

Scott M. Perl, Ph.D.

Research Scientist, NASA-JPL

Co-Principal Investigator, JPL Origins and Habitability Lab (OHL)

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Education

University of Southern California

2013-2019

- Ph.D., Geological Sciences & Geobiology

Dissertation: "Quantifying the Threshold of Biogenic Detection in Evaporites: Constraining Potential Martian Biomarker Preservation via Terrestrial Analogues"

Purdue University

2008-2011

- M.S., Aeronautical & Astronautical Engineering (Concentrations: Systems Engineering & Human Factors)

Thesis: A Multi-Level Approach to Enhance Information Exchange for the 2011 Mars Science Laboratory Mission

State University of New York at Stony Brook

2002-2008

- B.S., Geology
- B.E., Engineering Science (Concentration: Materials Sciences)

Undergraduate Research: Quantified the groundwater table within the Burns Formation, Mars by constraining secondary porosity within abraded rocks

Career Experience & Positions Held

Research Scientist, NASA Jet Propulsion Laboratory

2012-2024

JPL Science Lead, Ocean Worlds Reconnaissance & Characterization (ORCAA)

2022-Present

Science Lead, Deep Access Subsurface Extraction & Retrieval (DASER)

2021-Present

Scientist, Probe Using Radioisotopes for Icy Moons Exploration (PRIME)

2019-2020

Co-Principal Investigator, JPL Origins and Habitability Laboratory

2017-Present

Scientist, Extant Life Volume Imaging System (ELVIS), Europa Lander instrument

2017-2021

CRISM Investigation Scientist, Mars Reconnaissance Orbiter

2013-2018

Cycle Coordinator, Payload Operations and Science Team, Mars Reconnaissance Orbiter

2013-2018

Science Planner, Integrated Planning & Execution, Mars Science Laboratory

2012-2013

Research Affiliate in Mineral Sciences, Los Angeles Natural History Museum

2017-Present

Affiliate Scientist, Blue Marble Space Institute for Science

2019-Present

Graduate Research Assistant, Corsetti Geobiology Lab

2013-2018

Science Team Collaborator, Athena Science Team, Mars Exploration Rover

2005-2008

Undergraduate Research Assistant, McLennan Sedimentology and Geochemistry Lab

2004-2008

Professional Appointments

Co-Principal Investigator, Origins and Habitability Laboratory (OHL) at JPL

2017-Present

NASA Jet Propulsion Laboratory, Pasadena, CA

-Managing the OHL laboratory and group with of researchers consisting of visiting faculty, post-docs, graduate students, and summer interns.

-Alongside Co-PI Dr. Laurie Barge, we conduct fieldwork and laboratory experiments that generate research ideas and proposals in the fields of astrobiology, geobiology, origins of life, microbiology, habitability, and mineralogy.

Research Affiliate in Mineral Sciences, Los Angeles Natural History Museum (LA-NHM)

2017-Present

Los Angeles, CA

- Working with Dr. Aaron Celestian in the Mineral Sciences department of Research and Collections on mineral and fluidic analyses connected to geobiology, spectroscopy, and mineralogy.
- Giving talks during museum events, public science activities, and astrobiology outreach that showcase our research

Scientist, Blue Marble Space Institute of Science (BMSIS) 2019-Present
Seattle, Washington (Virtual Astrobiology Institute - <https://www.bmsis.org>)
 -Part of the BMSIS research institute highlighting several astrobiology and planetary geology programs and collaborations
 -Mentor in the BMSIS-Young Scientist Program (YSP) where I lead student initiative programs in geobiology, astrobiology, planetary geology, and mineralogy. Students can be remote or in-person and range from year-round to summer programs.

Mars Exploration Rover mission - Athena Science Team collaborator 2004-2012
NASA Jet Propulsion Laboratory, Pasadena, CA
 -Supporting rover operations as part of the Science Operations Working Group (SOWG) with science team members on daily mission planning and activities for the MER rovers on Mars. Attending team meetings and presenting my research using data received from *Opportunity*

Academic Research Appointments
Doctoral Research under Dr. Frank Corsetti 2013-2019
University of Southern California
 -Conducting microbiology and mineralogy experiments to determine geobiological preservation potential of evaporites with comparison to Martian surface and orbital CRISM data. Investigations includes fieldwork, sterile sample acquisition, microbiology lab techniques (DNA extractions, qPCR, 16S rRNA gene sequencing), instrument analyses (spectroscopy, Raman, XRF, Digital Holography, spectrophotometry), and optical techniques.

Graduate Research Assistant 2008-2010
Purdue University, West Lafayette, IN
 -Working with the System-of-Systems laboratory, created techniques to improve information exchange and decision support between human and robotic systems used in both the Mars Science Laboratory mission and the Mars Exploration Program.

Undergraduate Research Assistant under Dr. Scott McLennan 2004-2008
State University of New York at Stony Brook, Stony Brook, NY
 -While performing science team operations for the Mars Exploration Rover (MER) *Opportunity*, utilized Microscopic Imager (MI) data containing microtextural features to investigate the activity of groundwater flow through the subsurface regions in the Burns Formation in Meridiani Planum, Mars.

Funded Proposals

- Co-Investigator, NASA Science Mission Directorate (SMD): “*HALOQUEST: Halobacterium Astrobiological Laboratory for Observing and Questioning Extraterrestrial Signatures and Traits*” 2024-2026
- Co-Investigator, NASA PSTAR: *ORCAA: “Ocean Worlds Reconnaissance and Characterization of Astrobiological Analogs”* 2022-2026
- Principal Investigator, JPL Spontaneous Concepts R&TD "Life Detection Development and Data Assessment of Agnostic Nucleic Acids" 2023
- Principal Investigator, JPL Strategic University Research Partnerships with Princeton University “*Exploring abiotic constraints on microbial habitability in subsurface hypersaline brines*” 2020-2023
- Principal Investigator, JPL Spontaneous Concepts R&TD "Constraining Extreme Environment Adaptation Pathways: Tracing Genetic Divergence within a halophilic species" 2020
- Co-Investigator, NASA PSTAR: “*Detectability of Magmatic Intrusions within Sulfur-rich Sediments for Martian Mineralogical and in-situ Operational Analyses*” 2019-2023

- Principal Investigator, President's and Directors Fund, Caltech & JPL: “*Biogeochemical Signatures of 2018-2020 Hypersaline Brine systems*” (Co-PI: Alex Sessions)
- Co-Investigator, JPL FY19 Topical R&TD “*Prebiotic and Microbial Bioindicators for Exoplanet Discovery*” **2018-2020**
- Co-Investigator, JPL FY19 Topical R&TD “*Developing an Electrochemistry-Based Geochemical Framework for Organic Systems*” **2018-2020**
- Co-Investigator, JPL FY19 Spontaneous R&TD “*Broadband Dielectric Characterization of Water Inclusions in Evaporites at Martian Conditions*” **2019**
- Co-Investigator, JPL FY18 Topical R&TD “*Planetary Habitability Test Beds*” **2017-2019**
- Principal Investigator, JPL FY18 Strategic Concepts R&TD “*Hypersaline Microbial Preservation and Diversity from the Modern to the Permian for Future In-Situ Astrobiological Analyses*” **2018**
- Principal Investigator, JPL FY17 Strategic Concepts R&TD “*Identification and Validation of Biogenic Preservation within Minerals: Microbiological Techniques for Future Life Detection Missions*” **2016–2017**
- Co-Principal Investigator, JPL FY17 Strategic Concepts R&TD “*Assessing Current Astrobiology Capabilities at JPL*” (Co-PI: Laurie Barge) **2017–2018**
- Co-Investigator, JPL FY17 Strategic Concepts R&TD “*Dielectric Characterization of Evaporites Under Martian Conditions*” **2017**
- Principal Investigator, JPL Strategic R&TD “*Simulating Ocean World Microbiology and Pressure-Relevant Ecological System*” (**Delayed, COVID-19**)
- Co-Investigator, JPL Strategic R&TD “*Studies of Ocean World Materials and Minerals*” (**Delayed, COVID-19**)
- Co-Investigator, JPL Strategic R&TD “*Pressure Gradient Reactors to Simulate Mineral-Driven Chemistry and Biology under Enceladus-like conditions*” (**Delayed, COVID-19**)

Publications (Books and Book Chapters)

- **Perl, S. M.** and Baxter, B.K. (2020) Great Salt Lake as an Astrobiology Analogue for Ancient Martian Hypersaline Aqueous Systems (in Great Salt Lake as an Astrobiology Analogue for Ancient Martian Hypersaline Aqueous Systems. In: Baxter B., Butler J. (eds) Great Salt Lake Biology. Springer, Cham) Print ISBN: 978-3-030-40351-5 Online ISBN: 978-3-030-40352-2 https://doi.org/10.1007/978-3-030-40352-2_16

Publications (Journal Articles, in-prep)

1. Knecht, L.N., Gruchola, S., Cockell, C.S., **Perl, S.M.**, Wilhelm, M.B., Schmidt, P.K., Coenraad, P.K., Tulej, M., Thomas, N., Wurz, P., Riedo, A. (*in-prep*) Identifying Biomarkers and Habitability Indications on Polygonal Structures using Laser Mass Spectrometry.
2. **Perl, S.M.**, Nisson, D.M., Onstott, T.C. (*in-prep*) Single Cell Identification and Validation for Low Biomass Planetary Brine Environments.
3. Weber, J.M., Rodriguez, L.E., Cable, M.L., Ono, H., Ingham, M., Barge, L.M., **Perl, S.M.**, Henderson, B.L., Marusiak, A., Chodas, M., Melwani-Daswani, M., Hosseini, S.S. (*in-prep*) Enceladus Vent Explorer (EVE) Mission Concept Study: Architecture Development based on Instrument Selection
4. **Perl, S.M.**, Cockell, C.S., Fischer, W.W. and the Biology of Biosignature Detection Team (*in-prep*) On the Incorporation of Biological Validation into Planetary Science
5. **Perl, S.M.**, Cockell, C.S., Fischer, W.W., Lloyd, K.G., Treude, T., Corsetti, F.A., Leadbetter, J., Giovannelli D., Foreman, C.M., Freedman, K., Wilhelm, M.B., Lynch, K., Homann, M., Som, S.M., Wilson, L., Karunatillake, S., Bywaters, K., Mikucki, J., Celestian, A.C., Chen, P., Guan, L., Ibarra, Y., Sobron, P., Boland, J., Drake, H., Hosseini, S., Tosi, L.P., Malaska, M., Nisson, D.M., Garner, M., Murphy, A., Sharma, S., Willis, M., Eshelman, E (*in-prep*) Enabling Biological Validation and Agnostic Experiments for Extinct and Extant Microbial Life
6. Robinson A., McQuaig-Ulrich S., Dondero T., Javier B., **Perl, S.M.** (*in-prep*) Anaerobic Growth and Raman Analysis of *Haloflexax volcanii* in the Presence of Perchlorate

7. Sapers, H.M., **Perl, S.M.**, Mustard, Plesa, A-C., Spohn, T., Knapmeyer-Endrun, B., Hao, J., Michalski, J., Magnabosco, C., Miljkovic, K., Paardekooper, D., Pan, D., Sherwood Lollar, B., Vijendran, S., Wang, F., Westall, F., Zacny, K. (*in-prep*) Science of the Subsurface and Enabling Access: Conclusions from the International Space Science Institute (ISSI) New Mars Life Underground team
8. Rodriguez, L.E., Weber, J.M., Cable, M.L., Ono, H., **Perl, S.M.**, Castillo, J., Chodas, M., Ingham, M.D., Carpenter, K., Barge, L.M., Melwani-Daswani, M., Ferguson, S. (*in-prep*) A Comprehensive Science Traceability Matrix for Future Missions to Enceladus

Publications (Journal Articles, Submitted and In-revision)

1. **Perl, S.M.**, Cockell, C.S., Celestian, A. J., Corsetti, F.A., Basu, C. (*submitted*) “Quantifying abiogenic and biogenic breakdown within evaporite preservation environments”
2. Shkolyar, S., Bebout, L.E., Blank, J.G., Cady, S.L., Cavalazzi, B., Corbin, E., Davila, A.F., Des Marais, D., Fisk, M., Hickman-Lewis, K., Lima-Zaloumis, J., McLoughlin, N., Murphy, A.E., Noffke, N., **Perl, S.M.**, Pohorille, A., Potter-McIntyre, S.L., Rainwater, J.H., Westall, F. (*submitted*) Structural Biosignatures in the Life Detection Knowledge Base
3. **Perl, S.M.**, Murphy, A., Govindaraj, C., Santos, S.C., Glamoclijja, M., Hoehler, T., Shkolyar, S., Cady, S.L., Blank, J., Davila, A.F., Cortez, P., Burgess, A., (*submitted*) Astrobiological Importance of Terrestrial Crystal Habits for Life Detection Measurements

Publications (Journal Articles, Accepted and In-Press)

1. **Perl, S.M.**, Celestian, A. J., Seuylemezian, A., Tasoff, P., Baxter, B.K., Vaishampayan, P.A., Corsetti, F.A. (*accepted*) “Evaporitic Preservation of Modern Carotenoid Biomarkers and Halophilic Life in Martian Analogue Hypersaline Environments”
2. Basu, C. and **Perl, S.M.** (*accepted*) The use of RNA-seq for the study of Physiological Adaptations of Halophiles in Extreme Environments for Astrobiological Data Interpretation. *Frontiers in Astronomy and Space Sciences*.
3. Davila, A.F., Hoehler, T., Parenteau, N., Neveu, M., Shkolyar, S., Des Marais, D.J., Cady, S.L., Rios, A., Bebout, L., Lau, G., Jahnke, L., **Perl, S.M.**, Eigenbrode, J., Pohorille, A., Quinn, R. (*accepted*) Life Detection Knowledge Base: Taxonomy of Potential Biosignatures.

Publications (Journal Articles)

1. Cockell, C.S., Simons, M., Castillo-Rogez, J. Higgins, P.M., Kaltenegger, L., Keane, J.T., Leonard, E.J., Mitchell, K.L., Park, R.S., **Perl, S.M.**, & Vance, S.D. (2024) Sustained and comparative habitability beyond Earth. *Nat Astron* (2024). <https://doi.org/10.1038/s41550-023-02158-8>
2. Nisson, D.M., Walters, C.C., Chacón-Patiño, M.L., Weisbrod, C.R., Kieft, T.L., Sherwood-Lollar, B., Warr, O., Castillo, J., **Perl, S.M.**, Cason, E.D., Freifeld, B.M., Onstott, T.C. (2024) Radiolytically reworked Archean organic matter in a habitable deep ancient high-temperature brine. *Nat Commun* 14, 6163 (2023). <https://doi.org/10.1038/s41467-023-41900-8>
3. Nisson, D.M., Walters, C., Chacon, M., Kieft, T.L., Rodgers, R., Sherwood Lollar, B., Warr, O., Castillo, J., **Perl, S.M.**, Cason, E., Freifeld, B.M., Onstott, T.C. (2023) Organic Matter Contributes to Limited Habitability in an Ancient, Thermal, and Radiogenic Subsurface Brine. *Geochimica et Cosmochimica Acta*. v340, 1 January 2023, p65-84. <https://doi.org/10.1016/j.gca.2022.11.015>
4. **Perl, S.M.**, McLennan, S.M., Herkenhoff, K.E., and the Athena Science Team (2023, *submitted to JGR-Planets*) Secondary porosity in the Burns Formation, Meridiani Planum, Mars: Constraints on an infiltrating paleowater table.
5. Nisson, D.M., Kieft, T.L., Drake, H., Warr, O., Sherwood Lollar, B., Ogasawara, H., **Perl, S.M.**, Friefeld, B.M., Castillo, J., Whitehouse, M.J. and Kooijman, E. (2023). Hydrogeochemical and isotopic signatures elucidate deep

subsurface hypersaline brine formation through radiolysis driven water-rock interaction. *Geochimica et Cosmochimica Acta*, 340, 65-84.

6. Hein, M.J., Basu, C., **Perl, S.M.** (2022) Transcriptomic Analysis of Dunaliella salina Under Salt and UV Stresses. IN VITRO CELLULAR & DEVELOPMENTAL BIOLOGY 58 (4), 688-689
7. Weber, J.M., Henderson, B.L., LaRowe, D.E., Goldman, A.D., **Perl, S.M.**, Billings, K., Barge, L.M. (2022) Testing Abiotic Reduction of NAD⁺ Directly Mediated by Iron/Sulfur Minerals. *Astrobiology*. Jan 2022.25-34.<http://doi.org/10.1089/ast.2021.0035>
8. Dickson J., Martinez E., Pagano, J.J., Hudson, R., **Perl, S.M.**, Barge, L.M. (2022) Incorporating Microbes into Laboratory-Grown Chimneys for Hydrothermal Microbiology Experiments. *ACS Earth and Space Chemistry* 2022 6 (4), 953-961. DOI: 10.1021/acsearthspacechem.1c00354
9. **Perl, S.M.** Celestian, A.J., Cockell, C.S., Corsetti, F.A., Barge, L.M., Bottjer, D., Filiberto, J., Baxter, B.K., Kanik, I., Potter-McIntyre, S., Weber, J.M., Rodriguez, L.E., Daswani, M.M. (2021) A Proposed Geobiology-Driven Nomenclature for Astrobiological *In Situ* Observations and Sample Analyses. Volume 21, Number 7, 2021. Mary Ann Liebert, Inc. DOI: 10.1089/ast.2020.2318
10. Crandall, J.R., Filiberto, J., Castle, N., Potter-McIntyre, S.L., Schwenzer, S.P., Olsson-Francis, K., **Perl, S.M.** (2021) Habitability of Martian Noachian Hydrothermal Systems as Constrained by a Terrestrial Analog on the Colorado Plateau. *The Planetary Science Journal*, 2:138 (13pp) <https://doi.org/10.3847/PSJ/ac053e>
11. Weber, J.M., Henderson, B., LaRowe, D.E., Goldman, A.D., **Perl, S.M.**, Billings, K., Barge, L.M. (2021) Iron-sulfur minerals drive NAD⁺ reduction under prebiotic Earth conditions. *Astrobiology*. Jan 2022.25-34.<http://doi.org/10.1089/ast.2021.0035>
12. **Perl, S.M.**, Adeli, S., Basu, C., Baxter, B.K., Bowman, J. Boyd, E., Cable, M., Celestian, A.J., Cockell, C.S., Corsetti, F.A., Craft, K.L., Engelhart, A., Fairen, A.G., Potter-McIntyre, S., Lynch, K., Schneegurt, M., Schwenzer, S., Shkolyar, S., Theiling, B., Wade, B., Zaloumis, J. (2020) Salty Environments: The importance of evaporites and brine environments as habitats and preservers of biosignatures. *National Academy of Sciences, Planetary Science & Astrobiology Decadal Survey 2023-2032*.
13. Costello, L.J., Filiberto, J., Crandall, J.R., Potter-McIntyre, S.L., Schwenzer, S.P., Miller, M.A., Hummer, D.R., Karen Olsson-Francis, K., **Perl, S.** (2020) In Situ Alteration of a Mafic Dike Key to Understanding Habitability of the Martian Crust. Volume 80, Issue 2, 125613, ISSN 0009-2819, <https://doi.org/10.1016/j.chemer.2020.125613>. (<http://www.sciencedirect.com/science/article/pii/S0009281920300155>)
14. Cockell, C.S., Wilhelm, M.B., **Perl, S.M.**, Wadsworth, J., Payler, S., Palin, S., McMahon, S. (2020) “0.25 Ga salt deposits preserve geological signatures of habitable conditions and ancient lipids” *Astrobiology* Jul 2020.864-877.<http://doi.org/10.1089/ast.2019.2053> (Cover image of this issue is from our field site: <https://www.liebertpub.com/toc/ast/20/7>)
15. Hooks, M.R., Webster, P., Weber, J.M., **Perl, S.M.**, Barge, L.M. (2020) Effects of Amino Acids on Iron-Silicate Chemical Garden Precipitation *Langmuir* 36 (21), 5793-5801 <https://pubs.acs.org/doi/pdf/10.1021/acs.langmuir.0c00502>
16. Jones, J.P., Firdosy, S.A., Barge, L.M., Bescup, J.C., **Perl, S.M.**, Zhang, X., Pate, A.M., Price, R.E. (2020) 3D Printed Minerals as Astrobiology Analogs of Hydrothermal Vent Chimneys. *Astrobiology*. Dec 2020.1405-1412.<http://doi.org/10.1089/ast.2020.2260>
17. Wei, Y., Chin, K.B., Barge, L.M., **Perl, S.M.**, Hermis, N., Wei, T. (2020) Machine Learning Analysis of the Thermodynamic Responses of In Situ Dielectric Spectroscopy Data in Amino Acids and Inorganic Electrolytes. *J. Phys. Chem. B*. 124, 50, 11491–11500. <https://pubs.acs.org/doi/abs/10.1021/acs.jpcb.0c09266>

18. Carrier B.L., Beaty D.W., Meyer M.A., Blank J.G., Chou L., DasSarma S., Des Marais D.J., Eigenbrode J.L., Grefenstette N., Lanza N.L., Schuerger A.C., Schwendner P., Smith H.D., Stoker C.R., Tarnas J.D., Webster K.D., Bakermans C., Baxter B.K., Bell M.S., Benner S.A., Bolivar Torres H.H., Boston P.J., Bruner R., Clark B.C., DasSarma P., Engelhart A.E., Gallegos Z.E., Garvin Z.K., Gasda P.J., Green J.H., Harris R.L., Hoffman M.E., Kieft T., Koeppl A.H.D., Lee P.A., Li X., Lynch K.L., Mackelprang R., Mahaffy P.R., Matthies L.H., Nellessen M.A., Newsom H.E., Northup D.E., O'Connor B.R.W., **Perl S.M.**, Quinn R.C., Rowe L.A., Sauterey B., Schneegurt M.A., Schulze-Makuch D., Scuderi L.A., Spilde M.N., Stamenković V., Torres Celis J.A., Viola D., Wade B.D., Walker C.J., Wiens R.C., Williams A.J., Williams J.M., Xu J. (2020) Mars Extant Life: What's Next? Conference Report. *Astrobiology*, 27 May 2020, 20(6):785-814. DOI: 10.1089/ast.2020.223
19. Seyler, L., Azua-Bustos, A., Lee, M., Marlow, J. **Perl, S.M.**, Kujawinski, E.B., Cleaves II, J.H. (2020) "Metabolomics as an Emerging Tool in the Search for Astrobiologically-Relevant Biomarkers" *Astrobiology* DOI: 10.1089/ast.2019.2135 <https://www.liebertpub.com/doi/pdf/10.1089/ast.2019.2135>
20. Chan, M. A., Bowen B. B., Corsetti F.A., Farrand W.H., Law E.S., Newsom, H. E., **Perl S.M.**, Spear J. R., Thompson D. R. (2019) "Exploring, Mapping, and Data Management Integration of Habitable Environments in Astrobiology" *Front. Microbiol.*, 05 March 2019 <https://doi.org/10.3389/fmicb.2019.00147>
21. Cockell, C.S., Holt, J., Campbell, J., **Perl, S.M.** and 46 others (2018). "Subsurface scientific exploration of extraterrestrial environments (MINAR 5): Analogue science, technology and education in the Boulby Mine, UK." *International Journal of Astrobiology*, 1-26. doi:10.1017/S1473550418000186

Publications (Abstracts)

1. Sapers, H. M., Omelon, C., Pan, D., Küsel, K., J. **Perl, S.M.**, Rusely, C., Whyte, L., Orphan, V. (2024) Biogeochemical Diversity of Permafrost-Hosted Perennial Hypersaline Cold Springs. *19th International Symposium on Microbial Ecology*. 18-23 August 2024, Cape Town, South Africa.
2. Nisson, D.M., Daswani, M.M., **Perl, S.M.**, Hughes, E., Dharmapriya, P., Karunatillake, S., and the 2023 Sri Lanka Expedition Team (2024) Paleo-Fluid Conditions of Sri Lankan Serpentine Zones an an Analog for Noachian Habitability. *Astrobiology Science Conference*, 5-10, May 2024, AGU/LPI Contribution No. 1498237
3. Garner, M., **Perl, S.M.**, Foreman, C.M. (2024) Exploring Salt Composition Impacts on Brinicle Growth and Morphology. *Astrobiology Science Conference*, 5-10, May 2024, AGU/LPI Contribution No. 1499742
4. **Perl, S.M.**, Cockell, C.S., Fischer, W.W., Lloyd, K.G., Corsetti, F.A., Foreman, C.M., Freedman, K., Wilhelm, M.B., Lynch, K., Homann, M., Som, S.M., Wilson, L., Karunatillake, S., Bywaters, K., Mikucki, J., Celestian, A.C., Chen, P., Guan, L., Ibarra, Y., Sobron, P., Malaska, M., Nisson, D.M., Garner, M., Murphy, A., Sharma, S., Willis, M., Eshelman, E. (2024) The Biology of Biosignature Detection – Year One: Building the Experimental Framework for Extant and Extinct Life Measurements. *Astrobiology Science Conference*, 5-10, May 2024, AGU/LPI Contribution No. 1500139
5. Howell, S.M., Mikucki, J., Lesage, E., Campbell, S.W., Cwik, T.A., **Perl, S.M.**, Smith, M.W., Winebrenner, D.P., Burnett, J., Clance, J., Clavette, R., Garner, M., Haq, S., Hockman, B.J., Holmes, J., Javier, B., Shaffer, J., Wilson, L. (2024) Cryobot Analogue Mission: Ocean Worlds Reconnaissance and Characterization of Astrobiological Analogues (ORCAA). *Astrobiology Science Conference*, 5-10, May 2024, AGU/LPI Contribution No. 1500103
6. Basu, C., Nagalingam, S., Guenther, A.B., Patel, L., Shaurya, F., **Perl, S.M.** (2024) Molecular Physiological Responses of *Halobacterium salinarum* to Planetary Environmental Stresses. *Astrobiology Science Conference*, 5-10, May 2024, AGU/LPI Contribution No.1498237
7. Robinson, A., Ulrich, S., Dondero, T., Javier, B., **Perl, S.M.** (2024) Growth and Raman Analyses of *Haloferax volcanii* in Mars-relevant Conditions. *Astrobiology Science Conference*, 5-10, May 2024, AGU/LPI Contribution No.1500394.

8. Clance, J., Mikucki, J., Shaffer, J., Howell, S.M., Campbell, S.W., Cwik, T.A., **Perl, S.M.**, Smith, M.W., Winebrenner, D.P., Burnett, J., Clavette, R., Garner, M., Haq, S., Hockman, B.J., Holmes, J., Javier, B., Lesage, E., Rajguru, A., Valera, J., Wilson, L. (2024) Ground-truthing Ocean Worlds Life Detection Mission Concepts in the Juneau Icefield, Alaska. *Astrobiology Science Conference*, 5-10, May 2024, AGU/LPI Contribution No.1498389
9. Burchard, T., Freedman, K., **Perl, S.M.** (2024) Preservation of Biosignatures in Frozen and Non-frozen Brines in Hypersaline Planetary Analog Environments. *Astrobiology Science Conference*, 5-10, May 2024, AGU/LPI Contribution No.1500290
10. Javier, B., Garner, M., **Perl, S.M.**, Fischer, W.W., Howell, S.M., Lesage, E., Mikucki, J., Shaffer, J., Clance, J., Cwik, T., Winebrenner, D.P., Clavette, R., Haq, S., Campbell, S.W. (2024) Preservation of Psychrophile Biomolecules After Heating for Life Detection on Icy Moons. *Astrobiology Science Conference*, 5-10, May 2024, AGU/LPI Contribution No. 1500344
11. **Perl, S.M.**, Celestian, A.J., Cockell, C.S., Corsetti, F.A., Basu, C., Nisson, D.M., Garner, M., Valera, J., Javier, B.M. (2023) Microbial Pigment Robustness in Martian and Ocean Worlds Brines and Evaporites. 54th Lunar and Planetary Science Conference, held virtually, 13-17 March, 2023. LPI Contribution No. 2434
12. Javier, B.M., **Perl, S.M.**, C. Basu, W. Fischer, A. J. Celestian (2023) Detection and Preservation of Extremophile Biosignatures in Li-Bearing Evaporites for Life Detection. 54th Lunar and Planetary Science Conference, held virtually, 13-17 March, 2023. LPI Contribution No. 2825
13. Cortez, P. and **Perl, S.M.** (2023) Astrobiological Assessments of Geobiological Features within Habitable Environments: Developing the Geobiological Handbook of Measurements for Life Detection. 54th Lunar and Planetary Science Conference, held virtually, 13-17 March, 2023. LPI Contribution No. 2334
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Service to the Scientific Community

- **Team and Study Lead, The Biology of Biosignature Detection (KISS Workshop)** 2023-2024
 - Constructed and led a 31-person Keck Institute of Space Sciences workshop in determining the metrics for validating biological processes within the Martian subsurface, saline mineralogy, and Ocean World brine environments.
 - Leading simultaneous efforts to bring geomicrobiology and microbiology experiments to planetary science payloads and mission formulation in the post-Mars Sample Return timeframe.
- **Member, International Space Science Institute: New Mars Life Underground**, Bern, Switzerland 2022-2023
 - Part of the ~15 member international group led by John Mustard (Brown University) to determine the potential for subsurface microbial extant life on Mars, the in-situ science investigations needed to determine biogenicity, and potential pathways to access that evidence.
- **Steering Group Member, Mars Exploration Program Analysis Group (MEPAG), Mars Concurrent Exploration Science Analysis Group (MCE-SAG)** 2022-2023
 - Determining in-parallel Mars discipline science for missions and science investigations during the period prior to and after Mars Sample Return (MSR) campaigns
- **Community Report from the Biosignatures Standards of Evidence Workshop (2022)** Lead Authors: Victoria Meadows (University of Washington) and Heather Graham (NASA-GFCS) with ~40 others including **Scott Perl (JPL NASA)**, <https://arxiv.org/ftp/arxiv/papers/2210/2210.14293.pdf> 2022

- **Session Convener, Astrobiology Science Conference**, Diagenesis and Subsurface Habitable Environments **2022**
Sheppard, R., **Perl, S.M.**, Celestian, A.J., Horgan, B.H.N., Potter-McIntyre, S.L.
- **Session Convener, American Geophysical Meeting**, Exploring Hydrothermal Processes and Geochemistry Across the Solar System's Geologic Evolution and Habitability. Whitten, J.L., Karimi, S., Chandrajith, R., **Perl, S.M.**, Wray, J.J., Snow, J.E. Karunatillake, S. **2021**
- **Co-Author, White Paper to the National Academy of Sciences, Planetary Science & Astrobiology Decadal Survey 2023-2032**. GANGOTRI mission concept on the glacial key to the Amazonian climate of Mars. Karunatillake, S., Bramson, A., Zacny, K., Dundas, C., Ojha, L., Aharonson, O., Vos, E., Hood, D.R., Rogers, D., Levy, J., Doran, P., Mandt, K., Wilson, J., Hughes, E.B., Fuqua-Haviland, H., Moersch, J., **Perl, S.M.**, Haque, D.M.E., Skok, J. R., Harish, Vijayan, S., Bhardwaj, A., Christner, B., Sizemore, H., Keresztsuri, A., Schorghofer, N., Rutherford, K., Niles, P., Lorenzo, J., Mesick, K., Franz, H., Rodriguez-Manfredi, J., Coupland, D., Bramall, N., Bertone, P. **2020**
- **Lead Author, White Paper to National Academy of Sciences, Planetary Science & Astrobiology Decadal Survey 2023-2032**. Salty Environments: The importance of evaporites and brine environments as habitats and preservers of biosignatures (2020) **Scott M. Perl** (Lead), Solmaz Adeli (German Aerospace Center), Chhandak Basu (California State Uni. Northridge), Bonnie K. Baxter (Great Salt Lake Institute, Westminster College), Jeff Bowman (Scripps Institution of Oceanography), Eric Boyd (Montana State University), Morgan Cable (NASA Jet Propulsion Laboratory), Aaron J. Celestian (Los Angeles Natural History Museum), Charles S. Cockell (University of Edinburgh), Frank A. Corsetti (University of Southern California), Kate L. Craft (Johns Hopkins Applied Physics Laboratory), Aaron Engelhart (University of Minnesota), Alberto G. Fairen (Centro de Astrobiología), Suniti Karunatillake (Louisiana State University), Sally Potter-McIntyre (Southern Illinois University Carbondale), Frances Rivera-Hernandez (Georgia Institute of Technology), Kennda Lynch (Lunar and Planetary Institute, USRA), Mark Schneegurt (Wichita State University), Susanne Schwemmer (The Open University), Svetlana Shkolyar (USRA / NASA Goddard Space Flight Center), Bethany Theiling (NASA Goddard Space Flight Center), Brian Wade (Michigan State University), Jon Zaloumis (Arizona State University) and 29 Co-Signers. **2020**
- **Co-Author, Mars Extant Life: What's Next? Salts, Brines, and Evaporites Group Conference Report** **2019**
Bonnie K. Baxter-Clark, Steven Benner, Robert B. Bruner, Benjamin Brunner, Benton Clark, Priya DasSarma, Shiladitya DasSarma (Lead), Aaron Engelhart, Kennda Lynch, Larry H. Matthies, **Scott M. Perl**, Dirk Schulze-Makuch, Heather D. Smith, and Jie Xu. S.D.
- **Co-Author, White Paper to National Academy of Sciences - Astrobiology Science Strategy for the Search for Life in the Universe** “Seeking the origins of aqueous life on Titan” (Lead author: M. Cable) **2018**
- **Co-Author, White Paper to National Academy of Sciences - Astrobiology Science Strategy for the Search for Life in the Universe** “Enceladus: A Review of Recent Discoveries” (Lead author: M. Cable) **2018**
- **Session Chair, American Geophysical Union** “P019: Investigating mineral-organic interactions relevant to astrobiological systems on Mars and other planetary bodies” with Laurie Barge (Caltech/NASA-JPL), Jorge Valdés (Universidad Mayor, Centro de Genómica y Bioinformática, Santiago, Chile), and David S Holmes (Fundación Ciencia & Vida, Center for Bioinformatics and Genome Biology). **2017**
- **Session Chair, Astrobiology Science Conference**, Mars Biomarkers session “Modern and Ancient Biosignatures and the Search for Life on Mars” with Andrew Czaja (University of Cincinnati). **2017**
- **Reviewer**, Manuscript Submissions, Journal of Geophysical Review (JGR)-Planets, Geochimica et Cosmochimica Acta (GCA), Earth and Planetary Science Letters (EPSL), Philosophical Transactions of the Royal Society A: Mathematical, Physical, and Engineering Sciences (Phil. Trans. Royal Soc. A).

- **Reviewer, External Reviewer, Panel Secretary - Multiple NASA ROSES Proposal Cycles**, Mars Data Analysis Program (MDAP), Planetary Data Archiving, Restoration, and Tools (PDART), NASA Earth and Space Science Fellowship (NESSF), Mars Fundamental Research Program (MFRP), NASA Astrobiology Institute (NAI), Planetary Science and Technology through Analog Research (PSTAR), NASA Postdoctoral Program (NPP), Solar System Workings (SSW)

Selected Fieldwork and Expeditions

• MINAR X, Mine Astrobiology Research, UK Centre for Astrobiology	2022
• MINAR 8, Boulby Underground Laboratory, England (Zechstein Form.), UK Centre for Astrobiology	2020
• Salado formation, Waste Isolation Pilot Plant (WIPP), New Mexico, United States	2019
• Green River Basin, Colorado Plateau, UT, USA	2019
• MINAR 6, Boulby Underground Laboratory, England (Zechstein Form.), UK Centre for Astrobiology	2018
• Great Salt Lake, Ogden, UT, USA	2013-2016
• Death Valley, CA, USA (Crystal Springs Formation, Johnnie Formation, Noonday)	2014, 2016, 2018
• Mojave Desert, CA, USA	2016-2018
• MINAR 5, Boulby Underground Laboratory, England (Zechstein Form.), UK Centre for Astrobiology	2017
• Waimangu Volcanic Valley and Taupo Volcanic Zone hot springs, Rotorua, New Zealand	2015
• Rio Tinto Basin, (Minas de Rio Tinto), Seville, Spain	2014
• Cretaceous/Tertiary (K-T boundary), Zumaia, near Chapel of San Telmo, Basque Costal Region, Spain	2014
• Little Hot Creek (Long Valley, CA, USA) and Walker Lake (Reno, NV, USA)	2014

Educational Outreach and Teaching

• Whitby Museum , Part of the MINAR X Science Campaign	2022
○ Invited Public Lecture: “ <i>The Biology of Biosignatures on subsurface Mars and Ocean Worlds</i> ”	
• Westminster College , Astrobiology Lecture (BIOL-303)	2021
○ Invited Lecture: “ <i>Primer on Mars Sedimentology and Potential Geobiology for Extinct and Extant Life</i> ”	
• National Science Foundation , Bridge To The Geosciences, NASA-JPL module	2019
• Los Angeles Natural History Museum , Research & Collections Seminar Series	2018
○ Invited Talk: “ <i>Constraining Mineral-Microbial Interactions within Martian Analogue Evaporitic Preservation Environments</i> ”	
• National Science Foundation , Bridge To The Geosciences, NASA-JPL module	2018
○ Invited Speaker: “ <i>Perspectives on Mars Exploration: Astrobiology, Habitability, and Geobiology</i> ”	
• National Science Foundation , Bridge To The Geosciences (BTTG), Catalina Island module	2018
• Career Day , STEM career event Colton-Redlands-Yucaipa Regional Occupation Program	2017
• The Science & Application of Life Detection , University of Southern California	2012
○ Invited Speaker: “ <i>Science mission of the Mars Science Laboratory and the future of Mars astrobiology</i> ”	
• School of Aeronautics & Astronautics , Purdue University	2009
○ Guest Speaker: “ <i>Science Investigation Overview from the Mars Exploration Rover mission</i> ”	
• Science & Society SSO-102 “Exploration of the Solar System” , SUNY Stony Brook	2006
○ Guest speaker: “ <i>A day in the life of a Mission Scientist</i> ”	
• Undergraduate Research & Creative Activities (URECA) Celebration Day , SUNY Stony Brook	2005-2008
• College of Engineering & Applied Sciences – Exam Preparation Program , SUNY Stony Brook	2004
Calculus I (MAT-131), Calculus A (MAT-125), Calculus B (MAT-126)	

Mentoring and Students

2023-Present	Taylor Burchard, Department of Biophysics, University of California, Riverside
2022-Present	Adam Robinson, Department of Biology, St. Petersburg College, Florida
2022	Jess Pavlik, Department of Biology, Tulsa Community College & The University of Tulsa
2022	Crystal Dang, Department of Biology, Virginia Tech
2021-Present	Breanna Javier, Dept. of Biology / Geological & Planetary Sciences, California Institute of Technology
2021-Present	Meghan Winzler, Department of Microbiology, California State University Long Beach

2021-Present	Paulina Cortez, STAR program, San Diego State University
2020-2022	Zac Cooper, Department of Oceanography & Astrobiology (dual program), University of Washington
2020-Present	Devan Nisson, Geomicrobiology Research Group, Princeton University (now NASA Ames)
2020-Present	Madeline Garner, College of Coastal Georgia & Blue Marble Space Institute of Science
2019-Present	Jose Valera, University of California Santa Barbara, Department of Biology
2019-Present	Bea Baharier, Department of Astrobiology, Open University
2019	Jemma Dickson, Chemistry & Marine Biological Science College of the Atlantic
2019-2022	Eduardo Martinez, Civil Engineering, Environmental and Water Resource Engineering, Cal State LA
2019	Sarah Crucilla, Geological & Planetary Sciences, California Institute of Technology
2018-2022	Preston Tasoff, Department of Biology, Washington University
2018	Michelle Hooks, JPL STAR intern in teaching
2018-2019	Jonathan Major, Department of Geosciences
2018	Angel Chavez, Dept. of Chemical Engineering & Materials Science, University of California, Irvine
2017-2018	Taleen Mahseredjian, Dept. of Earth Sciences, University of Southern California

Selected Presentations (Talks)

- **Invited Talk, Ecology, Evolution, and Marine Biology, UC Santa Barbara** 2024
"Geologic Preservation of Halophilic Microorganisms and Metabolite Validation"
- **Invited Talk, Dept. of Biophysics, University of California, Riverside** 2024
"Verification of Extant Life in the Mineral Record: Utilizing Agnostic Chemical Biomarker Gradients"
- **Invited Talk, DIX Planetary Science Seminar, Geological and Planetary Sciences, Caltech** 2024
"Validating Cellular Life and Extant Biological Process from Martian Analog Brines and Evaporites"
<https://www.caltech.edu/campus-life-events/calendar/dix-planetary-science-seminar-145>'
- **Invited Talk, International Space Science Institute**, Bern, Switzerland, 2022
"Subsurface Biology on Mars: Probability, Preservation, and Determining Biogenicity"
- **Invited Talk, Environmental Geology & Geochemistry Seminar (EGGS)**, Princeton University 2022
"Quantifying Biosignature Preservation in Brine and Evaporitic Martian Analog Environments"
(<https://geosciences.princeton.edu/events/environmental-geology-geochemistry-seminar-eggs-perl>)
- **Invited Talk, UK Centre for Astrobiology**, University of Edinburgh 2020
"Evaporite Biomarker and Biosignature Validation from the Modern to the Permian"
- **Invited Talk, Marine Biology Research Division**, Scripps Institute of Oceanography 2020
"Halophilic Microorganism Preservation using Evaporite Mineralogy within Closed-Basin Lake Systems"
- **Invited Talk, Geological and Planetary Sciences-Yung Seminar Series**, California Institute of Technology 2019
"Validation of Preserved Biological Processes within Evaporitic Mineralogy: Implications for Extant and Extinct Life"
- **Mars Forum, Science Division**, NASA Jet Propulsion Laboratory 2017
"Identification and Validation of Biogenic Preservation: Defining Constraints within Martian Mineralogy"
- **Department of Earth Sciences, Paleoenvironment Seminar**, University of Southern California 2016
"On the detection and validation of biogenic matter within minerals: Constraining preservation potential within the Martian shallow subsurface via terrestrial analogues"
- **Mars Reconnaissance Orbiter, Science Discussion**, NASA Jet Propulsion Laboratory 2016
"Ancient Mars: Environmental Transitions and Habitability"

- **Planetary Science Seminar – Science Division**, NASA Jet Propulsion Laboratory **2012**
“Constraints on Permeability Resulting from Secondary Porosity in the Burns Formation, Meridiani Planum, Mars”
- **Graduate Circus – Department of Geosciences**, Stony Brook University **2008**
“Investigation of secondary porosity and permeability from Eagle to Victoria craters”
- **Mars Exploration Rover - Athena Science Team meeting**, Cornell University **2005**
“Grain Boundary & Secondary Porosity Analysis of the Burns Formation, Meridiani Planum, Mars”

Misc. Awards & Grants

NASA Jet Propulsion Laboratory – 10 Year Service Award	2022
NASA Honors Award - MRO Comet Siding Spring Observing Team – Group Achievement Award	2015
NASA Honors Award - MSL Prime Mission Science and Operations Team - Group Achievement Award	2015
NASA Astrobiological Institute Scholarship - Josep Comas i Solà International Summer School in Astrobiology, Universidad Internacional Menéndez Pelayo, Santander, Spain	2014
NASA Honors Award - MSL Project Operations Team - Group Achievement Award	2013
Mars Science Laboratory (MSL) Team Award – Science Planning Team	2012,2013
Seventh International Conference on Mars Student Award Grant	2007
Undergraduate Research & Creative Activities (URECA) Research and Travel Grants	2005-2007
Undergraduate Research & Creative Activities (URECA) Travel Grant	2007
Featured in “Stony Brook Claims to Fame”, “Research Roundup”, “Sciences at Stony Brook”	2005-2007
NASA Group Achievement Award – Mars Exploration Rover mission: 2 nd Extended Mission Sci. Team	2005
College of Engineering & Applied Sciences - Award in Teaching (Mathematics)	2004

Selected Conference Oral Presentations

Astrobiology Science Conference, Atlanta, GA	2022
Brines in the Solar System: Modern Brines, Biosignatures in Salt, held virtually, LPI sponsored	2021
Mars Extant Life: What's Next?, Potential Martian Extant Life Environments I: Ice and Salt, Carlsbad, NM	2019
Astrobiology Science Conference, Bellevue, WA	2019
Habitability: The First Four Billion Years – Biosignature Theory and Detection of Life, Big Sky, MT	2019
12 th Conference on Halophilic Microorganisms – Astrobiology session, Cluj-Napoca, Romania	2019
Committee on Space Research (COSPAR), Biosignature Detection in the Solar System, Pasadena, CA	2018
Astrobiology Science Conference, Mesa, AZ	2017
National Academy of Sciences – Space Studies Board: Searching for Life across Space & Time, Irvine, CA	2016
Biosignature Preservation and Detection in Mars Analog Environments, Lake Tahoe, NV	2016
Astrobiology Science Conference, Chicago, IL	2015
American Geophysical Union, San Francisco, CA	2012, 2014
Eighth International Conference on Mars, California Institute of Technology, Pasadena, CA	2014
Lunar and Planetary Science Conference, Lunar Planetary Institute, Houston, TX	2005-2009, 2013
Seventh International Conference on Mars, California Institute of Technology, Pasadena, CA	2007
Undergraduate Research & Creative Activities, Stony Brook University, Stony Brook, NY	2005-2007

General Work Experience

State University of New York at Stony Brook – Technical Support (President’s and Provost’s offices)	2007-2008
State University of New York at Stony Brook – Resident Assistant (RA)	2004-2007
-Responsibilities include creating instructive programs while serving as a mediator, counselor, crisis manager, and assistant to my 38 residents, at the same time enforcing campus policy and procedures.	
Department of Geosciences - McLennan group website – Webmaster	2003-2008
State University of New York at Stony Brook – Lab Manager	2003-2007

Professional Associations

American Geophysical Union (AGU)	2012-Present
Geological Society of America (GSA)	2003-Present