

# RACHEL Y. SHEPPARD

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## PROFESSIONAL APPOINTMENTS

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<b>Institute d’Astrophysique Spatiale, University of Paris-Saclay</b> <i>Marie Curie Postdoctoral Fellow</i>	June 2023 - present <i>Paris, France</i>
<b>Planetary Science Institute</b> <i>Research Scientist</i>	August 2022 - present <i>Tucson, AZ</i>
<b>Jet Propulsion Laboratory, Caltech</b> <i>Postdoctoral Fellow</i>	August 2020 - September 2022 <i>Pasadena, CA</i>

## EDUCATION

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### **Brown University**, Providence, RI

- ◊ **2020 Ph.D.**, Earth, Environmental & Planetary Sciences  
*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  
*Spectroscopic analysis of iron cycling in a terrestrial ultramafic lake and its implications for martian sedimentary systems.* Advisor: Ralph Milliken

### **Columbia University**, New York, NY

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

## PEER-REVIEWED PUBLICATIONS (†STUDENT)

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- E. M. Martinez<sup>†</sup>, L. E. Rodriguez, **R. Y. Sheppard**, S. Yi<sup>†</sup>, C. Cid, A. Khodayari, L. M. Barge. Nitrate reactivity in iron (oxy)hydroxide systems: Effect of pH, iron redox state, and phosphate. Under review, *Environmental Science & Technology*.
- 2023** H. T. Manelski<sup>†</sup>, **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. In press, *Journal of Geophysical Research: Planets*.
- 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.
- 2022** R. S. Vachula, **R. Y. Sheppard**, A. H. Cheung<sup>†</sup>. Preservation biases are pervasive in Holocene paleofire records. *Palaeogeography, Palaeoclimatology, Palaeoecology*. 602, 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.

**2022** M. Prakash<sup>†</sup>, 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.

**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).

**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.

**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*. 26.

**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.

**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.

**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.

**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.

**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.

## OTHER PUBLICATIONS (TRADE JOURNALS, WHITE PAPERS, ETC.)

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**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

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**2023-2025** Marie Skłodowska-Curie Actions research fellowship, European Commission (MSCA-EF). **PI.** “Spectral diversity within Ryugu.” (\$210,000.)

**2022-2025** ROSES Mars Science Laboratory Participating Scientist Program (MSL-PSP). **PI.** “Understanding Mg-sulfate distribution, hydration state, and crystallinity in Mt. Sharp.” (\$300,000.)

**2022** Spontaneous Research and Technology Development Program, Jet Propulsion Laboratory. **Co-I.** “Novel reaction design to test martian weathering.” (\$40,000.)

**2022** Data Science Working Group, Jet Propulsion Laboratory. **Co-I.** “Developing machine learning models to facilitate the untargeted identification and classification of organics in complex mixtures via tandem mass spectrometry.” (\$50,000.)

**2020-2022** Strategic Research and Technology Development Program, Jet Propulsion Laboratory. **Science PI.** “Experimental constraints on groundwater driven redox gradients on Mars.” (\$300,000.)

## MISSION & LABORATORY INVOLVEMENT

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**Hayabusa2 Team** June 2023 - present  
*Science Team Collaborator*

**Mars Science Laboratory (MSL) Team** May 2016 - present  
*Participating Scientist* 2022-present  
*Science Team Collaborator* 2016-2022

**Origins & Habitability Laboratory, JPL** August 2020 - present  
*Postdoctoral Fellow* Pasadena, CA

**NASA RELAB, Brown University** August 2015 - July 2020  
*Graduate Student* Providence, RI

**Gemological Institute of America** October 2013 - June 2015  
*Research Laboratory, Diamond Color Origin Group* New York, NY

**Lamont-Doherty Earth Observatory, Columbia University** May 2011 - August 2013  
*Research Assistant* Palisades, NY

## AWARDS & FELLOWSHIPS

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**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 5 YEARS ONLY, \*ORAL PRESENTATIONS)

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**2023 R. Y. Sheppard\***, W. Rapin, V. Tu, L. Lim, T. Gabriel, M. Hughes, A. Fraeman, D. Vaniman. Updated orbital perspective of the Mt. Sharp upper sulfates in preparation for in situ exploration. European Geophysical Union, Vienna, Austria. (*Scheduled.*)

**2023 R. Y. Sheppard**, W. Rapin, V. Tu, L. Lim, T. Gabriel, M. Hughes, A. Fraeman, D. Vaniman. Updated orbital perspective of the Mt. Sharp upper sulfates in preparation for in situ exploration. Lunar and Planetary Science Conference, The Woodlands, TX. (*Scheduled.*)

**2022 R. Y. Sheppard**, A. A. Fraeman, L. M. Barge, J. M. Weber, L. Rodriguez, E. Martinez. Laboratory sediment columns to explore habitability of the martian subsurface under different groundwater conditions. AbSciCon, Atlanta, GA.

**2022 R. Y. Sheppard\***, A. A. Fraeman, L. M. Barge, J. M. Weber, L. Rodriguez, E. Martinez. Laboratory sediment column simulations of chemical and redox gradients in the martian groundwater environment. Lunar and Planetary Science Conference, The Woodlands, TX.

**2021 R. Y. Sheppard\***, L. Barge, A. A. Fraeman, J. M. Weber, L. Rodriguez, E. Flores, E. Martinez. Laboratory sediment column simulations of chemical and redox gradients in the martian groundwater environment. American Geophysical Union Fall Meeting, New Orleans, LA.

**2021 R. Y. Sheppard**, R. E. Milliken, J. M. Russell, M. D. Dyar, E. C. Sklute, S. Bijaksana, M. Melles, & H. Vogel. Mineral and chemical changes in a 100 m long sediment core from Lake Towuti, Indonesia and implications for mafic lacustrine sediments in Gale crater, Mars. American Geophysical Union Fall Meeting, New Orleans, LA.

**2021 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. Lunar and Planetary Science Conference, The Woodlands, TX.

**2020 R. Y. Sheppard**, R. E. Milliken, & K. M. Robertson. Reflectance measurements of clays and sulfates under Mars-like temperature and relative humidity cycles and implications for clay-sulfate assemblages in Gale crater. Lunar and Planetary Science Conference, The Woodlands, TX. (*Canceled due to Covid-19.*)

**2020 R. Y. Sheppard**, R. E. Milliken, J. M. Russell, M. D. Dyar, E. C. Sklute, S. Bijaksana, M. Melles, & H. Vogel. Mineral and chemical changes in a 100 m long sediment core from Lake Towuti, Indonesia and implications for mafic lacustrine sediments in Gale crater, Mars. Lunar and Planetary Science Conference, The Woodlands, TX. (*Canceled due to Covid-19.*)

**2019 R. Y. Sheppard\***, R. Milliken, & K. M. Robertson, Cycling of hydrous minerals and implications for the martian hydrological cycle. American Geophysical Union Fall Meeting, San Francisco, CA.

**2019 R. Y. Sheppard**, R. Milliken, Y. Itoh, & M. Parente. Mineral stratigraphy around Mt. Sharp suggests aqueous processes affected the entire mound: directions for upcoming rover observations from orbital data. Ninth International Conference on Mars, Pasadena, CA.

**2019 R. Y. Sheppard**, R. Milliken, Y. Itoh, & M. Parente. Lateral continuity of mineralogical and morphological contacts in Mt. Sharp: linking upcoming rover observations and orbital data. Lunar and Planetary Science Conference, The Woodlands, TX.

**2018 R. Y. Sheppard\***, R. Milliken, Y. Itoh, & M. Parente. Assessing Lateral Variations in the Mineralogical Stratigraphy of Mt. Sharp: Linking Rover and Orbital Observations. American Geophysical Union Fall Meeting, Washington, D.C.

**2018 R. Y. Sheppard\***, R. Milliken, J. Russell, H. Vogel, M. Melles, & S. Bijaksana. Signatures of iron cycling in a terrestrial redox-stratified lake and implications for Gale Crater, Mars. Lunar and Planetary Science Conference, The Woodlands, TX.

## INVITED EXTERNAL TALKS & TEAM MEETINGS

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- 2022 R. Y. Sheppard.** Geoscience Research Colloquium, UNLV, Las Vegas, NV.
- 2022 R. Y. Sheppard.** Planetary Science Institute, Tucson, AZ.
- 2022 R. Y. Sheppard.** Astrobiology & Planetary Science Colloquium, Georgia Tech, Atlanta, GA.
- 2021 R. Y. Sheppard.** Research Colloquium, EAPS, Purdue, West Lafayette, IN.
- 2020 R. Y. Sheppard.** Research Colloquium, GPS, Caltech, Pasadena, CA.
- 2020 R. Y. Sheppard.** Research Colloquium, Jet Propulsion Laboratory, Pasadena, CA. (*Canceled due to Covid-19*)
- 2020 R. Y. Sheppard.** Geochemistry Colloquium, Lamont-Doherty Earth Observatory, Palisades, NY.
- 2019 R. Y. Sheppard.** Mars Science Laboratory team meeting, NASA Goddard, Greenbelt, MD.
- 2018 R. Y. Sheppard.** Towuti Drilling Project team meeting, Makassar, Indonesia.
- 2017 R. Y. Sheppard.** Towuti Drilling Project team meeting, Bandung, Indonesia.
- 2016 R. Y. Sheppard.** NASA Astrobiology Institute (NAI) team meeting, Williamstown, MA.

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**PRESENTATIONS: CONTRIBUTING AUTHOR (LAST 5 YEARS ONLY, †STUDENT)**

- 2023** T. C. Marlin<sup>†</sup>, J. M. Weber, **R. Y. Sheppard**, S. M. Perl, L. M. Barge. Chemical gardens as analogs for prebiotic chemistry on ocean worlds. European Astrobiology Network Association Conference, Madrid, Spain.
- 2023** W. Rapin, G. Dromart, J. Schieber, B.C. Clark, L. Kah, D. Rubin, S. Gupta, A. Roberts, G. Caravaca, **R. Y. Sheppard**, E. Dehouck, S. Le Mouelic, A. Bryk, B. Dietrich, P. Gasda, J. Frydenvang, O. Gasnault, N. Lanza. An aridification sequence in the clay-sulfate transition at Gale crater. LPSC, The Woodlands, TX.
- 2023** C. M. Weitz, K. M. Lewis, E. S. Kite, W. E. Dietrich, L. M. Thompson, C. D. O’Connell-Cooper, J. Schrieber, D. Rubin, P. Gasda, C. Mondro, W. Rapin, S. Gupta, A. Roberts, J. Frydenvang, J. Berger, H. Newsom, A. Bryk, M. P. Lamb, J. Grotzinger, W. W. Fischer, A. Cowart, J. Davis, J. Grant, A. Yingst, W. Farrand, T. Parker, A. Vasavada, A. Fraeman, R. Milliken, **R. Sheppard**, D. Ming, S. Simpson, E. Rampe, D. Fey, R. Arvidson. The marker band in Gale crater: A synthesis of orbital and ground observations. LPSC, The Woodlands, TX.
- 2023** A. A. Fraeman, R. E. Arvidson, K. M. Stack, J. Christian, **R. Y. Sheppard**. Mt. Sharp’s clay-sulfate transition: a regional perspective from orbital spectral and geomorphic datasets. LPSC, The Woodlands, TX.
- 2023** H. T. Manelski, **R. Y. Sheppard**, A. A. Fraeman, R. C. Wiens, J. R. Johnson, E. B. Rampe, J. Frydenvang, N. L. Lanza, O. Gasnault. Variability in Mt. Sharp group bedrock as seen by ChemCam passive and active spectra. LPSC, The Woodlands, TX.
- 2023** R. S. Vachula, **R. Y. Sheppard**, A. H. Cheung. Preservation biases affect charcoal-based paleofire interpretations. INQUA, Rome, Italy.
- 2022** R. S. Vachula, **R. Y. Sheppard**, A. H. Cheung. Preservation biases affect charcoal-based paleofire interpretations. GSA Annual Meeting, Denver, CO.
- 2022** W. Rapin, **R. Y. Sheppard**, G. Dromart, J. Schieber, B. C. Clark, L. Kah, D. Rubin, B. L. Ehlmann, S. Gupta, G. Caravaca, N. Mangold, E. Dehouck, S. Le Mouelic, O. Gasnault, J. V. Clark, A. Bryk, B. Dietrich, R. C. Wiens. The Curiosity rover investigates an aridification sequence in the layered sulfate-bearing unit. Europlanet Science Conference, Granada, Spain.

- 2022** J. M. Weber, L. E. Rodriguez, **R. Y. Sheppard**, E. Martinez<sup>†</sup>, L. M. Barge. Understanding habitability and prebiotic chemistry with continuous-flow terrestrial analogs. *Invited*. AbSciCon, Atlanta, GA.
- 2022** T. C. Marlin<sup>†</sup>, J. M. Weber, **R. Y. Sheppard**, S. M. Perl, L. M. Barge. Chemical gardens as analogs for prebiotic chemistry on ocean worlds. AbSciCon, Atlanta, GA.
- 2022** D. Valadez<sup>†</sup>, E. Flores<sup>†</sup>, E. Martinez<sup>†</sup>, **R. Y. Sheppard**, R. P. Hodyss, J. M. Weber, J. Castillo<sup>†</sup>, B. Henderson, L. M. Barge. Sorption of prebiotic organics on iron sulfide minerals in ocean world analog systems. AbSciCon, Atlanta, GA.
- 2022** E. Martinez<sup>†</sup>, E. Flores<sup>†</sup>, D. Valadez<sup>†</sup>, J. M. Weber, T. C. Marlin<sup>†</sup>, **R. Y. Sheppard**, L. M. Barge. Organic acid adsorption onto iron (oxy)hydroxides under ocean world analog conditions. AbSciCon, Atlanta, GA.
- 2022** J. M. Weber, E. Martinez<sup>†</sup>, **R. Y. Sheppard**, L. E. Rodriguez, L. M. Barge. Mars weathering experiments: development and use of continuous-flow packed bed for geologic exploration. LPSC, The Woodlands, TX.
- 2022** H. T. Manelski<sup>†</sup>, **R. Y. Sheppard**, A. A. Fraeman, J. R. Johnson, R. Wiens, N. Lanza, J. Frydenvang. Classification of ChemCam passive spectral targets in Gale crater. LPSC, The Woodlands, TX.
- 2022** J. K. Ando<sup>†</sup>, **R. Y. Sheppard**, A. A. Fraeman, V. Sun. Locations and multispectral features of distinct classes of diagenetic features within the Murray formation, Gale crater, Mars. LPSC, The Woodlands, TX. (*Received the LPSC Dwornik Award.*)
- 2022** W. Rapin, **R. Y. Sheppard**, G. Dromart, J. Schieber, B. Clark, L. Kah, D. Rubin, B. L. Ehlmann, S. Gupta, G. Caravaca, N. Mangold, E. Dehouck, S. Le Mouelic, O. Gasnault, J. V. Clark, A. Bryk, B. Dietrich, R. C. Wiens. The Curiosity rover is exploring a key sulfate-bearing orbital facies. LPSC, The Woodlands, TX.
- 2022** E. Martinez<sup>†</sup>, E. Flores<sup>†</sup>, T. C. Marlin<sup>†</sup>, D. Valadez<sup>†</sup>, J. M. Weber, **R. Y. Sheppard**, R. P. Hodyss, L. M. Barge. Organic acid adsorption on iron (oxy)hydroxides under ocean world analog conditions. Origins of Life Gordon Research Conference, Oxnard, CA. (*Cancelled due to Covid-19*)
- 2021** T. F. Bristow, E. B. Rampe, **R. Sheppard**, R. Milliken. In situ mineralogy of a clay-sulfate transition in Gale crater. AGU Fall Meeting, New Orleans, LA.
- 2021** A. A. Fraeman, M. Hughes, C. Seeger, J. Ando<sup>†</sup>, S. Jacob, J. Johnson, **R. Sheppard**, R. Arvidson, M. Rice, J. Bell. Spectral properties of diagenetic features near the clay-sulfate transition in Mt. Sharp. AGU Fall Meeting, New Orleans, LA.
- 2021** S. N. Lamm<sup>†</sup>, L. E. Rodriguez, **R. Y. Sheppard**, S. M. Perl, A. J. Celestian, L. M. Barge. Classification of iron (oxy)hydroxides and sulfides using mission-ready spectroscopic techniques and machine learning. GSA Annual Meeting, Portland, OR.
- 2020** R. E. Milliken, J. P. Grotzinger, **R. Sheppard**, R. Wiens, R. Gellert, L. M. Thompson, A. Vasavada, T. Bristow, & N. Mangold. The chemistry and mineralogy of an ancient lacustrine sequence on Mars: observations, interpretations, and future prospects. LPSC, The Woodlands, TX. (*Cancelled due to Covid-19*)
- 2019** R. E. Milliken, J. P. Grotzinger, R. Wiens, R. Gellert, L. M. Thompson, **R. Sheppard**, A. Vasavada, T. Bristow, & N. Mangold. The chemistry and mineralogy of an ancient lacustrine sequence on Mars: lessons learned from integrating rover and orbiter datasets. Ninth International Conference on Mars, Pasadena, CA.

## MENTORING EXPERIENCE

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### **2021 Undergraduate advisees hosted by Caltech/JPL:**

- ◇ Jordan Ando – *LPSC Dwornik Award 2022. Now a PhD student at the University of Hawaii*
- ◇ Henry Manelski – *now a PhD student at Purdue*

### **2016-2020 Undergraduate advisees hosted by Brown University:**

- ◇ Ana Colón – *now a PhD student at the University of Oregon*
- ◇ Christopher Yen – *LPSC Dwornik Award Honorable Mention 2019. Now a PhD student at WashU*
- ◇ Grant Rutherford – *now a PhD student at MIT*
- ◇ Catherine Miranda
- ◇ Sarah Martinez

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

## SERVICE & OUTREACH

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

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

**2021 Reviewer**, Graduate Women In Science (GWIS) National Fellowship Program.

**2020 Panelist**, NASA review panel.

**2019 Session Convener and Chair**, American Geophysical Union Fall Meeting, “*Evidence of water-rock interaction throughout the Solar System,*” oral and poster session.

**2019 Executive Secretary**, NASA review panel.

**2019 Workshop Leader**, Girl Scout Senior Leadership Conference, Salve Regina University. “*Craters, spacecraft, and the surfaces of our Solar System.*”

**2019-2023 Participant**, semiannual Skype a Scientist outreach program for K-12 students and incarcerated adults across the world.

**2018-2020 GeoW+ Co-Founder, Graduate Student Leader**, Brown University DEEPS. Inter-sectional mentoring group for geoscience undergraduates.

**2018-2020 Diversity & Inclusion Action Committee**, Brown University DEEPS. Committee consisted of faculty, staff, and graduate students. *Invited by Department Chair.*

**2018-2020 Faculty Representative**, Brown University DEEPS. Liaison between faculty and graduate students, invited attendee to faculty meetings. *Elected.*

**2018-2019 Planetary Climate Task Force**, Brown University DEEPS. Task force consisted of faculty, staff, and graduate students. *Elected.*

## FIELD WORK & SHORT COURSES

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**2021** Revolutionizing Access to the Martian Surface, **Keck Institute for Space Studies**, Caltech (10 day workshop, invited).

**2018** Agouon Institute Advanced Geobiology Field School, Caltech, **Naukluft Mountains, Namibia** (12 days in the field, invited).

**2016** Sedimentary Cycle of Earth and Mars field intensive, Brown University, **Guadalupe Mountains, TX** (5 days in the field).

**2016** Reflective Teaching, Harriet W. Sheridan Center, Brown University (12 week course).

**2013** Research sample collection from the Punchbowl Fault, **San Gabriel Mountains, CA** (3 days in the field).

**2012** Geologic Mapping intensive, Columbia University, **Catskill Mountains, NY** (12 days in the field).

**2011** Research sample collection from the Champlain Thrust Fault, **Adirondack Mountains, VT** (2 days in the field).