

Laura M. (Laurie) Barge

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Research website: www.lauriebarge.com | Lab website: origins-habitability.jpl.nasa.gov

Relevant Expertise: Barge has 15 years of experience in developing laboratory experiments to simulate chemistry in planetary environments; her research has led to development of methods to simulate hydrothermal systems on early Earth and ocean worlds. She co-founded and co-leads the JPL Origins and Habitability Laboratory, an astrobiology research group which studies how life emerges and can be detected on planets. Barge is an Investigation Lead for the NASA Astrobiology Institute (NAI) JPL Icy Worlds team; Science-PI of the NASA-funded In-Situ Vent Analysis Divebot for Exobiology Research (InVADER) project; and PI of the “Becoming Biotic” team funded by the NASA-NSF Ideas Lab for the Origins of Life. From 2012-2017 Barge chaired the NAI focus group “Thermodynamics, Disequilibrium, Evolution”, which hosted scientific meetings at a variety of astrobiology institutes around the world. From 2014-2018 she was a member of the advisory board of the ELSI Origins Network (EON); and currently she is a Steering Committee member for the NSF Research Coordination Network (RCN) on the Exploration of Life's Origins. She is involved with the NASA Astrobiology program's RCN's as a steering committee member for the Network for Ocean Worlds (NOW), and an Action Group lead for the Network for Life Detection (NFoLD). She was also recently named as a 2020 Scialog “Signatures of Life in the Universe” Fellow. For her origin of life research Barge has received the NASA Early Career Public Achievement Medal, the JPL Lew Allen Award, and the Presidential Early Career Award for Scientists and Engineers.

Current Positions:

Research Scientist, NASA Jet Propulsion Laboratory 2015 – present

- Co-lead, Origins and Habitability Laboratory at JPL. Lead astrobiology research team of ~10 students / postdocs whose projects span themes such as origin of life, habitability, and life detection. Hold weekly quiet hours with individuals, weekly lab / group meetings; facilitate ongoing program of seminars for the group; manage laboratory.
- Science Lead, In-Situ Vent Analysis Divebot for Astrobiology Research (InVADER). Science-PI for a large project to send an innovative astrobiology spectroscopy payload to ocean world analog vent sites in the Pacific ocean.
- Investigation Lead, NASA Astrobiology Institute Icy Worlds team. Lead an Investigation (one of four within the \$8M project) consisting of ~12 Co-I's/collaborators researching the emergence of life in hydrothermal vents.
- PI, NASA-NSF Ideas Lab for the Origins of Life, “Becoming Biotic”. Lead multi-institution effort to attempt to recapitulate ancient metabolic pathways by replacing protein enzymes with non-protein catalysts in early Earth conditions; supervise lab efforts at JPL involving contractors / postdoc.
- Task Lead, JPL Strategic Research & Technology Development Initiative “Fate of Organics in Ocean Worlds”. Lead a team on a 3-year Task: “Understanding abiotic organic chemistry in Ceres’ and Enceladus’ oceans”.
- Co-PI, NSF “Bridge to the Geosciences”. Develop and annually lead 3 one-day “geo-modules” at various institutions in the LA area, for cohorts of 20 community college students to learn about careers in geoscience.

HiRISE Investigation Scientist, Mars Reconnaissance Orbiter, NASA Jet Propulsion Laboratory 2015 – present

- Act as liaison between the High Resolution Imaging Science Experiment (HiRISE) instrument team at University of Arizona and the Mars Reconnaissance Orbiter (MRO) project at JPL.
- Conduct Mars-related research and perform mission-related outreach, e.g. public talks, JPL Open House.
- MRO cycle coordinator at JPL: conduct 5-week preparation for MRO's 2-week observing cycles.

Education:

Ph.D., 12/2009, Geological Sciences, University of Southern California, Los Angeles, CA

Advisor: Prof. Ken Nealson; Thesis title: “Self-organized chemical precipitates: Laboratory and field studies”

NASA Harriett G. Jenkins Pre-doctoral Fellow; USC College Merit Fellow

B.S., 8/2004, Astronomy and Astrophysics, Villanova University, Villanova, PA

Additional training:

2011 São Paulo Advanced School of Astrobiology (SPASA), São Paulo, Brazil.

2009 NASA/Nordic Astrobiology Summer School: “*Water, Ice and the Origin of Life in the Universe*” Iceland, July 2009.

2006 International Summer School in Astrobiology: “*Origins: From the Big Bang to Life.*” Spain, July 2006.

LAPLACE Astrobiology Winter School: “*Habitable Planets Around Sun-like Stars: Common or Rare?*”. Tucson, AZ
Jan 2006.

2005 NAI Astrobiology Winter School “*Water on Earth and in Space*”, Hawaii, Jan 2005.

Other Professional Experience:

Oak Crest Institute of Science, Visiting Researcher, 2013 – present.

Blue Marble Space Institute of Science, Research Scientist, 2013 – present; 2019-2020 Nominated & elected scientist representative to the BMS Board of Directors

NASA Jet Propulsion Laboratory

NASA Astrobiology Institute Postdoctoral Fellow (3/2013-3/2015)

Caltech Postdoctoral Scholar, NAI Icy Worlds Team (6/2010-3/2013)

Phoenix/Mars Science Laboratory Landing Site Working Groups, Graduate Researcher, 2004-2006

University of Southern California, Dept. of Earth Sciences Research / Teaching Assistant, 2004-2009

Marathon Oil Company, Petrophysics Intern, Summer 2008.

NASA Goddard Space Flight Center, NASA Academy Intern, Summer 2004.

Publications:

** = Student / postdoc under my supervision

Published / In press:

- R. Hudson, R. de Graaf, M. Rodin, N. Lane, S.E. McGlynn, A. Ohno, Y.M.A. Yamada, R. Nakamura, **L.M. Barge**, D. Braun, V. Sojo. (2020) CO₂ reduction driven by a pH gradient. *Proc. Natl. Acad. Sci.*, accepted.
- Hooks M. R.**, Webster P., Weber J. M.**, Perl S., **Barge L. M.** (2020) Effects of Amino Acids on Iron-Silicate Chemical Garden Precipitation. *Langmuir*, 36, 21, 5793–5801.
- T. R. Maltais**, D. VanderVelde, D. LaRowe, A. D. Goldman, **L. M. Barge** (2020) Reactivity of Metabolic Intermediates and Cofactor Stability Under Model Early Earth Conditions. *Origins of Life and Evolution of Biospheres*, DOI: 10.1007/s11084-019-09590-9.
- B.R. Lam, **L.M. Barge**, A.C. Noell, K.H. Nealson (2019) Detecting Microbial Metabolism and Differentiating Between Abiotic and Biotic Signals Observed by Bioelectrochemical Systems in Soils. *Astrobiology*, 20, 1, 39-52, doi: 10.1089/ast.2018.1892.
- L.M. Barge**, E. Flores**, M.M. Baum, D. VanderVelde, M.J. Russell (2019) Redox and pH Gradients Drive Amino Acid Synthesis in Iron Oxyhydroxide Mineral Systems. *Proc. Natl. Acad. Sci.*, 116 (11) 4828-4833; <https://doi.org/10.1073/pnas.1812098116>.
- Q. Wang, **L. M. Barge**, O. Steinbock (2019) Microfluidic Production of Pyrophosphate Catalyzed by Mineral Membranes Over Steep pH Gradients. *Chemistry - A European Journal*, 25, 18, 4732-4739, <https://doi.org/10.1002/chem.201805950>.
- S.D. Vance, **L.M. Barge**, S.S.S. Cardoso, J.H.E. Cartwright. (2019) Self-assembling ice membranes on Europa: Brinicle properties, field examples, and possible energetic systems in icy ocean worlds. *Astrobiology*, 19, 5, <https://doi.org/10.1089/ast.2018.1826>.
- L.M. Barge** (2019) Considering planetary environments in origin of life studies. *Nature Communications* 9, 5170 <https://doi.org/10.1038/s41467-018-07493-3>
- Hendrix A.R., Hurford T.R., **Barge, L.M.**, Bland M.T., Bowman, J.S., and 23 co-authors (2019) The NASA Roadmap to Ocean Worlds. *Astrobiology*, 19, 1, DOI: 10.1089/ast.2018.1955.
- L. M. Barge**, F. C. Krause, J.-P. Jones, K. Billings, P. Sobron (2018) Geo-Electrodes and Fuel Cells for Simulating Hydrothermal Vent Environments. *Astrobiology*, 18 (9), 1147-1158.
- H.L. Juntunen, L. Leinen, B.K. Pitts, S.M. O'Hanlon, B. Theiling, **L.M. Barge**, P. Videau, M.O. Gaylor (2018) Investigating the kinetics of montmorillonite clay-catalyzed conversion of anthracene to 9,10-anthraquinone in the context of prebiotic chemistry. *Origins of Life and Evolution of Biospheres*, doi: 10.1007/s11084-018-9562-9.
- Chin K. B., Chi I., Pasalic J., Huang C.-K., **Barge L. M.** (2018) An introductory study using impedance spectroscopy technique with polarizable microelectrode for amino acids characterization. *Review of Scientific Instruments* 89, 045108, <https://doi.org/10.1063/1.5020076>.
- Barge L. M.** and White L.M. (2017) Experimentally Testing Hydrothermal Vent Origin of Life on Enceladus and Other Icy/Ocean Worlds. *Astrobiology*, Special Collection on Enceladus, 17(9):820-833 <https://doi.org/10.1089/ast.2016.1633>.
- Barge L.M.**, Cardoso S.S.S., Cartwright J.H.E., Doloboff I.J.**, Flores E.**, Macías-Sánchez E., Sainz-Díaz C.I., Sobrón P. Self-Assembling Iron Oxyhydroxide / Oxide Tubular Structures: Laboratory-Grown and Field Examples from Rio Tinto. *Proceedings of the Royal Society of London A*, Published 9 November 2016. DOI: 10.1098/rspa.2016.0466.
- Barge L.M.**, Branscomb E., Brucato J.R., Cardoso S.S., Cartwright J.H., Danielache S.O., Galante D., Kee T.P., Miguel Y., Mojzsis S., Robinson K.J., Russell M.J., Simoncini E., Sobron P. (2017) Thermodynamics, Disequilibrium,

Evolution: Far-From-Equilibrium Geological and Chemical Considerations for Origin-Of-Life Research. *Origins of Life and Evolution of Biospheres*. 47(1):39-56, DOI: 10.1007/s11084-016-9508-z.

- O. Steinbock, J. H. E. Cartwright, **L. M. Barge**. (2016) The Fertile Physics of Chemical Gardens. *Physics Today*, 69(3), 44, doi: 10.1063/PT.3.3108. (Featured on cover of March 2016 issue)
- C. Scharf, N. Virgo, H. J. Cleaves II, M. Aono, N. Aubert-Kato, A. Aydinoglu, A. Barahona, **L. M. Barge**, S. A. Benner, M. Biehl, R. Brassler, C. J. Butch, K. Chandru, L. Cronin, S. Danielache, J. Fischer, J. Hernlund, P. Hut, T. Ikegami, J. Kimura, K. Kobayashi, C. Mariscal, S. McGlynn, B. Menard, N. Packard, R. Pascal, J. Pereto, S. Rajamani, L. Sinapayen, E. Smith, C. Switzer, K. Takai, F. Tian, Y. Ueno, M. Voytek, O. Witkowski, H. Yabuta (2015) A Strategy for Origins of Life Research. *Astrobiology* 15(12):1031-1042, DOI: 10.1089/ast.2015.1113.
- L. M. Barge**, Y. Abedian**, M. J. Russell, I. J. Doloboff**, J. H. E. Cartwright, R. D. Kidd, I. Kanik. (2015) From Chemical Gardens to Fuel Cells: Generation of Electrical Potential and Current Across Self-Assembling Iron Mineral Membranes. *Angewandte Chemie International Edition*, 54, 28:8184-8187, DOI: 10.1002/anie.201501663.
- L. M. Barge**, S. S. S. Cardoso, J. H. E. Cartwright, G. J. T. Cooper, L. Cronin, A. De Wit, I. J. Doloboff, B. Escribano, R. E. Goldstein, F. Haudin, D. E. H. Jones, A. L. Mackay, J. Maselko, J. J. Pagano, J. Pantaleone, M. J. Russell, C. I. Sainz-Díaz, O. Steinbock, D. A. Stone, Y. Tanimoto, N. L. Thomas. (2015) From Chemical Gardens to Chemobionics. *Chemical Reviews*, 115 (16), pp 8652–8703, DOI: 10.1021/acs.chemrev.5b00014.
- L. M. Barge**, Y. Abedian**, I. J. Doloboff**, J. E. Nunez**, M. J. Russell, R. D. Kidd, I. Kanik. (2015) Chemical Gardens as Flow-Through Reactors Simulating Natural Hydrothermal Systems. *Journal of Visualized Experiments*, 105, DOI: 10.3791/53015.
- B. T. Burcar, **L. M. Barge**, D. Trail, E. B. Watson, M. J. Russell, L. B. McGown. (2015) RNA Oligomerization in Laboratory Analogues of Alkaline Hydrothermal Vent Systems. *Astrobiology*, 15(7): 509-522. doi:10.1089/ast.2014.1280.
- L. M. Barge**, T. P. Kee, I. J. Doloboff**, J. M. P. Hampton, M. Ismail, M. Pourkashanian, J. Zeytounian**, M. M. Baum, J. Moss, C.-K. Lin, R. D. Kidd, I. Kanik (2014) The Fuel Cell Model of Abiogenesis: A New Approach to Origin-of-Life Simulations. *Astrobiology*, 14(3):254-70.
- Russell, M. J., **Barge, L. M.**, Bhartia, R., Bocanegra, D., Bracher, P., Branscomb, E., Kidd, R., McGlynn, S., Meier, D., Nitschke, W., Shibuya, T., Vance, S., White, L. (2014) The Drive to Life on Rocky and Icy Worlds. *Astrobiology*, 14, 4, 308-343.
- Barge, L. M.**, **Doloboff, I. J., Russell, M. J., VanderVelde, D., White, L. M., Stucky, G. D., Baum, M. M., **Zeytounian, J., Kidd, R., Kanik, I. (2014) Pyrophosphate Synthesis in Iron Mineral Films and Membranes Simulating Prebiotic Submarine Hydrothermal Systems. *Geochimica Cosmochimica Acta*, 128, 1-12.
- J. Petruska and **L. M. Barge**. (2013) Bilaterally Symmetric Facial Morphology Simulated by Diffusion-Controlled Chemical Precipitation in Gel. *Chemical Physics Letters* 556, 315–319.
- L. M. Barge**, A. A. Pulschen, A. P. M. Emygdio, C. Congreve, D. E. Kishimoto, A. G. Bendia, A. Teles, J. DeMarines, D. Stoupin (2013) Life, the Universe, and Everything: An Education Outreach Proposal to Build a Traveling Astrobiology Exhibit. *Astrobiology*, Vol. 13, No. 3, DOI: 10.1089/ast.2012.0834.
- L.M. Barge**, I. J. Doloboff**, L. M. White, G. D. Stucky, M. J. Russell, I. Kanik. (2012) Characterization of Iron-Phosphate-Silicate Chemical Garden Structures. *Langmuir*, 28 (8), pp 3714-3721 (Featured on cover of Feb 28, 2012 issue)
- M. A. Chan, S.L. Potter, B.B. Bowen, W. T. Parry, **L. M. Barge**, W. Seiler, E.U. Petersen, J. R. Bowman (2012) Characteristics of terrestrial ferric oxide concretions and implications for Mars. In J. Grotzinger and R. Milliken, *Sedimentary geology of Mars: SEPM Special Publication No. 102*, p. 253-270.
- B. Schoepp-Cothenet, W. Nitschke, **L. M. Barge**, A. Ponce, M. J. Russell, A. I. Tsapin (2011) Comment on “A Bacterium That Can Grow by Using Arsenic Instead of Phosphorus” *Science*, vol. 332, no. 6034, pl 1149.
- L. M. Barge**, D. E. Hammond, M. A. Chan, S. Potter, J. Petruska, K. H. Nealson (2011) Precipitation Patterns Formed by Self-Organizing Processes in Porous Media. *Geofluids*, 11: 124-133.
- L. M. Barge**, K. Nealson, J. Petruska (2010) Organic Influences on Inorganic Patterns of Diffusion-Controlled Precipitation in Gels. *Chemical Physics Letters*, Vol. 493, Issues 4-6, pp. 340-345.

Submitted / in prep:

- L. M. Barge**, E. Flores**, J. Weber**, M. M. Baum, D. VanderVelde, A. Castonguay. Effects of Geochemical and Environmental Parameters on Abiotic Organic Chemistry Driven by Iron Hydroxide Minerals. Submitted to *JGR-Planets*, 2020.
- N. Hermis**, G. LeBlanc, **L. M. Barge**. Simulation of Prebiotic Early Earth Hydrothermal Chimney Systems in a Thermal Gradient Environment. Submitted to *Journal of Visualized Experiments*, 2020.
- L. M. Barge**, J.-P. Jones, J. Pagano, E. Martinez**, J. Bescup. 3-Dimensional Analysis of a Simulated Prebiotic Hydrothermal Chimney. Submitted to *ACS Earth and Space Chemistry*, 2020.
- V. P. Aguirre, S. Jovic, P. Webster, C. Buser, J. A. Moss, **L. M. Barge**, Y. Tang, Y. Guo, M. M. Baum. Synthesis and Characterization of Mixed-valent Iron Double Layer Hydroxides (“Green Rust”). Submitted to *ACS Earth and Space Chemistry*, 2020.
- J.-P. Jones, S. A. Firdosy, **L. M. Barge**, J. C. Bescup, S. M. Perl, X. Zhang, A. M. Pate, R. E. Price. 3D Printed Minerals as Astrobiology Analogs of Hydrothermal Vent Chimneys. Submitted to *Astrobiology*, 2020.
- S. M. Perl, A. J. Celestian, C. S. Cockell, F. A. Corsetti, **L. M. Barge**, and 12 co-authors. A Proposed Geobiology-driven Nomenclature for Astrobiological In-Situ Observations and Sample Analyses. Submitted to *Astrobiology*, 2020.

Funded Projects / Grants:

As PI / Co-PI / Science-PI:

- 2020 Co-PI, NSF Improving Undergraduate Student Education (IUSE), "Pathways to STEM" (PI: Marianne Smith, Citrus College)
- 2020 PI, JPL Spontaneous R&TD: "A New Magnetic Electron Detection Technique for Astrobiology"
- 2019 PI, JPL Researchers on Campus program: "Fate of nitrate/nitrite in an ancient ocean on Mars"
- 2019 JPL Strategic RTD "Fate of Organics on Ocean Worlds", PI / Task Lead: "Understanding abiotic organic chemistry driven by minerals in Ceres' and Enceladus' oceans"
- 2019 PI, JPL Spontaneous R&TD, "Can nitrates on Mars drive subsurface organic chemistry?"
- 2019 JPL Lew Allen Award proposal; "Studying Venus to Understand Astrobiology of Terrestrial Planets"
- 2015-2019 Co-PI, NSF Improving Undergraduate STEM Education (IUSE), "GP-EXTRA - Bridge to the Geosciences for Community College Students", (PI: Marianne Smith, Citrus College)
- 2018-2021 PI, NASA Habitable Worlds, "Phosphorus Redox Chemistry on Icy and Rocky Planets"
- 2018-2021 Science-PI, NASA PSTAR, "In-Situ Vent Analysis Divebot for Exobiology Research" (PI: Pablo Sobron)
- 2017-2019 PI, JPL Topical R&TD, "Planetary Habitability Test Beds"
- 2018 PI, JPL Spontaneous R&TD, "Phosphorus Chemistry on Early and Present Day Mars"
- 2017 PI, NASA/NSF Ideas Lab for the Origins of Life, "Becoming Biotic: Recapitulating the Origin of Ancient Metabolic Pathways"
- 2017 PI, JPL Spontaneous R&TD, "Which Came First, Proteins or Cofactors? Recreating Metabolic Reactions on the Early Earth"
- 2016 PI, NASA Astrobiology Institute Director's Discretionary Fund, "Catalytic Diversity at the Emergence of Metabolism: Hydrothermal Carbon Dioxide Reduction on Fe/Ni-Sulfide Catalysts"
- 2016 PI, JPL Spontaneous R&TD, "Geo-Electrodes for Astrobiology Experiments"
- 2015 JPL Advanced Concept Development: "Sulfate and amino acid absorption in Mars analog minerals"
- 2014 PI, NASA Astrobiology Institute Early Career Collaboration Grant: "Prebiotic Phosphorus Chemistry",
- 2013 PI, NASA Astrobiology Institute Early Career Collaboration Grant: "Effects of Catalytic Iron-Containing Minerals on RNA Synthesis"
- 2007 PI, NASA Astrobiology Institute Lewis and Clark Fund for Exploration and Field Research: "A Study of Precipitation in Diffusion-Controlled Systems: Implications for Concretion Formation in Terrestrial and Martian Systems"

As Co-I:

- 2020-2023 Co-I, NASA Habitable Worlds: "Habitability of saponite-rich hydrothermal systems of early Mars" (PI: Roy Price, SUNY Stony Brook)
- 2015-2019 Investigation Lead / Co-I, NASA Astrobiology Institute, Cooperative Agreement Notice (CAN-7), "Icy Worlds: Astrobiology at the Water-Rock Interface and Beyond" (PI: Isik Kanik)
- 2018-2021 Co-I, NASA MaTISSE, "In-situ Spectroscopic Europa Explorer (iSEE)" (PI: Pablo Sobron, SETI)
- 2019 Co-PI, JPL Technical Equipment and Facilities Infrastructure Management (TEFIM) Program, "Geobiology Analysis Suite" (suite of laboratory Raman and LIBS instruments for geobiology research)
- 2019 Co-I, JPL Spontaneous R&TD, "Power Generation from Hydrothermal Vent Energy for Robotics and In Situ Sensing Operations"; (PI: Terry Hendricks, JPL)
- 2018 Co-I, JPL Topical R&TD, "Developing an Electrochemistry-Based Geochemical Framework for Organic Systems" (PI: Keith Chin, JPL)
- 2018 Co-I, JPL Topical R&TD, "Prebiotic and Microbial Bioindicators for Exoplanet Discovery" (PI: Tiffany Kataria, JPL)
- 2018 Co-I, JPL Presidents & Director's Fund, "Biogeochemical signatures of hypersaline brine systems" (PI: Scott Perl)
- 2018 Co-Lead, JPL Blue Sky Study: Planetary Soils
- 2017 Co-I, JPL Spontaneous R&TD, "Hydrothermal Vent Instrument Anchoring Platform" (PI: Chris Yahnker, JPL)
- 2017 Co-I, JPL Spontaneous R&TD, "New Electromechanical Technique for Detecting Life in Simulated Ocean World Environments using a Portable In-Situ Electrochemical Impedance Spectroscopy (EIS) System" (PI: Keith Chin)
- 2016 Co-Lead, JPL Blue Sky Study: Origin of Life
- 2014 JPL Planetary Instrument Advanced Concept Development, "Simulated Seafloor Systems for Origin of Life Studies"
- 2013 Co-I, JPL Strategic University Partnership Program award, "Microbial Fuel Cells for in-situ life detection"

Activities, Service, Leadership:

Steering Committee member, NASA Network for Ocean Worlds (NOW)

NASA Network for Life Detection (NFoLD): Lead NFoLD Action Group: Impact NASA Programs and Missions.

Conferences

- Astrobiology Science Conference (AbSciCon) 2021, Scientific Organizing Committee
- AbSciCon 2019, Session Organizer:
 - Plenary Session: Ocean World Exploration in our Solar System
 - Session: Beyond CHNOPS: Exploring Habitability on Icy Ocean Worlds
 - Session: Growing the Astrobiology Field: Inviting K-12, Undergraduates, Underrepresented Groups, Citizen Scientists, and the Public into the Search for Life and Its Origins
- AGU 2018, Session Organizer (P33G Analogue Studies of Gradient Systems Relevant to Astrobiology on Ocean Worlds and Mars)
- Goldschmidt 2018, Session Chair (Prebiotic Chemistry and the Archean Record of Early Life)
- AGU 2017, Session Chair (Investigating mineral-organic interactions relevant to astrobiological systems on Mars and other planetary bodies)

Steering Committee member, NSF Research Coordination Network on the Exploration of Life's Origins. Award led by The Santa Fe Institute will host a series of core meetings / topical working groups over a 5-year period that will explore the rules under which life is assembled.

ELSI Origins Network (EON) Advisory Board, 2014-2018. Member of a 12-person international advisory board for the ELSI Origins Network, an international origin of life institute run by the Earth-Life Science Institute of Tokyo Tech.

Member, Roadmap for Ocean Worlds (ROW) team, NASA Outer Planet Assessment Group (OPAG), 2016-present. Lead "Detection of Life" theme and participate in ROW meetings, to produce documents of science goals relating to specific targets, for use in future studies of / missions to ocean worlds.

JPL Study Lead:

- Co-Lead, 2018 JPL Blue Sky Study for Planetary Soils. Creating chemical analogs of Mars and icy world soils / sediments for use in life detection studies; spring 2018.
- Co-lead, 2017 JPL Space Life Sciences study for Astrobiology. leading 4-month study (with S. Perl) to assess Astrobiology expertise at JPL, develop an astrobiology community, and strategize paths forward.
- Co-lead, 2016 JPL Blue Sky Study for the Origin of Life. Co-led a ~6-month study to recommend JPL's institutional investment and strategies for origin of life research.

2012-2017 Co-chair, NASA Astrobiology Institute Focus Group: "Thermodynamics, Disequilibrium, Evolution". Organized two workshops per year in cooperation with other astrobiology and planetary science institutes around the world: including Centro de Astrobiologia (Madrid); Earth-Life Science Institute (Japan); Brazilian Synchrotron Light Laboratory (LNLS); INAF-Astrophysical Observatory of Arcetri (Italy).

NASA Proposal Review Panels, Small Innovative Missions for Planetary Exploration (SIMPLEx), Maturation of Instruments for Solar System Exploration (MaTISSE), Habitable Worlds, Exobiology.

Referee, *Nature Scientific Methods, Nature Astronomy, Journal of Physical Chemistry, Langmuir, Chemical Physics, Journal of the American Chemical Society, Angewandte Chemie, Journal of Molecular Evolution, Astrobiology, Origins of Life and Evolution of Biospheres.*

Organizer (Conferences / Events)

- Co-Organizer, Geochemical requirements for the emergence of life: VIII TDE Focus Group workshop, Earth-Life Science Institute (ELSI), Tokyo, Japan, Nov. 2014.
- Co-Organizer, Workshop on "Engines of Life: Thermodynamic Pathways to Metabolism". Beyond Center, Arizona State Univ. and the NAI TDE Focus Group, 5/2013.
- Organizing committee, 2012 Astrobiology Graduate Conference (Los Angeles, CA).
- Organizing committee, 2012 Astrobiology Research Focus Group (USC Wrigley Center, Catalina Island, CA).
- Organizing committee, Research Focus Group at the 2009 Astrobiology Graduate Conference, Seattle, WA. (Funded by the NAI Conference and Workshop Fund.)

Memberships: American Chemical Society (ACS), International Society for the Study of the Origin of Life (ISSOL), American Geophysical Union (AGU)

Outreach:

- Featured on NASA's "Ask an Astrobiologist" series, <https://astrobiology.nasa.gov/ask-an-astrobiologist/episodes/32/>
- Invited speaker, "Findings of Water on Mars", Space Fest 2015, California Science Center (Los Angeles).
- California State University Los Angeles, 2018 National Chemistry Week invited speaker / activity leader, Oct 2018
- University of Southern California, Earth Sciences Career Mentorship Panelist, April 2018
- Invited STEM Industry Panelist, USC Beyond the PhD 2016: PhD and Postdoctoral Career Conference.
- Invited panelist, Citrus College Careers in Math and Science workshop, 2013.
- Invited panelist, "Women in Planetary Sciences" panel at the YSS Undergraduate Planetary Science Research Conference at LPSC, 2011 and 2013.

Media:

Featured in Knowable Magazine, “Searching high and low for the origins of life”, by Anne N. Connor:
<https://www.knowablemagazine.org/article/physical-world/2020/searching-high-and-low-origins-life>

Appeared in CBS Mission Unstoppable, “Nets, Neighborhoods and NASA”: <https://www.cbs.com/shows/mission-unstoppable/video/cLLoupSSWqojCjcog2xv0hsmZm2whbzU/mission-unstoppable-nets-neighborhoods-and-nasa/>

JPL Feature Story, “NASA Study Reproduces Origins of Life on Ocean Floor”, 2/25/2019, by Arielle Samuelson,
<https://www.jpl.nasa.gov/news/news.php?feature=7340>

Featured in PBS “Second Genesis: The Quest For Life Beyond Earth”, with Carolyn Porco, <http://www.pbs.org/the-farthest/second-genesis/> (start at 12:37)

Featured in Astrobiology Magazine, “Hydrothermal Experiments Bring Enceladus to Earth”, by Charles Choi, Nov 30, 2017, <https://www.astrobio.net/news-exclusive/hydrothermal-vent-experiments-bring-enceladus-earth/>

Featured in Scientific American, “Life's Origins by Land or Sea? Debate Gets Hot” by Rachel Brazil, ChemistryWorld on May 15, 2017. <https://www.scientificamerican.com/article/lifes-origins-by-land-or-sea-debate-gets-hot/>

Featured in Engadget, “The search for a habitable second Earth”, by Steve Dent, May 27, 2017
<https://www.engadget.com/2017/05/27/search-habitable-planets-second-earth-exoplanets/>

Featured in NOVA web short, “Make your own hydrothermal vent”, By Karishma Desai and Ari Daniel,
<http://www.pbs.org/wgbh/nova/earth/make-your-own-vent.html>

Featured in New Scientist, “Genesis in a jar: How chemical gardens may lead us to alien life”, Aug 10 2016 by Joshua Sokol, <https://www.newscientist.com/article/2100538-genesis-in-a-jar-how-chemical-gardens-may-lead-us-to-alien-life/>

Featured in Nautilus Magazine, “The Fly in the Primordial Soup”, by Nathaniel Comfort, June 23, 2016,
<http://nautil.us/issue/37/currents/the-fly-in-the-primordial-soup>

Appeared in *How the Universe Works* (Discovery Channel), S04E05 “Dawn of Life”, aired 12/15

JPL Feature Story, “Researchers Use Seafloor Gardens to Switch on Light Bulb”, August 5, 2015, by Whitney Clavin,
<http://www.jpl.nasa.gov/news/news.php?feature=4679>.

Astrobiology Magazine News Exclusive, “Could ‘Green Rust’ be a Catalyst for Martian Life?”, May 21, 2015, by Elizabeth Howell, <http://www.astrobio.net/news-exclusive/could-green-rust-be-a-catalyst-for-martian-life/>

Orange County Register, “Did sea-floor battery spark life on Earth?”, by Pat Brennan, April 26, 2014.
<https://www.ocregister.com/2014/04/28/did-sea-floor-battery-spark-life-on-earth/>

Invited Guest, Planetary Radio, “Was a Natural Fuel Cell Key to the Origin of Life on Earth?”, with Matt Kaplan:
<http://www.planetary.org/multimedia/planetary-radio/show/2014/0701-was-a-natural-fuel-cell-key-to-the-origin-of-life-on-earth.html>.

JPL Feature Story, “New Study Outlines ‘Water World’ Theory of Life’s Origins”, April 15, 2014, by Whitney Clavin,
<http://www.jpl.nasa.gov/news/news.php?release=2014-115>.

NASA Astrobiology Institute Research Highlights, “The Seafloor Electric”, 04/15/2014,
<http://astrobiology.nasa.gov/articles/2014/4/15/the-seafloor-electric/>

Radio Interview, KPFT-FM Houston, *Weltanschauung* weekly show with Michael DeLeonardis, April 10, 2014.

JPL Feature Story, “How Did Life Arise? Fuel Cells May Have Answers”, March 13, 2014, by Whitney Clavin,
<http://www.jpl.nasa.gov/news/news.php?release=2014-079>

Astrobiology Magazine News Exclusive, “Life’s Fuel Cells”, March 13, 2014, by Sheyna Gifford,
<http://www.astrobio.net/exclusive/6062/life%E2%80%99s-fuel-cells>

NASA Astrobiology Institute Research Highlights, “Life’s Origins in a Prebiotic Fuel Cell”, 03/14/2014, by Aaron Gronstal,
<http://astrobiology.nasa.gov/articles/2014/3/14/lifes-origins-in-a-prebiotic-fuel-cell/>

University of Leeds press release, “Simulating how the Earth Kick-Started Metabolism”, by Sarah Reed, 03/13/14,
http://www.leeds.ac.uk/news/article/3504/simulating_how_the_earth_kick-started_metabolism

Daily Galaxy, “What We Might Find in Europa’s Alien Ocean World”, 03/2014,
http://www.dailygalaxy.com/my_weblog/2014/03/what-we-might-find-in-europas-alien-ocean-world.html

Universe Today, “Did Life on Earth As We Know It Come From Geological Life?”, by Elizabeth Howell, 03/13/14,
<http://www.universetoday.com/110310/did-life-on-earth-as-we-know-it-come-from-geological-life/>

Oak Crest Institute of Science, press release, “How the Earth Kick-started its Metabolism Simulated in a Laboratory”, by Lisa Lucio, 03/2014. <http://oak-crest.org/oakcrest-news/how-the-earth-kick-started-its-metabolism-simulated-in-a-laboratory/>

Featured in Chemical & Engineering News: “Gardens of Eden”, by Carmen Drahl, March 18, 2013. Vol. 91, Issue 11, pp. 44-45, <http://cen.acs.org/articles/91/i11/Gardens-Eden.html>

Honors / Awards:

- 2020 Scialog “Signatures of Life in the Universe” Fellow
- 2019 Presidential Early Career Award for Scientists and Engineers (PECASE) for innovative fuel cell-based research
- 2019 NASA Early Career Public Achievement Medal (for advances in origin of life research)
- 2019 NASA Group Achievement Award, InSight EDL Communications Team
- 2018 JPL Lew Allen Award for Excellence, for pioneering research on the application of electrochemistry to studies of the origin and emergence of life. (Awarded to 4 JPL-ers annually to recognize and encourage significant individual

accomplishments or leadership in scientific research or technological innovation by JPL employees during the early years of their professional careers.)

- 2016 Selected to attend the NSF-NASA Ideas Lab for the Origins of Life (proposal was selected in 2017)
- 2016 Jet Propulsion Laboratory Voyager Award (for leadership in astrobiology activities visible outside JPL)
- 2015 NASA Group Achievement Award (Icy Worlds Team)
- 2013-2015 NASA Astrobiology Postdoctoral Fellowship
- 2012, 2011 American Astronomical Society International Travel Grant
- 2009 Women in Science and Engineering (WiSE) Travel Grant
NASA Harriet G. Jenkins Pre-doctoral Fellowship
USA Funds Access to Education Scholarship
- 2008 Women in Science and Engineering (WiSE) Merit Fellowship
USC Dean Joan M. Schaefer Research Award
Phi Kappa Phi Love of Learning Award
- 2007 American Astronomical Society International Travel Grant
USC Dean Joan M. Schaefer Merit Scholarship / Research Award
USC Dept. of Earth Sciences Outstanding Teaching Assistant Award (2007 & 2006)
- 2006 Mars Exploration Program Student Travel Grant
- 2004 Keck Fellowship, University of Southern California
College Merit Award Fellowship, USC College of Letters and Sciences
National Merit Scholarship, Villanova University (2000-2004)
Blue White Scholarship, Villanova University (2003-2004)

Selected Invited Talks

- Invited speaker, COST Chemobionics meeting (Prague, Jan 2020)
- Astrobiology Science Conference 2019: Plenary panel member, "Plenary Session: Unresolved Issues in the Origins of Life: Multidisciplinary Perspectives", Seattle, WA
- Intrepid Sea, Air and Space Museum (NYC): Invited guest speaker, 2019 World Water Day Europa; Family Astronomy Night series ("The Search for Life on Mars"), 2018.
- Invited speaker, Molecular Origins of Life – Center for Advanced Studies (CAS) Conference 2018, "Simulating Prebiotic Chemistry in Hydrothermal Systems on Early Earth and Ocean Worlds", Munich, Germany, Oct 2018.
- Goldschmidt 2018, Keynote Speaker (Prebiotic Chemistry and Habitability in Serpentinizing Hydrothermal Systems on Early Earth and Other Worlds), Session: Microbe-Fluid-Rock Interaction in Hydrothermal Systems,
- COSPAR 2018 Solicited talk, Scientific Event F3.2: The Evolving Chemical Universe: From Proto-stars to the Origin of Life. ("Experimental Simulations of Prebiotic Chemistry Driven by Hydrothermal Gradients in Ocean Worlds")
- 2018 Gordon Research Conference on the Origins of Life, Invited Speaker (Session: Prebiotic Environments)
- 2018 Gordon Research Conference on Geobiology, Discussion Leader (Life Detection)
- Invited Lecturer, 2018 NASA/ESA International Summer School in Astrobiology (Biomarkers: Signs of Life Through Space and Time), Santander, Spain. Lectures: "Ocean Worlds: Geochemistry, Redox Cycling, and Habitability"; "Ocean Worlds: Defining Biosignatures and Developing Strategies for Life Detection".
- Invited Speaker, International Symposium on *Environments of Terrestrial Planets Under the Young Sun: Seeds of Biomolecules*, ("Exploring Environmental Conditions for Prebiotic Chemistry on Early Terrestrial Planets"), Goddard Space Flight Center, April 2018.
- Astrobiology Science Conference 2017: Invited talk, session on Origin of Life in Hydrothermal Vents, "Prebiotic Chemistry in Chemical Garden Structures at Hydrothermal Vents: The Importance of Gels and Gradients". Mesa, AZ
- American Geophysical Union Invited talk, session on Enceladus: "Simulating Prebiotic Chemistry in Alkaline Hydrothermal Vents on Enceladus and other Ocean Worlds", San Francisco, Dec 2016.
- Conference on Re-conceptualizing the origin of life, Carnegie Institute: Invited speaker, "Hydrothermal chimneys as flow-through chemical reactors: Laboratory simulations of far-from-equilibrium systems at seafloor interfaces", Washington DC, 2015.
- Invited Plenary Speaker, *Habitability in the Universe: From the Early Earth to Exoplanets*; First conference of the COST (European Cooperation in Science and Technology) ORIGINS Action, Portugal, March 2015.
- Princeton Origin of Life Workshop, Invited speaker, *Testing the Emergence of Bioenergetics in Hydrothermal Vents*. Princeton Center for Theoretical Science, January 2013.
- Invited Speaker, *Energetics of Chemical Gardens in Prebiotic Systems*, Lorentz Center workshop on "Chemical Gardens", Leiden University, the Netherlands, May 2012.

Invited university seminars / lectures:

- 2020: McGill Astronomy Seminar Series; Queens University Astronomy seminar; Caltech Yuk Lunch Seminar
- 2019: University of Southern California and Caltech astrobiology course guest lecturer; U. of Nevada Las Vegas Geoscience department seminar; Earth-Life Science Institute (ELSI, Tokyo Tech)

- 2018: Johns Hopkins University Applied Physics Lab; U. of Tulsa
- 2017: Caltech Planetary Science Seminar
- 2016: CSU Northridge astronomy seminar; U. of Tulsa; Johns Hopkins and Space Telescope Science Institute
- 2015: Caltech Yuk Lunch Seminar; University of Washington Astrobiology Colloquium Series; Florida State University Chemistry Seminar Series; Georgia Tech Planetary Seminar Series; UCLA iPLEX Lunch series
- 2014: Oak Crest Institute of Science (Monrovia, CA); USC Geobiology Seminar Series; Institute for Genomic Biology, University of Illinois Urbana-Champaign; ELSI
- 2013: Georgia Tech, Center for Ribosomal Origins and Evolution; ELSI and Japan Agency for Marine-Earth Science and Technology (JAMSTEC); University of Leeds, School of Chemistry
- 2012: University of Budapest; University of Wisconsin-Madison Geology Department
- 2011: Caltech Inorganic-Organometallics Seminar; Caltech Yuk Lunch seminar

Student and Postdoc Supervision:

2020-present: Rachel Sheppard, JPL Postdoc (Mars redox environments)
 2019-present: Ph.D. committee member for Chris Mehta, University of South Florida
 2019-present: Jessica Weber, JPL Postdoc (origin of life)
 2019-present: Laura Rodriguez, JPL Postdoc (hydrothermal vents)
 2017-present: Ninos Hermis, M.S. candidate / graduate student intern, CSULA (fuel cells, temperature gradients)
 2013-present: Erika Flores, M.S. candidate / graduate student intern, CSULA (reductive amination in iron hydroxides)
 2018-present: Eduardo Martinez, M.S. candidate, CSULA (chemical gardens)
 2018-present: Jonathan Major, M.S. candidate, University of Tulsa, (phosphorus on Mars / ocean worlds)
 2019: Sarah Crucilla, undergraduate intern, Caltech (origin of metabolism)
 2018-present: committee member for Carolyn Lang, Ph.D. candidate, University of South Florida
 2017-2019: Michelle Hooks, NASA STAR fellow, USC (organic effects on chemical gardens)
 2018: Angel Chavez, undergraduate intern, UC Irvine (Mars soil simulations)
 2018: Hiroki Nishimura, undergraduate intern, Tokyo University of Marine Science and Technology (phosphorus)
 2017: Thora Maltais, Postdoctoral researcher (TCA cycle reactions on early Earth)
 2016-2017: Ryan Cameron, undergraduate intern, Tulsa Community College / CSU-Northridge (electrochemistry)
 2013-2017: Lily Abedian, undergraduate intern, UC San Diego (electrochemistry, phosphorus chemistry)
 2017: Liz Miller, undergraduate intern, Bard College (reductive amination in iron hydroxides)
 2016: Arden Hammer, undergraduate intern, Oberlin College (organic effects on chemical gardens)
 2016: Kayo Kallas, undergraduate intern, Santa Monica College (reductive amination in iron hydroxides)
 2011-2015: Ivria Doloboff, undergraduate intern, CSU-Long Beach (chemical gardens; phosphorus chemistry)
 2013-2015: Timothy Lin, undergraduate intern, UC Riverside (carbon reduction on hydrothermal sulfide minerals)
 2015: Arlette Valencia, undergraduate intern, Citrus College (iron hydroxides)
 2014: Jessica Nunes, undergraduate intern, Citrus College (iron hydroxide chemical gardens, organics, phosphorus)
 2012-2013: Nery Rafael, undergraduate intern, CSU-Long Beach (iron hydroxides)
 2012: John Zeytounian, undergraduate intern, University of Southern California (electrochemistry of iron sulfides)

Teaching/Mentoring:

2013-present: Mentor for various JPL/NASA undergraduate and graduate intern programs, typically 5+ students per year, including: JPL Student Independent Research Internship (SIRI) Program, Minority Student Programs, NASA Undergraduate Internship (UI) program, JPL Visiting Student Research Program (JVS RP), Caltech SURF Summer Intern Program), JPL Student Internship Program.
 2014-2017 Mentor, Tulsa Community College / JPL intern program
 2014-present Mentor, Citrus College / JPL intern program (with Dr. Marianne Smith)
 2014 Mentor, Blue Marble Space Institute of Science Young Researcher Program (YSP).
 2013 Postdoc Mentor, Women Mentoring Women Program at Caltech
 Interviewee, *Gigniks* (non-profit film project interviewing professionals for high school career guidance).
 2007 Teaching Assistant, GEOL 125 – Earth History (USC Dept. of Earth Sciences)
 Teaching Assistant, GEOL 240 – Earthquakes (USC Dept. of Earth Sciences)
 2006 Assistant Science Instructor (Astronomy), Sally Ride Science Camp at UCLA.
 2001-2004 Teaching Assistant, AST 1073 – Stellar Lab (Villanova Dept. of Astronomy and Astrophysics)
 Teaching Assistant, AST 1075 – Planets Lab (Villanova Dept. of Astronomy and Astrophysics)
 Teaching Assistant, PHY 2601 – Computational Physics Lab (Villanova Dept. of Physics)

Published Abstracts:

Over 70 published abstracts for national and international conferences (Lunar and Planetary Science Conference; AGU;

Astrobiology Science Conference; Goldschmidt; International Conference for the Origin of Life; AAS Division of Planetary Sciences, American Astronomical Society; etc).