

Curriculum Vitae

Jesse D. Tarnas

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Professional Experience

NASA Postdoctoral Fellow, NASA Jet Propulsion Laboratory, November 2020-present
Advisor: Kathryn Stack Morgan, *JPL Research Scientist and Mars 2020 Rover Mission Deputy Project Scientist*

Member: Mars 2020 Rover Mission Science Team, November 2020-present

Academic History

Ph.D. '21, Brown University Department of Earth, Environmental and Planetary Sciences

Sc.M. '18, Brown University Department of Earth, Environmental and Planetary Sciences

B.A. '16, Wesleyan University Department of Physics

B.A. with honors '16, Wesleyan University Department of Astronomy

ORCID: 0000-0002-6256-0826

Advisor:

- John Mustard
Professor of Earth, Environmental, and Planetary Sciences and Professor of Environment and Society
Earth, Environmental, and Planetary Science

Dissertation Committee Members:

- Yan Liang
Professor of Earth, Environmental, and Planetary Sciences
Earth, Environmental, and Planetary Science
- Ralph Milliken
Associate Professor of Earth, Environment, and Planetary Sciences
Earth, Environmental, and Planetary Science
- Stephen Parman
Associate Professor of Earth, Environmental, and Planetary Sciences
Earth, Environmental, and Planetary Science

Dissertation Outside Reader:

- Victoria Orphan

James Irvine Professor of Environmental Science and Geobiology; Alan V.C. Davis and Lenabelle Davis Leadership Chair, Center for Environmental Microbial Interactions; Director, Center for Environmental Microbial Interactions
California Institute of Technology, Division of Geological and Planetary Sciences

Publications

Origins of carbonate-bearing rocks in Jezero crater: Implications for ancient habitability in subsurface environments, **J.D. Tarnas**, K.M. Stack, M. Parente, J.F. Mustard, A.H.D. Koepfel, K.R. Moore, B.H.N. Horgan, F.P. Seelos, E.A. Cloutis, P.B. Kelemen, D. Flannery, A.J. Brown, K.R. Frizzell, P. Pinet, *Submitted*.

Imaging Mars Analog Minerals' Reflective Spectra and Testing Mineral Detection Algorithms with Hyperspectral Data, X. Wu, J.F. Mustard, **J.D. Tarnas**, X. Zhang, E. Das, Y. Liu, *Submitted*.

Crustal Groundwater Volumes Greater than Previously Thought, G. Ferguson, J.C. McIntosh, O. Warr, B. Sherwood Lollar, C.J. Ballentine, J.S. Famiglietti, J.-H. Kim, J.R. Michalski, J.F. Mustard, **J.D. Tarnas**, J.J. McDonnell, *Submitted*.

Stratigraphic Relationships in Jezero Crater, Mars –Constraints on the Timing of Fluvial-Lacustrine Activity from Orbital Observations, S. Holm-Alwmark, K.M. Kinch, M.D. Hansen, S. Shahrzad, K. Svennevig, W.J. Abbey, R.B. Anderson, F.J. Calef III, S. Gupta, E. Hauber, B.H.N. Horgan, L.C. Kah, J. Knade, N.B. Miklusick, K.M. Stack, V.Z. Sun, **J.D. Tarnas**, and C. Quantin-Nataf, *Submitted*.

Earth-like habitable environments in the subsurface of Mars, **J.D. Tarnas**, J.F. Mustard, B. Sherwood Lollar, V. Stamenković, K.M. Cannon, J.-P. Lorand, T.C. Onstott, J.R. Michalski, O. Warr, A.M. Palumbo, A.-C. Plesa, *Astrobiology* (2021), 21, 7.

Successes and challenges of factor analysis target transformation applications to visible-to-near-infrared hyperspectral data, **J.D. Tarnas**, J.F. Mustard, X. Wu, E. Das, K.M. Cannon, C.B. Hundal, A.C. Pascuzzo, J.R. Kellner, M. Parente, *Icarus* (2021), 114402.

Joint Hapke Model and Spatial Adaptive Sparse Representation with Iterative Background Purification for Martian Serpentine Detection, X. Wu, X. Zhang, J.F. Mustard, **J.D. Tarnas**, H. Lin, Y. Liu, *Remote Sensing* (2021), 13(3), 500.

Bridge to the stars: A mission concept to an interstellar object, K. Moore, S. Courville,...**J.D. Tarnas**,..., C., Budney, *Planetary and Space Science* (2021), 105137.

Dynamic Aperture Factor Analysis/Target Transformation (DAFA/TT) for serpentine and Mg-carbonate mapping on Mars with CRISM near-infrared data, Honglei Lin, **J. D. Tarnas**, J. F. Mustard, Xia Zhang, Yong Wei, Weixing Wan, F. Klein, and J.R. Kellner, *Icarus* (2021), 114168.

Mars Extant Life: What's Next? Conference Report, B.L. Carrier, D.W. Beaty, M.A. Meyer, ...**J.D. Tarnas**, ..., J. Xu, *Astrobiology* (2020), 20, 6.

Abiotic Sources of Molecular Hydrogen on Earth, F. Klein, **J.D. Tarnas**, W. Bach, *Elements* (2020), 16, 19-24.

Orbital identification of hydrated silica in Jezero crater, Mars, **J.D. Tarnas**, J.F. Mustard, H. Lin, T.A. Goudge., E.S. Amador-French, M.S. Bramble, C.H. Kremer, X. Zhang, Y. Itoh, M. Parente, *Geophysical Research Letters* (2019), 46, 22.

Scientific Exploration of Mare Imbrium with OrbitBeyond, Inc.: Characterizing the Regional Volcanic History of the Moon, A.M. Palumbo, A.N. Deutsch, M.S. Bramble, **J.D. Tarnas**, ..., V. Vatsal, *New Space* (2019), 7, 3.

The next frontier for planetary and human exploration, V. Stamenković, L. W. Beegle, K. Zacny, ..., **J. D. Tarnas**, ..., R. Woolley, *Nature Astronomy* (2019), 3, 116-120.

Radiolytic H₂ production on Noachian Mars: Implications for habitability and atmospheric warming, **Tarnas, J. D.**; Mustard, J. F.; Sherwood Lollar, B.; Bramble, M. S.; Cannon, K. M.; Palumbo, A. M.; Plesa, A.-C., *Earth and Planetary Science Letters* (2018), 502, 133-145.

Universal heating curve of damped Coulomb plasmas in a Paul trap, **Tarnas, J. D.**; Nam, Y. S.; Blümel, R., *Physical Review A* (2013), 88, 041401(R).

Publications in Preparation

Quantification of abiotic and microbial methane production rates in the Precambrian crust, **J.D. Tarnas**, J.F. Mustard, B. Sherwood Lollar, V. Stamenkovic, O. Warr, In Preparation.

Guided Endmember Extraction (GEEEn), a new method for analyzing visible-to-near-infrared spectral data, **J.D. Tarnas**, J.F. Mustard, C.B. Hundal, E. Das, A.C. Pascuzzo, M. Parente, In Preparation.

Diverse deltaic clays in Jezero crater, M. Parente, **J.D. Tarnas**, ..., In Preparation.

Astrobiology Primer 3.0, M.J. Schaible, ...**J.D. Tarnas**, ..., In Preparation.

Planetary Science and Astrobiology Decadal Survey Papers

Deep Trek: Science of Subsurface Habitability and Life on Mars, A Window into Subsurface Life in the Solar System, Lead Team: Vlada Stamenkovic, Kennda Lynch, Penelope Boston, **Jesse Tarnas**, Co-authors: Charles Edwards, Barbara Sherwood Lollar, ..., Ryan Timoney.

Deep Trek: Mission Concepts for Exploring Subsurface Habitability and Life on Mars, A Window into Subsurface Life in the Solar System, Lead: Charles Edwards, Co-authors: Vlada Stamenkovic, Penelope Boston, Kennda Lynch, **Jesse Tarnas**, Barbara Sherwood Lollar, ..., Ryan Timoney.

The evolution of habitable environments on terrestrial planets: Insights and knowledge gaps from studying the geologic record of Mars, Lead: Briony Horgan, Co-authors: Janice Bishop, ..., **Jesse Tarnas**, ..., Christina Viviano.

Conferences and Presentations

Convened Conference Sessions

Co-convenor, New Mars Underground (and Beyond) 3.0: AGU Fall Meeting (2020). Primary convenor: Rachel Harris, co-convenor: Ana-Catalina Plesa.

Chaired Conference Sessions

Astrobiology I: Looking for Life on Mars, Microbial Impact of Human Exploration, Curation and Contamination Measurements. 49th Lunar and Planetary Science Conference (2018). Co-chair: Amy Williams.

Invited Colloquia and Talks

11/25/2020, Hawaii Institute of Geophysics and Planetology, University of Hawaii at Manoa.

Conference Papers and Presentations

Subsurface water-rock-gas interactions, habitability, and planetary evolution, 2020 Conference of the National Society of Black Physicists, NOV 2020, **Tarnas, J.**

Abiotic CH₄ Production in the Subsurface of Terrestrial Planets, Goldschmidt 2020, JUN 2020, Presented, **Tarnas, J.**; Mustard, J.; Sherwood Lollar, B.; Stamenkovic, V.; Warr, O.

Constraining the origin of hydrated silica in Jezero crater and its accessibility by NASA's Mars 2020 rover, 51st Lunar and Planetary Science Conference, MAR 2020, Meeting cancelled, **Tarnas, J.D.**; Mustard, J.F.; Parente, M.; Seelos, F.P.; Itoh, Y.; Saranathan, A.M.

Abiotic H₂, CH₄, and SO₄ production on Earth and Mars: atmospheric warming agents and redox energy sources for ancient and modern subsurface martian life, 51st Lunar and Planetary Science Conference, MAR 2020, Meeting cancelled, **Tarnas, J.D.**; Mustard, J.F.; Sherwood Lollar, B.; Stamenkovic, V.; Warr, O.; Cannon, K.M.; Palumbo, A.M.; Plesa, A.-C.

Bridge to the stars: a mission concept to an interstellar object, 51st Lunar and Planetary Science Conference, MAR 2020, Meeting cancelled, Moore, K.; ...; **Tarnas, J.**; ... Mitchell, K.

Mars' subsurface environment: where to search for groundwater? , 51st Lunar and Planetary Science Conference, MAR 2020, Meeting cancelled, Plesa, A.-C.; Stamenkovic, V.; Breuer, D.; Hauber, E.; **Tarnas, J.D.**; Mustard, J.F.; Mischna, M.; and the TH₂OR and VALKYRIE Teams

Hyperspectral target detection and application to low abundance serpentine mapping, 51st Lunar and Planetary Science Conference, MAR 2020, Meeting cancelled, Wu, X.; Mustard, J.F.; Zhang, X.; **Tarnas, J.D.**

Laboratory testing of mineral detection algorithms for minerals at low abundance using visible-infrared hyperspectral data, 51st Lunar and Planetary Science Conference, MAR 2020, Meeting cancelled, Das, E.; **Tarnas, J.D.**; Mustard, J.F.; Wu, X.

Laboratory testing of mineral detection and abundance algorithms: factor analysis detection and nonlinear mixture modeling, 51st Lunar and Planetary Science Conference, MAR 2020, Meeting cancelled, Mustard, J.F.; **Tarnas, J.D.**; Wu, X.; Das, E.; Parente, M.

“Mars Extant Life: What’s Next?” conference report, 51st Lunar and Planetary Science Conference, MAR 2020, Meeting cancelled, Carrier, B.L.;... **Tarnas, J.D.**; Webster, K.D.

Abiotic CH₄ flux from the Precambrian Shield on Earth and during the Noachian Hesperian and Amazonian periods on Mars, 2019 AGU Fall Meeting, San Francisco, CA, DEC 2019, Presented, **Tarnas, J.D.**; Mustard, J.F.; Sherwood Lollar, B. Warr, O.; Cannon, K.M.; Palumbo, A.M., Plesa-A.C.

Water-rock Alteration and Geochemical Conditions in the Hawai’i Scientific Drilling Program Core: Implications for Understanding the 3-D architecture of Volcanic Subsurface, 2019 AGU Fall Meeting, San Francisco, CA, DEC 2019, Presented, Mustard, J.F.; **Tarnas, J.D.**; Wu, X.

Deep groundwaters on Earth as analogs for modern martian habitat, Mars Extant Life: What’s Next?, Carlsbad, NM, NOV 2019, Presented, **Tarnas, J.D.**; Mustard, J.F.; Sherwood Lollar, B.; Warr, O.; Palumbo, A.M.; Plesa, A.-C

A Sparsity Divergence Constrained Factor Analysis and Target Transformation Method and Application to Hydrous Minerals Detection of Hyperspectral Imagery, 2019 AGU Fall Meeting, San Francisco, CA, SEP 2019, Presented, Wu, X.; **Tarnas, J.D.**; Zhang, X.; Mustard, J.F.

Mars could have been warmed by eccentricity variations or a subsurface biosphere, Ninth International Mars Conference, Pasadena, CA, JUL 2019, Presented, **Tarnas, J.D.**; Mustard, J.F.; Sherwood Lollar, B.; Cannon, K.M.; Palumbo, A.M.; Plesa, A.-C.

Mineral detections over Jezero crater using advanced data processing techniques for CRISM data—the CRISM “Fandango”, Ninth International Conference on Mars, Pasadena, CA, JUL 2019, Presented, Parente, M.; Arvidson, R.; Itoh, Y.; Lin, H.; Mustard, J.F.; Saranathan, A.M.; Seelos, F.P.; **Tarnas, J.D.**

A geologic record of the first billion years of Mars history at the Mars 2020 landing site, Ninth International Conference on Mars, Pasadena, CA, JUL 2019, Presented, Mustard, J.F.; Bramble; M.S., Kremer, C.H.; **Tarnas, J.D.**; Pascuzzo, A.; Head, J.W.

Is Abiotic Methane Production Sufficient for Warming Noachian and Hesperian Mars?, 2019 Astrobiology Science Conference, Bellevue, WA, JUN 2019, Presented, **Tarnas, J.D.**; Mustard, J.F.; Sherwood Lollar, B.; Cannon, K.M.; Palumbo, A.M.; Plesa, A.-C.

An insufficient methane budget for warming Noachian and Hesperian Mars, 50th Lunar and Planetary Science Conference, Woodlands, TX, MAR 2019, Presented, **Tarnas, J.D.**; Mustard, J. F., Sherwood Lollar, B.; Cannon, K. M.; Palumbo, A. M., Plesa, A.-C.; Bramble, M.S.

Convergence on Mineral Detections over Gale Crater, NE Syrtis and Jezero Crater using Advanced Data Processing Techniques for CRISM Hyperspectral Imaging Data, 50th Lunar and Planetary Science Conference, Woodlands, TX, MAR 2019, Presented, Parente M., Arvidson, R.E., Itoh, Y., Lin, H., Mustard, J.F., Saranathan, A.M., Seelos, F.P., **Tarnas, J.D.**

Hydrated silica in the Jezero deltas, 50th Lunar and Planetary Science Conference, Woodlands, TX, MAR 2019, Presented, **Tarnas, J.D.**; Mustard, J.F.; Lin, H.; Goudge, T.A.; Amador, E.S.; Bramble, M.S.; Zhang, X.

Laboratory Testing of the Factor Analysis-Target Transformation Method for Mineral Detection at Low Abundance from Visible-Infrared Hyperspectral Data, 50th Lunar and Planetary Science Conference, Woodlands, TX, MAR 2019, Presented, Mustard, J.F.; **Tarnas, J.D.**; Parente, M.

Scientific Exploration of Mare Imbrium with OrbitBeyond Inc.: Characterizing the Regional Volcanic History of the Moon, 50th Lunar and Planetary Science Conference, Woodlands, TX, MAR 2019, Presented, Tokle, L.; Palumbo, A.; Deutsch... **Tarnas, J.**; ... Vatsal, V

VNIR Characterization of the Martian North Polar Ice Cap 2): Constraining the Surface Compositions, 50th Lunar and Planetary Science Conference, Woodlands, TX, MAR 2019, Presented, Pascuzzo, A.C.; **Tarnas, J.D.**; Mustard, J.F.; Lin, H.

H₂ and CH₄ Production, Storage, and Release over ~4.5 Gyr of Martian History: Implications for Atmospheric Warming, Habitability, and ISRU, American Geophysical Union Fall Meeting, Washington, D.C., DEC 2018, Presented, **Tarnas, J.D.**; Mustard, J. F., Sherwood Lollar, B.; Bramble, M.S.; Cannon, K. M.; Palumbo, A. M., Plesa, A.-C.

Production of H₂ on Mars Through Radiolysis and Implications for Habitability, Goldschmidt 2018, Boston, MA, AUG 2018, Presented, **Tarnas, J. D.**; Mustard, J. F., Sherwood Lollar, B.; Bramble, M.S.; Cannon, K. M.; Palumbo, A. M., Plesa, A.-C.

Target Transformation Constrained Sparse Unmixing (TTCSU) Algorithm for Retrieving Hydrous Minerals on Mars: Application to Southwest Melas Chasma, International Archives of the Photogrammetry, Remote Sensing & Spatial Information Sciences; ISPRS TC III Mid-term Symposium "Developments, Technologies and Applications in Remote Sensing", Beijing, China, MAY 2018, Presented, Lin, H.; Zhang, X.; Wu, X.; **Tarnas, J.D.**; Mustard, J.F.

Characterization of serpentine and carbonate in Mars 2020 landing site candidates using Integrated Dynamic Aperture Target Transformation and Sparse Unmixing (IDATTSU), 49th Lunar and Planetary Science Conference, Woodlands, TX, MAR 2018, Under Review, **Tarnas, J.D.**; Lin, H.; Mustard, J.F.; Zhang, X.

Dynamic Aperture Target Transformation (DATT): A Novel and Valuable Method for Mineral Detection on Mars, 49th Lunar and Planetary Science Conference, Woodlands, TX, MAR 2018, Presented, Lin, L.H.; **Tarnas, J.D.**; Mustard, J.F.; Zhang, X.; Wu, X.

Hydrated silicates and carbonates mapping in candidate Mars 2020 rover landing sites with integration of Dynamic Aperture Target Transformation and Sparse Unmixing (IDATTSU), 49th Lunar and Planetary Science Conference, Woodlands, TX, MAR 2018, Presented, Zhang, X.; Lin, H.; Mustard, J.F.; **Tarnas, J.D.**

Radiolytic H₂ Production, Transport, and Dissolution on Noachian Mars, 49th Lunar and Planetary Science Conference, Woodlands, TX, MAR 2018, Presented, **Tarnas, J.D.**; Mustard, J.F.; Sherwood Lollar, B.; Bramble M.S.; Cannon, K.M.; Palumbo, A.M.; Plesa, A.-C.

Radiolytic H₂ Production on Noachian Mars: Implications for Subsurface Habitability, 4th International Conference on Early Mars, Flagstaff, AZ, OCT 2017, Presented, **Tarnas, J. D.**; Mustard, J. F., Sherwood Lollar, B.; Bramble, M.S.; Cannon, K. M.; Palumbo, A. M.

Radiolytic Hydrogen Production on Noachian Mars, 2017 Astrobiology Science Conference, Mesa, AZ, APR 2017, Presented, Tarnas, J. D.; Mustard, J. F.; Sherwood Lollar, B.; Bramble, M. S.

Hydrogen production from the upper 15 km of martian crust via serpentinization: implications for habitability, 48th Lunar and Planetary Science Conference, Woodlands, TX, MAR 2017, Presented, Mustard, J. F.; **Tarnas, J. D.**

Radiolytic Hydrogen Production on Noachian Mars, 48th Lunar and Planetary Science Conference, Woodlands, TX, MAR 2017, Presented, **Tarnas, J. D.**; Mustard, J. F.; Sherwood Lollar, B.; Bramble, M. S.

HOMER: A smallsat ground penetrating radar sounding fleet to map planetary surfaces at high resolution, 47th LPSC, Woodlands, TX, MAR 2016, Presented, Persaud, D.; Wu, T.; **Tarnas, J.**; Preudhomme, M.; Jurg, M.; Chalumeau, C.; Buckley, H.; Lombard- Poirot, N

Transit, Secondary Eclipse, and Phase Curve Modeling to Characterize Kepler Exoplanet Candidates, 227th Meeting of the American Astronomical Society, Kissimmee, FL, JAN 2016, Presented, **Tarnas, J.**, Redfield, S.

Subsurface Feature Mapping of Mars using a High Resolution Ground Penetrating Radar System, 2015 AGU Fall Meeting, San Francisco, CA, DEC 2015, Presented, Wu, T.; Persaud, D.; Preudhomme, M.; Jurg, M.; Smith, M.K.; Buckley, H.; **Tarnas, J.**; Chalumeau, C.; Poirot-Lombard, N.; Mann, B.

Determination of the amount of peroxy in granite rock using the Seebeck Effect, 2015 AGU Fall Meeting, San Francisco, CA, DEC 2015, Presented, Tregloan-Reed, J.; **Tarnas, J.**, Plante, Z.; Freund, F.

Workshop Papers or Presentations

Canadian Institute for Advanced Research (CIFAR) Launch Pad meeting on abiotic CH₄ production. Meeting Leads: Oliver Warr and **Jesse Tarnas**.

CRISM “Fandango” Progress Report: Validated Derived Products for the Perseverance Jezero Mapping Team, Perseverance Science Team Meeting, Virtual, MAR 2020, Presented, Arvidson, R.; Seelos, F.; Parente, M.; **Tarnas, J.**; Christian, J.; Itoh, Y.; Mustard, J.; O’Sullivan, J.; Pollite, D.; Saranathan, A.; Frizzell, K.

Dynamic Aperture Factor Analysis/Target Transformation (DAFA/TT) application to CRISM data, APL CRISM Mapping Meeting, Laurel, MD, JAN 2019, Presented, **Tarnas, J.D.**; Lin, H.; Mustard, J.F.; Zhang, X.

Dynamic Aperture Factor Analysis/Target Transformation (DAFA/TT) analysis of CRISM data, CRISM virtual meeting, Providence, RI, SEP 2018, Presented, **Tarnas, J.D.**; Lin, H.; Mustard, J.F.; Zhang, X.;

Fellowships and Awards

External Honors and Awards

- NASA Postdoctoral Fellowship, 10/2020
- RI Space Grant Travel Grant, NASA RI Space Grant, 1800, 04/30/2019
- Mars Student Travel Grant for 4th Landing Site Workshop for the Mars 2020 Rover Mission, Mars Exploration Program at NASA Headquarters, 1000, 09/19/2018
- SSERVI SEED Grant for 2017 Sudbury Field Camp, SSERVI, 1273, 08/22/2017

Brown University Honors and Awards

- Brown University Dissertation Fellowship, 07/22/2020
- Research Matters Semi-Finalist 2020. Finalist selection postponed.
- Brown University Doctoral Research Grant, Brown University, \$1800, 05/08/2019, 05/08/2019
- Brown University Graduate Conference Travel Grant, Brown University, \$650, 11/16/2018, 11/16/2018
- Brown University Graduate Conference Travel Grant, Brown University, \$650, 04/22/2017, 04/28/2017
- Sigma Xi, member 2019-present

Teaching and Mentoring

Teaching

<i>Appointment Type</i>	<i>Instructor</i>	<i>Term</i>	<i>Course</i>	<i>Section</i>	<i>Title</i>	<i>Enrollment</i>	<i>Supervised</i>
<i>Teaching Assistant</i>	Fischer, Karen Tullis, Jan	Fall 2018	GEOL 0220	S01	Physical Processes in Geology	47	47
<i>Teaching Assistant</i>	Milliken, Ralph	Spring 2017	GEOL 0810	S01	Planetary Geology	76	76

Mentoring

Undergraduate, Eashan Das

Undergraduate, Asutosh Swain

Secondary, Jhariel Estrella

Secondary, Aniketh Swain

Professional Development

- Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) “Fandango” Advanced Data Analysis Working Group, 11/2018-08/2020. I was the lead participant from Brown University in the CRISM “Fandango” group, a team composed of members from Brown University, Washington University in St. Louis, Johns Hopkins University Applied Physics Lab, University of Massachusetts at Amherst, Planetary Science Institute, and other institutions. We tested advanced methods for processing and analyzing CRISM hyperspectral data by determining if these different approaches can reach consensus regarding spectral signals and compositional interpretations from those signals. We developed hyperspectral image and mineral map products, validated by the teams within this group, for delivery to the Perseverance rover Science Team and Mapping Team.
- JPL Planetary Science Summer Seminar, Pasadena, CA, 05/20/2019, 08/09/2019, In this NASA-sponsored program that takes place via 11 weeks of webinars, culminating in a week at NASA's Jet Propulsion Laboratory (JPL), we were taken through the entire process of designing a robotic space mission. This included working one-on-one with

JPL's A-Team (space mission architecture team) and Team-X (space mission design team) and presenting the mission design to a panel of NASA scientists, engineers, and administrators. Many successful NASA mission leaders have gone through this program. We designed a mission to intercept an interstellar object passing through the Solar System.

- NASA Volcanology Workshop, Big Island, HI, 07/11/2019, 07/17/2019, NASA-sponsored, fully funded workshop to study volcanism on the Big Island of Hawaii. It is designed to allow planetary scientists to develop a better understanding of field volcanology on Earth, which improves our interpretive capabilities regarding volcanic processes on other planets, observed in images and other forms of remote sensing data.
- Short Course and Field School at Sudbury Impact Structure, Sudbury, Ontario, 09/23/2017, 09/30/2017, I received funding from NASA's Solar System Exploration Research Virtual Institute (SSERVI) to participate in this Sudbury field camp, where we studied field geology of one of the largest impact structures on Earth. Studying the effects of impacts on Earth rocks allows us to understand how they affect other planetary (sub)surfaces.
- Subsurface science fieldwork in Kidd Creek Mine, Ontario through Stable Isotope Laboratory at University of Toronto. We sampled and studied the geochemistry of the longest-isolated groundwater discovered to-date by humans, and how this geochemistry affects Earth's subsurface biosphere (February 2019).
- Remote sensing fieldwork in Nanyuki Kenya, through the Institute at Brown for Environment and Society SEED grant to Kartzinel and Kellner labs (July 2018).

Service

Brown University Department of Earth, Environmental and Planetary Sciences Diversity Working Group member.

Graduate student representative: Brown University Department of Earth, Environmental and Planetary Sciences external review.

Professional Organizations and Committees including Peer Reviews, Journals, Books, etc.

- Planetary and Space Science, Manuscript Reviewer.
- Geophysical Research Letters, Manuscript Reviewer.
- Nature Scientific Reports, Manuscript Reviewer.
- Journal of Geophysical Research: Planets, Manuscript Reviewer.
- Astrobiology, Manuscript Reviewer.
- International Journal of Astrobiology, Manuscript Reviewer.
- Icarus, Manuscript Reviewer.

Multiple NASA proposal review panels.

Selected Research Press

- The New Yorker: <https://www.newyorker.com/tech/annals-of-technology/how-to-plan-a-space-mission>

Orbital identification of hydrated silica in Jezero crater, Mars; Tarnas et al. 2019:

- Washington Post: <https://www.washingtonpost.com/science/2019/11/16/mars-rover-will-visit-perfect-spot-find-signs-life-new-studies-show/>
- CNN: <https://www.cnn.com/2019/11/13/world/mars-2020-rover-fossils-scen-trnd/index.html>
- Science Times: <https://www.sciencetimes.com/articles/24263/20191115/mars-jezero-crater-nasa-space.htm>
- MIT Technology Review: <https://www.technologyreview.com/2019/11/14/65053/the-landing-site-for-nasas-mars-2020-rover-might-be-home-to-fossilized-life/>
- Astronomy Magazine: <https://astronomy.com/news/2019/12/fossils-on-mars-if-they-exist-nasas-mars-2020-rover-has-a-shot-at-finding-them>

Radiolytic H₂ production on Noachian Mars: Implications for habitability and atmospheric warming; Tarnas et al. 2018:

- Newsweek: <https://www.newsweek.com/ancient-mars-had-prime-conditions-life-thrive-below-its-surface-1137175>
- Science Daily: <https://www.sciencedaily.com/releases/2018/09/180924102040.htm>
- Astronomy Now: <https://astronomynow.com/2018/09/24/ancient-mars-could-have-supported-sub-surface-biosphere/>

Profiles

- East Side Monthly: <http://eastsidemonthly.com/stories/the-martian-chronicler,29496>