. Treiman, B. M. Tutolo, A. A. Fraeman, A. Vasavada. Retrograde sulfate precipitation in the martian crust. Under review, *Nature Geoscience*.

A. L. Roberts†, S. Gupta, A. Cowart, S. G. Banham, L. Edgar, W. Rapin, W. E. Dietrich, E. S. Kite, J. M. Davis, C. A. Mondro, K. Lewis, W. Farrand, A. B. Bryk, **R. Y. Sheppard**, L. C. Kah, G. Caravaca, A. Yingst, D. Fey, A. Fraeman, A. R. Vasavada. An aeolian depositional sequence shaped by near-surface water at the base of the Layered Sulfate unit, Gale crater, Mars. Under review, *Journal of Geophysical Research: Planets*.

E. B. Hughes, F. Rivera-Hernández, J. Wray, W. Rapin, J. Johnson, K. Rammelkamp, O. Forni, P. Gasda, B. Tutolo, A. Eng†, E. Kite, A. Roberts†, E. Sklute, D. Das, L. Kah, A. Cowart, A. Pandey, E. Dehouck, **R. Y. Sheppard**, O. Gasnault, S. Le Mouélic, N. Lanza. Formation of warm-temperature salts in Gale crater, Mars. Under review, *Science Advances*.

◇Published:

2026 R. Y. Sheppard, J. M. Weber, L. E. Rodriguez, C. Trejo†, E. M. Hausrath, L. M. Barge. The effect of clay minerals on Li in martian groundwater simulant. *Icarus*, 443, 116769. doi:10.1016/j.icarus.2025.11676

2026 J. M. Meusburger, T. F. Bristow, D. Vaniman, E. B. Rampe, S. J. Chipera, D. F. Blake, S. L. Simpson, **R. Y. Sheppard**, G. Berlanga. Rover-induced mineral transformations: Extent of the effect for the Mars Science Laboratory and opportunities for future landed missions. *Journal of Geophysical Research: Planets*, 131, e2025JE009631, doi:10.1029/2025JE009631.

2026 J. M. Weber, E. M. Martinez†, **R. Y. Sheppard**, L. E. Rodriguez, A. Celestian, B. L. Teece, L. M. Barge. Mars mineral weathering experiments in a continuous-flow reactor. *Geofluids*, 2026, 6180315. doi:10.1155/gfl/6180315

2026 P. Gasda, E. Kite, L. Thompson, C. Mondro, W. Dietrich, C. Weitz, B. Tutolo, W. Farrand, E. Hausrath, A. Cowart, N. Lanza, K. Lewis, S. Gupta, A. Roberts†, W. Goetz, H. E. Newsom, L. Crossey, J. Lightholder, C. Hardgrove, J. Schieber, S. Schwenzer, S. VanBommel, S. Schroder, C. O'Connell-Cooper, D. Das, D. Rubin, W. Rapin, T. Bristow, E. Rampe, D. Archer, C. Seeger, G. Caravaca, J. Johnson, S. Le Mouélic, J. Grant, J. Davis, J. Lasue, A. Yingst, A. Bryk, M. Lamb, W. Fischer, C. House, E. Dehouck, A. Essunfeld, R. Milliken, **R. Sheppard**, M. Minitti, D. Ming, S. Simpson, J. Frydenvang, R. Williams, R. Arvidson, R. Gellert, O. Gasnault, S. Clegg, D. M. Delapp, A. Vasavada, A. Fraeman. Amapari Marker Band metal-enrichments: Potential mechanisms and implications for surface and subsurface water and weathering in Gale crater. In press, *Journal of Geophysical Research: Planets*.

2025 R. Fukai, M. Nishimura, K. Yumoto, Y. Cho, Y. Shimizu, M. Matsuoka, E. Tatsumi, S. Furukawa, T. Yada, K. Hatakeda, K. Yogata, Y. Enokido, R. Tahara, A. Miyazaki, S. Kawasaki, S. Sugita, S. Mori, S. Nakahara, Y. Aikyo, H. Miyamoto, C. Pilorget, D. Loizeau, L. Nardelli†, **R. Sheppard**, C. Lantz, L. Riu, J.-P. Bibring, R. Brunetto, T. Okada, M. Abe, T. Usui. Non-destructive description of Bennu samples towards comparative studies with Ryugu samples. *Meteoritics and Planetary Science*, 1-14. doi:10.1111/maps.70077

2025 C. Pilorget, T. Okada, J.-P. Bibring, D. Loizeau, K. Hatakeda, L. Nardelli†, L. Riu, **R. Y. Sheppard**, T. Jiang, M. Mahlke, R. Brunetto, R. Fukai, M. Abe, A. Aléon-Toppani, D. Baklouti, Y. Enokido, V. Hamm, S. Kawasaki, C. Lantz, A. Miyazaki, A. Moussi-Soffys, M. Nishimura, F. Poulet, R. Tahara, T. Usui, T. Yada, K. Yogata. Compositional diversity in pristine Bennu samples revealed by the IR hyperspectral microscope MicrOmega at JAXA Curation Center and comparison with Ryugu samples. *Nature Communications*, 16:9532. doi:10.1038/s41467-025-65438-z.

2025 A. R. Trussell†, J. F. Bell III, W. H. Farrand, L. C. Kah, E. B. Hughes, C. D. O'Connell-Cooper, L. M. Thompson, **R. Y. Sheppard**, H. Manelski†, G. Paar, B. S. Douglass, A. M. Eng†, J. R. Johnson. Dark-toned halite-enriched veins above the Marker Band record a drying environment in Gale Crater. *Journal of Geophysical Research: Planets*, 130, e2025JE009244. doi:10.1029/2022JE007706

2025 R. Y. Sheppard, D. Loizeau, A. A. Fraeman, E. B. Rampe, C. Pilorget, J.-P. Bibring. Mg sulfate can spectrally obscure siderite: Implications for martian surface carbonates. *Frontiers in Astronomy and Space Sciences* special issue, "Remote Sensing and Modelling of Planetary and Moon Surfaces," 12:1549242. doi:10.3389/fspas.2025.1549242

2025 J. Ando†, **R. Y. Sheppard**, A. B. Bryk, V. Sun, C. H. Seeger†, A. A. Fraeman, A. M. Eng†, L. Kah, A. N. Rudolph. Diagenetic features reveal the influence of the Greenheugh Pediment on the alteration history of Gale crater, Mars. *Journal of Geophysical Research: Planets*, 130, e2024JE008891.

doi:10.1029/2024JE008891.

2025 R. Y. Sheppard, J. Cuadros. Chapter "Lithologic and textural context of clays inferred from remote sensing" within the book *Clay on Mars.* Editor: Javier Cuadros. Elsevier, Developments in Clay Science, Volume 12.

2025 E. M. Martinez†, E. Flores†, D. Valadez†, J. M. Weber, D. VanderVelde, **R. Y. Sheppard**, R. P. Hodyss, J. Castillo-Rogez†, M. Melwani Daswani, B. Henderson†, L. M. Barge. Organic adsorption onto iron sulfide and hydroxide minerals: Implications for Ceres sample return analysis. *ACS Earth & Space Chemistry.* doi:10.1021/acsearthspacechem.4c00372

2025 A. B. Bryk, W. E. Dietrich, K. A. Bennett, V. K. Fox, C. M. Fedo, M. P. Lamb, E. S. Kite, Lucy M. Thompson, S. G. Banham, J. Schieber, J. A. Grant, A. R. Vasavada, A. A. Fraeman, Patrick J. Gasda, R. C. Wiens, O. Gasnault, J. P. Grotzinger, K. Stack-Morgan, R. E. Arvidson, S. Le Mouélic, S. Gupta, R. M. E. Williams, **R. Y. Sheppard**, K. W. Lewis, D. M. Rubin, W. Rapin, M. N. Hughes, M. Turner, S. A. Wilson, J. M. Davis, R. E. Kronyak, L. Le Deit, L. C. Kah, J. Frydenvang, R. J. Sullivan, C. C. Bedford, E. Dehouck, H. E. Newsom, M. C. Malin. Pediment formation and subsequent erosion in Gale crater: clues to climate history of Mars. *Icarus*, 430, 116445. doi:10.1016/j.icarus.2024.116445

2024 N. A. Carman†, E. M. Hausrath, A. Celestian, J. Chavez†, N. Hermis, D. E. LaRowe, A. Fraeman, **R. Y. Sheppard**, C. T. Adcock, O. Tschauner, E. B. Rampe, R. Price, L. M. Barge. Simulated Fe/Mg-silicate chimneys as analogs to saponite-rich hydrothermal systems on early Earth and Mars. *ACS Earth & Space Chemistry*, 8(10), 1982–1996. doi:10.1021/acsearthspacechem.4c00109

2024 A. Rudolph, B. Horgan, K. Bennett, C. Weitz, **R. Y. Sheppard**, L. Scuderi, A. Bryk, K. Lewis, A. Roberts†. An orbital comparison of a late mantling unit on Aeolis Mons with other erosion-resistant strata explored by MSL in Gale crater, Mars. *Journal of Geophysical Research: Planets.* 129, e2023JE008242. doi:10.1029/2023JE008242

2024 T. Marlin†, J. M. Weber, **R. Y. Sheppard**, S. Perl, D. Diener, M. Baum, L. M. Barge. Chemical gardens as analogs for prebiotic chemistry on ocean worlds. *Chemistry.* doi:10.1016/j.chempr.2024.08.012

2024 M. J. Meyer†, R. E. Milliken, K. M. Stack Morgan, L. A. Edgar, E. B. Rampe, M. L. Turner, K. W. Lewis, E. S. Kite, G. Caravaca, A. R. Vasavada, W. E. Dietrich, A. B. Bryk, O. Gasnault, S. Le Mouélic, C. H. Seeger, **R. Y. Sheppard**. The geological context and significance of the clay-sulfate transition region in Mount Sharp, Gale crater, Mars: An integrated assessment based on orbiter and rover data. *GSA Bulletin*, doi:10.1130/B37355.1

2024 A. M. Eng†, M. S. Rice, W. H. Farrand, J. R. Johnson, S. Jacob, E. B. Rampe, L. M. Thompson, D. Applin, J. Bishop, E. Cloutis, M. Gabbert, K. Lapo, A. Rudolph, C. Seeger, **R. Sheppard**. A Mastcam multispectral investigation of rock variability in Gale crater, Mars: Implications for alteration in the clay-sulfate transition of Mount Sharp. *Journal of Geophysical Research: Planets.* 129, 2. doi:10.1029/2023JE008033

2023 E. M. Martinez†, L. E. Rodriguez, **R. Y. Sheppard**, Z. Yi†, C. Cid, A. Khodayari, L. M. Barge. Nitrate reactivity in iron (oxy)hydroxide systems: Effect of pH, iron redox state, and phosphate. *Earth & Space Chemistry.* 7, 11. doi:10.1021/acsearthspacechem.3c00218

2023 H. T. Manelski†, **R. Y. Sheppard**, A. A. Fraeman, R. Wiens, J. Johnson, J. Frydenvang, N. Lanza, O. Gasnault. Compositional Variations in Sedimentary Deposits in Gale Crater as seen by ChemCam Passive and Active Spectra. *Journal of Geophysical Research: Planets.* 128, 3. doi:10.1029/2022JE007706

2022 R. Y. Sheppard, R. E. Milliken, K. M. Robertson. Presence of clay minerals can obscure spectral evidence of Mg sulfates: Implications for orbital observations of Mars. *Icarus*. 383, 115083. doi:10.1016/j.icarus.2022.115083

2022 R. S. Vachula, **R. Y. Sheppard**, A. H. Cheung†. Preservation biases are pervasive in Holocene paleofire records. *Palaeogeography, Palaeoclimatology, Palaeoecology*. 602, 111165. doi:10.1016/j.palaeo.2022.111165

2022 C. Lee, J. M. Weber, L. E. Rodriguez, **R. Y. Sheppard**, L. M. Barge, E. L. Berger, A. S. Burton. Chirality in organic and mineral systems: A review of reactivity and alteration processes relevant to prebiotic chemistry and life detection missions. *Symmetry* special issue, "Chirality, Prebiotic Chemistry, and the Origins of Life." 14(3), 460. doi:10.3390/sym14030460

2022 M. Prakash†, J. M. Weber, L. E. Rodriguez, **R. Y. Sheppard**, L. M. Barge. Database on carbon reduction: Implications for future research. *International Journal of Astrobiology*, 21(6), 423-440. doi:10.1017/S1473550422000052

2021 R. Y. Sheppard, M. T. Thorpe, A. A. Fraeman, V. K. Fox, R. E. Milliken. 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* special issue, "Expanding Views of Clays, Oxides, and Evaporites on Aquaplanets in the Solar System," 11(986). doi:10.3390/min11090986

2021 R. Y. Sheppard, R. E. Milliken, J. M. Russell, M. D. Dyar, E. Sklute, H. Vogel, M. Melles, S. Bijaksana, A. K. M. Hasberg, M. A. Morlock. Iron mineralogy and sediment color in a 100 m drill core from Lake Towuti, Indonesia reflect catchment and diagenetic conditions. *Geochemistry, Geophysics, Geosystems*. 22, e2020GC009582. doi:10.1029/2020GC009582

2020 R. Y. Sheppard, R. E. Milliken, Y. Itoh, M. Parente. Updated perspectives and hypotheses on the mineralogy of Lower Mt. Sharp, Mars, as seen from orbit. *Journal of Geophysical Research: Planets*. 126. doi:10.1029/2020JE006372

2020 J. Russell, H. Vogel, S. Bijaksana, M. Melles, A. Deino, A. Hafidz, A. Hasberg†, M. Morlock†, T. von Rintelen, **R. Y. Sheppard**†, B. Stelbrink, J. Stevenson. The Late Quaternary tectonic, biogeochemical, and environmental evolution of ferruginous Lake Towuti, Indonesia. *Palaeogeography, Palaeoclimatology, Palaeoecology*. 556, 109905. doi:10.1016/j.palaeo.2020.109905

2019 R. Y. Sheppard†, R. E. Milliken, J. M. Russell, M. D. Dyar, E. Sklute, H. Vogel, M. Melles, S. Bijaksana, A. K. M. Hasberg†, M. A. Morlock†. Characterization of iron in Lake Towuti sediment. *Chemical Geology*. 512, 11-30. doi:10.1016/j.chemgeo.2019.02.029

2017 B. C. Johnson, **R. Y. Sheppard**†, A. C. Pascuzzo†, E. A. Fisher†, S. E. Wiggins†. Porosity and salt content determine if subduction can occur in Europa's ice shell. *Journal of Geophysical Research: Planets*. 122. doi:10.1002/2017JE005370

2015 R. E. Sheppard†, P. J. Polissar, H. M. Savage. Organic thermal maturity as a proxy for frictional fault heating: experimental constraints on methylphenanthrene kinetics at earthquake timescales. *Geochimica et Cosmochimica Acta*. 151, 103-116. doi:10.1016/j.gca.2014.11.020

2014 H. M. Savage, P. J. Polissar, **R. Sheppard**†, C. D. Rowe, E. E. Brodsky. Biomarkers heat up during earthquakes: New evidence of seismic slip in the rock record. *Geology*. 42(2), 99-102. doi:10.1130/G34901.1

OTHER PUBLICATIONS

2021 Revolutionizing Access to the Mars Surface. Editors: C. J. Culbert, B. L. Ehlmann, A. A. Fraeman, editors. Final Workshop Report for the W. M. Keck Institute for Space Studies (KISS), Pasadena, CA.

2015 R. E. Sheppard, W. Wang, T. Moses. Analysis of melee diamonds using FTIR spectroscopy. *Gems & Gemology.* 51(1).

2015 R. E. Sheppard, U. D'Haenens-Johansson, K. S. Moe, W. Wang. HPHT synthetic diamond melee in high-quality mounted jewelry piece. *Gems & Gemology.* 51(1).

2014 W. Wang, M. Altobelli, C. Dieck, **R. E. Sheppard.** Screening of small yellow melee for treatment and synthetics. *Gems & Gemology.* 50(4).

RESEARCH GRANTS

2026 Soleil Synchrotron Beamtime Grant. "IR reflectivity of salt-bearing ices under high pressure." **15 shifts. PI,** 100% funds to Sheppard.

2025-2028 Mars Science Laboratory Participating Scientist Program Augmentation (MSL-PSE25), NASA ROSES. "Identifying primary and secondary hydrous minerals in upper strata of Mt. Sharp." **$50,000. PI,** 100% funds to Sheppard.

2023-2027 Mars Data Analysis Program (MDAP), NASA ROSES. "Analyses of sulfates in chaos regions on Mars." **$540,000. Co-I** with Cathy Weitz (PI) and Janice Bishop (Co-I), 25% funds to Sheppard.

2023-2027 Marie Skłodowska-Curie Actions research fellowship, European Commission (MSCA-EF). "Spectral diversity within Ryugu." **€210,000. PI,** 100% funds to Sheppard.

2022-2025 Mars Science Laboratory Participating Scientist Program (MSL-PSP), NASA ROSES. "Understanding Mg-sulfate distribution, hydration state, and crystallinity in Mt. Sharp." **$300,000. PI,** 100% funds to Sheppard.

2022 Spontaneous Research and Technology Development Program (SRTD), Jet Propulsion Laboratory. "Novel reaction design to test martian weathering." **$40,000. Co-I** with Jessica Weber (PI) and Laura Rodriguez (Co-I), 20% funds to Sheppard.

2022 Data Science Working Group, Jet Propulsion Laboratory. "Developing machine learning models to facilitate the untargeted identification and classification of organics in complex mixtures via tandem mass spectrometry." **$50,000. Co-I** with Laura Rodriguez (PI) and Jessica Weber (Co-I), 20% funds to Sheppard.

2020-2022 Strategic Research and Technology Development Program, Jet Propulsion Laboratory. "Experimental constraints on groundwater driven redox gradients on Mars." **$300,000. Science PI,** 100% funds to Sheppard.

MISSION INVOLVEMENT

OSIRIS-REx 2023 - present
MicrOmega Team

Hayabusa2 2023 - present
MicrOmega Team

Mars Science Laboratory (MSL) 2016 - present
CheMin Team Member *2025-present*
Participating Scientist *2022-present*
Science Team Collaborator *2016-2022*

AWARDS & FELLOWSHIPS

2022 Seal of Excellence, European Commission, Marie Skłodowska-Curie Actions.

2019 Dissertation Fellowship, Brown University (6 mo.).

2017, 2015 NASA Group Achievement Award, MSL Science and Operations Team.

2015-2018 Presidential Fellowship, Brown University (3 yr.).

2013 Walter C. Pitman III Award, Columbia University Dept. Earth & Environmental Sciences.

CONFERENCE PRESENTATIONS (LAST 3 YEARS ONLY, †STUDENT)

2025 R. Y. Sheppard, C. Pilorget, D. Baklouti, D. Loizeau, K. Hatakeda, T. Jiang, L. Nardelli†, J.-P. Bibring, M. Mahlke, F. Poulet, R. Brunetto, C. Lantz, T. Okada, R. Fukai, M. Abe, A. Aléon-Toppani, Y. Enokido, S. Kawasaki, A. Miyazaki, M. Nishimura, L. Riu, T. Usui, T. Yada, K. Yogata. A comparison of spectral features of hydrated phosphorous-rich material within Bennu and Ryugu, with implications for evolutionary history. Hayabusa2 Symposium, Sagamihara, Japan.

2025 R. Y. Sheppard, C. Pilorget, D. Baklouti, D. Loizeau, T. Jiang, L. Nardelli†, J.-P. Bibring, M. Mahlke, F. Poulet, R. Brunetto, A. Aléon-Toppani, C. Lantz, K. Hatakeda, T. Okada, R. Fukai, M. Abe, Y. Enokido, S. Kawasaki, L. Riu, A. Miyazaki, M. Nishimura, T. Usui, T. Yada, K. Yogata. Characterization of hydrated phosphorous-rich material within Bennu returned samples using near-infrared to mid-infrared spectra. European Planetary Science Conference, Helsinki, Finland.

2025 R. Y. Sheppard, D. Loizeau, A. A. Fraeman, E. B. Rampe, C. Pilorget, J.-P. Bibring. Sulfate can obscure spectral evidence of carbonate: MicrOmega observations with implications for Mars. European Planetary Science Conference, Helsinki, Finland.

2025 R. Y. Sheppard, D. Loizeau, A. A. Fraeman, E. B. Rampe, C. Pilorget, J.-P. Bibring. Presence of Mg-sulfate can obscure spectral evidence of carbonate: MicrOmega observations with implications for Mars. Lunar and Planetary Science Conference, The Woodlands, TX.

2025 R. Y. Sheppard, J. Ando†, A. B. Bryk, V. Sun, C. H. Seeger†, A. A. Fraeman, A. M. Eng†, L. Kah, A. N. Rudolph. Effects of geologic features including Greenheugh Pediment on the morphology, size, and distribution of diagenetic features within Mt. Sharp, Gale crater. Lunar and Planetary Science Conference, The Woodlands, TX.

2024 R. Y. Sheppard, D. Loizeau, E. B. Rampe, A. A. Fraeman. The presence of Mg sulfate can obscure spectral evidence of siderite. The 10th International Conference on Mars, Pasadena, CA.

PRESENTATIONS: CONTRIBUTING AUTHOR (LAST 3 YEARS ONLY, †STUDENT)

2026 V. E. Concepcion†, C. Hardgrove, S. Czarnecki, **R. Sheppard**. Linking subsurface hydrogen to amorphous and iron-bearing phases across the clay-sulfate transition at Gale crater. LPSC, The Woodlands, TX.

2026 E. M. Hausrath, E. B. Rampe, T. Bristow, S. Chipera, V. Tu, B. Tutolo, D. Vaniman, R. V. Morris, D. Blake, J. Meusburger, T. Peretyazhko, D. Ming, P. Craig, N. Castle, R. T. Downs, S. Morrison, R. Hazen, A. Yen, A. Pandey, S. Simpson, M. Thorpe, A. H. Treiman, D. J. Des Marais, **R. Sheppard**. Mineralogical examination of the boxwork unit (Altadena Member), Gale crater, Mars by the CheMin X-ray diffractometer. LPSC, The Woodlands, TX.

2025 E. Hausrath, J. Hall, E. B. Rampe, T. Bristow, A. McAdam, L. Chou, S. Chipera, V. Tu, B. Tutolo, E. Dehouck, D. Vaniman, R. V. Morris, D. Blake, J. Meusburger, T. Peretyazhko, D. Ming, P. Craig, N. Castle, R. T. Downs, S. Morrison, R. Hazen, A. H. Treiman, A. Yen, A. Pandey, S. Simpson, M. Thorpe, D. J. Des Marais, **R. Sheppard**, B. C. Clark. Potential extended past habitability of Mars from recent mineralogical measurements in Gale crater. AGU, New Orleans, LA.

2025 E. B. Rampe, T. F. Bristow, D. F. Blake, D. T. Vaniman, S. J. Chipera, D. J. Des Marais, R. T. Downs, J. P. Grotzinger, R. M. Hazen, D. W. Ming, R. V. Morris, S. M. Morrison, A. H. Treiman, A. S. Yen, C. N. Achilles, G. W. Downs, N. Castle, P. I. Craig, E. M. Hausrath, A. Pandey, T. S. Peretyazhko, **R. Sheppard**, S. L. Simpson, M. T. Thorpe, V. M. Tu, B. Tutolo. Minerals in Gale Crater, Mars: 13 Earth-Years of XRD Data from the CheMin Instrument. Mineralogical Society of America Symposium, Tucson, AZ.

2025 W. Rapin, G. Dromart, J. Schieber, B. C. Clark, L. Kah, D. Rubin, S. Gupta, A. Roberts, N. Mangold, G. Caravaca, L. Edgar, **R. Y. Sheppard**, M. Loche, E. Dehouck, P. Beck, S. Le Mouélic, A. Bryk, W. E. Dietrich, P. Gasda, O. Gasnault, N. Lanza. Mars through the clay-sulfate transition as recorded in Gale crater stratigraphy. Mars Through Time International Conference, Paris, France.

2025 M. Mahlke, C. Lantz, C. Pilorget, D. Baklouti, R. Brunetto, K. Hatakeda, T. Jiang, D. Loizeau, **R. Sheppard**, A. Aléon-Toppani, M. Abe, J.-P. Bibring, Y. Enokido, R. Fukai, V. Hamm, S. Kawasaki, T. Le Pivert-Jolivet, A. Miyazaki, L. Nardelli†, M. Nishimura, T. Okada, F. Poulet, L. Riu, R. Tahara, T. Usui, T. Yada, K. Yogata. European Planetary Science Conference, Helsinki, Finland.

2025 L. Nardelli†, R. Brunetto, C. Pilorget, K. Hatakeda, T. Jiang, J.-P. Bibring, T. Okada, R. Fukai, M. Abe, Y. Enokido, **R. Sheppard**, S. Kawasaki, C. Lantz, D. Loizeau, M. Mahlke, A. Miyazaki, M. Nishimura, L. Riu, R. Tahara, T. Usui, T. Yada, K. Yogata. Spectral variations of phyllosilicate features in Bennu grains: Evidence from NIR and MIR measurements of pristine returned samples at ISAS curation facility. European Planetary Science Conference, Helsinki, Finland.

2025 C. Pilorget, T. Okada, J.-P. Bibring, D. Loizeau, K. Hatakeda, L. Nardelli†, L. Riu, **R. Y. Sheppard**, T. Jiang, M. Mahlke, R. Brunetto, R. Fukai, M. Abe, A. Aléon-Toppani, D. Baklouti, Y. Enokido, V. Hamm, S. Kawasaki, C. Lantz, A. Miyazaki, A. Moussi-Soffys, M. Nishimura, F. Poulet, R. Tahara, T. Usui, T. Yada, K. Yogata. Characterization of the Bennu samples in their pristine state with the NIR hyperspectral microscope MicrOmega at JAXA Curation Center and preliminary comparison with Ryugu samples. MetSoc (Meteoritical Society Annual Meeting), Perth, Australia.

2025 C. Pilorget, T. Okada, J.-P. Bibring, D. Loizeau, K. Hatakeda, L. Nardelli†, L. Riu, **R. Y. Sheppard**, M. Mahlke, R. Brunetto, R. Fukai, M. Abe, D. Baklouti, Y. Enokido, V. Hamm, T. Jiang, S. Kawasaki, C. Lantz, A. Miyazaki, A. Moussi-Soffys, M. Nishimura, F. Poulet, R. Tahara, T. Usui, T. Yada, K. Yogata. Non-destructive analysis and curation of Bennu samples without atmospheric exposure. Japan Geoscience Union Meeting, Chiba, Japan.

2025 C. Weitz, **R. Sheppard**, J. Bishop, S. Cartwright, F. Seelos. Analyses of sulfate deposits in the martian equatorial chaos regions. EGU, Vienna, Austria.

2025 T. Jiang, C. Pilorget, D. Baklouti, D. Loizeau, K. Hatakeda, M. Abe, J.-P. Bibring, Y. Enokido, R. Fukai, S. Kawasaki, C. Lantz, A. Miyazaki, L. Nardelli†, M. Nishimura, T. Okada, L. Riu, **R. Y. Sheppard**, R. Tahara, T. Usui, T. Yada, K. Yogata. Detection of NH-rich compounds in Bennu

pristine samples via IR characterization at JAXA Curation Center and comparison with Ryugu. EGU, Vienna, Austria.

2025 C. Pilorget, T. Okada, J.-P. Bibring, D. Loizeau, K. Hatakeda, L. Nardelli†, L. Riu, **R. Y. Sheppard**, M. Mahlke, R. Brunetto, R. Fukai, M. Abe, D. Baklouti, Y. Enokido, V. Hamm, T. Jiang, S. Kawasaki, C. Lantz, A. Miyazaki, A. Moussi-Soffys, M. Nishimura, F. Poulet, R. Tahara, T. Usui, T. Yada, K. Yogata. Characterization of the Bennu samples in their pristine state with the NIR hyperspectral microscope MicrOmega at JAXA Curation Center and preliminary comparison with Ryugu samples. LPSC, The Woodlands, TX.

2025 R. Fukai, Y. Enokido, M. Nishimura, K. Yumoto, Y. Cho, Y. Shimizu, M. Matsuoka, E. Tatsumi, S. Furukawa, T. Yada, K. Hatakeda, K. Yogata, R. Tahara, A. Miyazaki, S. Kawasaki, S. Sugita, S. Mori, S. Nakahara, Y. Aikyo, H. Miyamoto, C. Pilorget, D. Loizeau, L. Nardelli†, **R. Sheppard**, C. Lantz, L. Riu, J.-P. Bibring, R. Brunetto, T. Okada, M. Abe, T. Usui. Non-destructive observation of Bennu samples in JAXA without atmospheric exposure. LPSC, The Woodlands, TX.

2025 L. Nardelli†, R. Brunetto, C. Pilorget, K. Hatakeda, **R. Sheppard**, J.-P. Bibring, T. Okada, R. Fukai, M. Abe, Y. Enokido, T. Jiang, S. Kawasaki, C. Lantz, D. Loizeau, M. Mahlke, A. Miyazaki, M. Nishimura, L. Riu, , R. Tahara, T. Usui, T. Yada, K. Yogata. Investigating alteration processes recorded in the phyllosilicates present in Bennu samples with a combination of NIR hyperspectral microscopy and MIR micro-spectrometry. LPSC, The Woodlands, TX.

2025 C. Weitz, **R. Y. Sheppard**, J. L. Bishop, S. Cartwright, F. P. Seelos. Finding order in the martian chaos through analyses of sulfates. LPSC, The Woodlands, TX.

2025 A. R. Trussell, J. F. Bell III, W. H. Farrand, L. C. Kah, E. B. Hughes, C. D. O'Connell-Cooper, B. S. Douglass, J. R. Johnson, A. M. Eng, H. Manelski, **R. Y. Sheppard**. Dark-toned halite veins as a record of a drying environment in Gale crater. LPSC, The Woodlands, TX.

2025 A. Pandey, E. B. Rampe, D. Vaniman, S. Chipera, R.V. Morris, T. Bristow, D. Blake, J. Meusburger, T. Peretyazhko, D. Ming, P. Craig, N. Castle, R. T. Downs, S. Morrison, R. Hazen, A. H. Treiman, A. Yen, B. Tutolo, E. Hausrath, S. Simpson, M. Thorpe, V. Tu, D. J. Des Marais, **R. Y. Sheppard**. Insights into the Mineralogy of the Sulfate-bearing Unit, Gale Crater, Mars. LPSC, The Woodlands, TX.

2025 J. V. Clark, B. Sutter, A. McAdam, P. D. Archer, J. Lewis, H. Franz, L. Chou, C. Knudson, D. Burtt, J. Eigenbrode, J. Stern, P. Casbeer, S. Simpson, J. Berger, V. Tu, B. Tutolo, C. Malespin, P. Mahaffy, D. P. Glavin, C. House, R. Milliken, E. Rampe, **R. Y. Sheppard**. A record of arid surface conditions and aqueous alteration in the layered sulfate-bearing unit and Marker Band Valley as revealed by the Sample Analysis at Mars Evolved Gas Analyzer instrument. LPSC, The Woodlands, TX.

2025 V. E. Concepcion†, C. Hardgrove, S. Czarnecki, **R. Y. Sheppard**. Using the Dynamic Albedo of Neutrons instrument to correlate hydration with elemental variability and mineralogy in the clay-sulfate transition. LPSC, The Woodlands, TX.

2025 L. F. Lim, W. Rapin, O. Gasnault, S. Connell, R. C. Wiens, E. Dehouck, P.-Y. Meslin, S. Schröder, **R. Sheppard**. Hydration in the sulfate-bearing units, Gale crater, Mars. LPSC, The Woodlands, TX.

2025 S. N. Lamm†, **R. Y. Sheppard**, A. Yanchillinia, C. P. Marshall, A. J. Celestian, B. Lacroix, P. Sobron, L. M. Barge, L. E. Rodriguez. Machine Learning Strategies to Distinguish Iron Sulfide, Oxide, and (Oxy)hydroxide Minerals using Raman and LIBS Spectroscopy. LPSC, The Woodlands, TX.

2024 C. Pilorget, T. Okada, J.-P. Bibring, D. Loizeau, K. Hatakeda, L. Riu, **R. Sheppard**, L. Nardelli†, T. Yada, K. Yogata, M. Nishimura, T. Usui, V. Hamm, A. Moussi-Soffys, M. Abe, A. Aléon-Toppani,

D. Baklouti, R. Brunetto, J. Carter, Y. Enokido, Y. Hitomi, T. Jiang, S. Kawasaki, K. Kumagai, Y. Langevin, C. Lantz, M. Mahlke, A. Miyazaki, K. Nagashima, A. Nakano, A. Nakata, T. Ojima, F. Poulet, K. Sakamoto, R. Tahara, K. Tamanoi. First characterizations of Bennu samples by the NIR hyperspectral microscope MicrOmega at the ISAS Curation Center and comparison with Ryugu samples. Hayabusa2 Symposium, Sagamihara, Japan.

2024 A. L. Roberts†, S. Gupta, A. Cowart, L. Edgar, W. Rapin, W. E. Dietrich, E. S. Kite, S. G. Banham, J. M. Davis, C. A. Mondro, W. Farrand, A. B. Bryk, T. Kubacki, N. Moore, **R. Y. Sheppard**, L. C. Kah, G. Caravaca, A. Fraeman, A. R. Vasavada. What depositional processes and paleoenvironments formed the layered sulphate unit in Gale crater, Mars?: Insights from Marker Band Valley. Geofutures Planetary Geoscience Conference.

2024 W. H. Farrand, B. Horgan, **R. Y. Sheppard**, A. Klidaras, A. Broz. Carbonate detections in the SWIR to MWIR amidst masking phases in stratigraphy clay deposits on Mars. AGU, Washington, D.C.

2024 O. Barraud, J. Carter, M. Vincendon, A. Stcherbinine, **R. Sheppard**. Spectral variability in the south polar region of Mars. EPSC, Berlin, Germany.

2024 W. Rapin, G. Dromart, J. Schieber, B.C. Clark, P. Beck, L. Kah, D. Rubin, S. Gupta, A. Roberts†, G. Caravaca, L. Edgar, **R. Y. Sheppard**, E. Dehouck, S. Le Mouélic, A. Bryk, W.E. Dietrich, P. Gasda, O. Gasnault, N. Lanza. Sulfate-bearing strata sequence extends early Mars environments conducive to prebiotic evolution. The 10th International Conference on Mars, Pasadena, CA.

2024 A. A. Fraeman, R. E. Arvidson, M. N. Hughes, **R. Y. Sheppard**, J. Berger, J. Frydenvang, C. Seeger, A. Eng, M. J. Meyer, E. Rampe, K. M. Stack. Mt. Sharp's clay-sulfate transition: A regional perspective from orbital spectral and geomorphic datasets. The 10th International Conference on Mars, Pasadena, CA.

2024 A. L. Roberts†, S. Gupta, A. Cowart, L. A. Edgar, W. E. Dietrich, W. Rapin, E. Kite, S. G. Banham, J. M. Davis, C. Mondro, B. Farrand, A. B. Bryk, T. Kubacki, N. Moore, G. Caravaca, A. Fraeman, A. Vasavada. **R. Y. Sheppard**. Depositional processes and environments of the Layered Sulfate unit, Gale crater, Mars. The 10th International Conference on Mars, Pasadena, CA.

2024 V. M. Tu, D. F. Blake, E. B. Rampe, **R. Y. Sheppard**. Mineralogy and habitability during the Hesperian age in Gale crater, Mars. The 10th International Conference on Mars, Pasadena, CA.

2024 S. L. Simpson, E. B. Rampe, C. A. Achilles, A. Pandey, T. F. Bristow, D. F. Blake, S. J. Chipera, D. T. Vaniman, R. T. Downs, J. M. Meusburger, D. W. Ming, R. V. Morris, S. M. Morrison, V. M. Tu, M. T. Thorpe, B. Tutolo, A. S. Yen, D. J. Des Marais, G. Downs, J. P. Grotzinger, R. M. Hazen, A. H. Treiman, S. Van Bommel, N. Castle, P. I. Craig, R. Gellert, E. M. Hausrath, T. S. Peretyazhko, L. M. Thompson, J. A. Berger, **R. Y. Sheppard**. The composition and abundance of X-ray amorphous material in smectite and Mg-sulfate-bearing regions in Gale crater, Mars. The 10th International Conference on Mars, Pasadena, CA.

2024 E. Harris†, J. M. Davis, S. Gupta, W. E. Dietrich, S. Banham, A. L. Roberts†, W. Rapin, O. Gasnault, A. Cowart, **R. Sheppard**. The sedimentology and stratigraphy of Texoli Butte: Curiosity's investigation into the Upper Sulfate-bearing Unit of Mt. Sharp, Gale crater, Mars. The 10th International Conference on Mars, Pasadena, CA.

2024 E. B. Hughes, F. Rivera-Hernandez, W. Rapin, J. R. Johnson, P. Gasda, D. Das, E. Sklute, O. Gasnault, N. Lanza, L. C. Kah, B. Tutolo, P.Y. Meslin, E. Dehouck, **R. Y. Sheppard**. Hydrated Na-Mg-sulfate suggests warmer concentrated fluids infiltrated the sulfate unit, Gale crater, Mars. LPSC, The Woodlands, TX.

2024 A. B. Bryk, W. E. Dietrich, C. M. Fedo, G. Caravaca, J. M. Davis, M. P. Lamb, J. A. Grant, R. C. Wiens, O. Gasnault, J. P. Grotzinger, A. R. Vasavada, K. Stack-Morgan, R. E. Arvidson, S. Le Mouélic, V. K. Fox, K. A. Bennett, S. Gupta, R. M. E. Williams, **R. Y. Sheppard**, K. W. Lewis, D. M. Rubin, W. Rapin, A. A. Fraeman, S. Banham, M. N. Hughes, M. Turner, S. W. Purdy, and E. S. Kite. In situ investigation of the Gediz Vallis Ridge: A remnant late-stage debris flow dominated fan deposit in Gale crater. LPSC, The Woodlands, TX.

2024 W. H. Farrand, A. R. Trussell, J. R. Johnson, J. F. Bell, A. Eng, E. B. Rampe, **R. Y. Sheppard**, O. Gasnault. Mastcam multispectral and ChemCam passive reflectance examination of dark-toned rocks from the Stimson to Upper Gediz Valis Ridge in Gale crater, Mars. LPSC, The Woodlands, TX.

2024 E. Harris†, J. Davis, W. E. Dietrich, S. Banham, A. L. Roberts†, **R. Y. Sheppard**. Sedimentology and stratigraphy of the Texoli butte: MSL Curiosity rover analysis of the upper sulphate-bearing unit in Gale crater. UK Planetary Forum Early Careers meeting, London, UK.

2024 N. A. Carman†, E. M. Hausrath, A. Celestian, J. Chavez, N. Hermis, D. E. LaRowe, A. Fraeman, **R. Y. Sheppard**, C. T. Adcock, O. Tschauner, R. Price, L. M. Barge. Understanding the geochemical conditions of simulated hydrothermal vents as analogs to saponite-rich hydrothermal environments on early Earth and Mars. AbSciCon, Providence, RI.

MENTORING EXPERIENCE

◇Undergraduate advisees/stagiaires hosted by Institut d'Astrophysique Spatiale (unfunded):

Name	Period	Outputs
Maëlys Boubet (L2)	2024–2025, 8 weeks	Recherche d'immersion report
Talia Druon (L2)	2024–2025, 8 weeks	Recherche d'immersion report
Dido Chavda (stagiaire)	2024, 1 week	Stage de 3e report
Adèle Barbaroux (stagiaire)	2024, 1 week	Stage de 3e report

◇Undergraduate advisees hosted by Caltech/JPL (funded by Sheppard/Fraeman):

Name	Period	Outputs	Position Afterwards
Jordan Ando	2021, 4 months	LPSC Dwornik Award (2022); Ando, Sheppard, et al. (2025) *JGR: Planets*	PhD student at the University of Hawaii (current)
Henry Manelski	2021, 4 months	Manelski, Sheppard, et al. (2023) *JGR: Planets*	PhD (2026) Purdue University, Postdoc at University of Munich (current)

◇Undergraduate advisees hosted by Brown University (funded by Milliken):

Name	Period	Outputs	Position Afterwards
Sarah Martinez	2018-2019, 3 months	-	-
Christopher Yen	2016-2017, 12 months	LPSC Dwornik Award Hon. Mention (2019)	PhD (2024) WashU, Postdoc University of Lausanne (current)
Ana Colón	2017, 3 months	-	PhD student at the University of Oregon (current)
Grant Rutherford	2017, 3 months	-	PhD student at MIT (current)
Catherine Miranda	2017, 3 months	-	-

◇**2018 Leadership Alliance Summer Program Coordinator**, Brown University.

TEACHING EXPERIENCE

2024 Lecturer, Planetary Surfaces Summer School, lecture "Spectroscopy 101," University of Glasgow. Organizer: Divya Persaud.

2024 Co-Instructor, Summer Course *Climate Change, Economics, and the Wine Industry*, lecture "The Effects of Geology on French Wines," Rice University Global Paris Center, Paris, France. Included three day trips and final projects. Lead instructor: Sylvia Dee, Rice University.

2018 Instructor, STEM II Program Summer Course *Our Solar System Up Close*, Brown University. Included labs and final projects.

2018 Teaching Assistant, *Planetary Geology* (GEOL0810), Brown University. Lead instructor: Ralph Milliken.

2017 Teaching Assistant, STEM II Program Summer Course *Our Solar System Up Close*, Brown University. Included labs and final projects. Lead instructor: Hannah Kaplan.

SERVICE & OUTREACH (LAST 5 YEARS ONLY)

Recent journal referee work: *Nature Geoscience, Journal of Geophysical Research: Planets, Journal of Geophysical Research: Biogeosciences, Icarus, Advances in Space Research, Astrobiology.*

2026 Proposal reviewer, NASA program.

2025 Proposal reviewer, NASA program.

2025 Proposal reviewer, NASA program.

2024 Proposal reviewer, NASA program.

2024 Session Chair, The 10th International Conference on Mars, *"Carbonates and the Jezero Margin Unit."*

2024 Proposal reviewer, Deutsche Forschungsgemeinschaft (DFG).

2023 Proposal reviewer, NASA program.

2023 Panelist, NASA review panel.

2023 Judge, Mission Design Challenge, Womanium Global Astrobiology Program.

2022 Session Convener and Chair, AbSciCon, *"Diagenesis and subsurface habitable environments."*

2021 Proposal reviewer, Graduate Women In Science (GWIS) National Fellowship Program.

2020 Panelist, NASA review panel.

FIELD WORK

2018 Naukluft Mountains, Namibia, 12 days in the field, Agouron Institute Advanced Geobiology Field School, Caltech.

2016 Guadalupe Mountains, TX, 5 days in the field, Brown University.

2013 San Gabriel Mountains, CA, 3 days in the field, Columbia University.

2012 Catskill Mountains, NY, 12 days in the field, Columbia University.

2011 Adirondack Mountains, VT, 2 days in the field, Columbia University.