

# Cecilia B. Sanders, PhD

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## Deep Time Peter Buck Postdoctoral Fellow

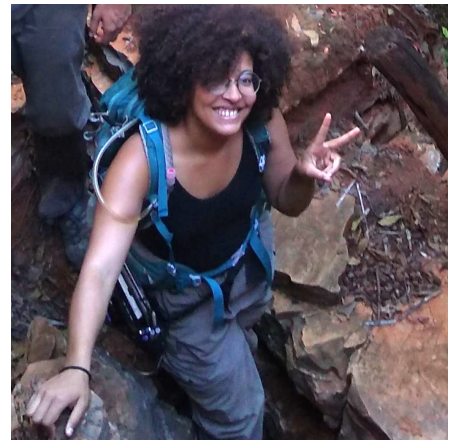
Smithsonian National Museum of Natural History

Starting Summer 2024

## Assistant Professor

University of Maryland Department of Geology

Starting 2025



## Education

- 2018 – 2022 **Ph.D. Geobiology, Caltech** Geological and Planetary Sciences.  
Doctoral Thesis: *Geological and Geochemical Explorations of the Salitre Formation Phosphorite, Eastern Brazil.* <https://doi.org/10.7907/rd4m-7x08>
- 2016 – 2018 **M.Sc. Planetary Science, Caltech** Geological and Planetary Sciences.
- 2012 – 2016 **B.A. Earth and Planetary Sciences and Astrophysics, Harvard University**  
Senior thesis title: *Impact gardening as a mechanism for hydrothermal alteration and atmospheric evolution on Noachian Mars.*  
Junior thesis title: *When planets breathe – Models constrain the circumstances for detection of biomarker gases on the terrestrial exoplanets of M Dwarfs.*

## Awards

### Awards and Achievements

- 2024 – present **Deep Time Peter Buck Postdoctoral Fellowship**, Smithsonian National Museum of Natural History.
- 2022 – 2024 **Morton K. Blaustein Postdoctoral Fellowship**, Johns Hopkins Department of Earth and Planetary Sciences.
- 2016 – 2022 **NSF Graduate Research Fellowship**, National Science Foundation.
- 2020 **Award for educational outreach**, Caltech Division of Geological and Planetary Sciences.
- 2018 **Ian Campbell Award for outstanding achievement in field geology courses**, Caltech Division of Geological and Planetary Sciences.
- 2015 **Leo Goldberg Prize in Astronomy**, Harvard-Smithsonian Center for Astrophysics. Junior thesis award.

## Research Publications

### Journal Articles

- Sanders, C. B.**, Present, T., Marroquin, S., & Grotzinger, J. (2024). Sulfur geochemistry of the salitre formation phosphorites: Implications for the role of microbial ecology and sulfur cycling in phosphogenesis on an ediacaran carbonate platform. *Geochimica et Cosmochimica Acta*, 367. <https://doi.org/10.1016/j.gca.2023.12.033>

- 2 **Sanders, C. B.,** Eiler, J., & Grotzinger, J. (2023). Paragenesis of an ediacaran carbonate-platform phosphorite: Constraints from optical petrography and texture-specific clumped isotope paleothermometry. *Sedimentary Geology*, 444. <https://doi.org/10.1016/j.sedgeo.2022.106316>
- 3 **Sanders, C. B.,** & Grotzinger, J. P. (2021). Sedimentological and stratigraphic constraints on depositional environment for Ediacaran carbonate rocks of the São Francisco Craton. *Precambrian Research*, 363. <https://doi.org/10.1016/j.precamres.2021.106328>
- 4 Wordsworth, R., Kalugina, Y., Lokshtanov, S., Viagasın, A., Ehlmann, B., Head, J., **Sanders, C. B.,** & Wang, H. (2014). Transient reducing greenhouse warming on early mars. *Geophysical Research Letters*, 44(2), 665–671. <https://doi.org/10.1002/2016GL071766>

## Conference Proceedings

- 1 **Sanders, C. B.** (2023). Oral presentation: Interrogating the role of microorganisms in the genesis of sedimentary phosphorite deposits at the Precambrian-Cambrian boundary, In *Mid-Atlantic Geobiology Symposium*, Newark, DE.
- 2 **Sanders, C. B.,** & Grotzinger, J. (2020). Invited oral presentation: Sedimentary context and diagenetic history of phosphatic microbialites, Ediacaran Una-Bambuı carbonate platform, Eastern Brazil, In *American Geophysical Union Fall Meeting (ICEE 2020)*, Virtual.
- 3 **Sanders, C. B.,** Orphan, V. J., Ehlmann, B. L., & Grotzinger, J. P. (2019). Oral presentation: Sweet Honey in the Rock – Cultivating and characterizing the biosignatures of chemolithotrophic microorganisms on Mars analog substrates, In *16th Annual Southern California Geobiology Symposium*, Pasadena, CA.
- 4 **Sanders, C. B.,** Orphan, V. J., Ehlmann, B. L., & Grotzinger, J. P. (2018a). Poster: Sweet Honey in the Rock – Cultivating and characterizing the biosignatures of chemolithotrophic microorganisms on Mars analog substrates, In *American Geophysical Union Fall Meeting 2018*, Washington, DC.
- 5 **Sanders, C. B.,** Orphan, V. J., Ehlmann, B. L., & Grotzinger, J. P. (2018b). Poster: Sweet Honey in the Rock – Cultivating and characterizing the biosignatures of chemolithotrophic microorganisms on Mars analog substrates, In *Simons Collaboration on the Origins of Life*, New York, NY.
- 6 **Sanders, C. B.,** & Wordsworth, R. (2016). Oral presentation: Impact gardening as a mechanism for hydrothermal alteration and atmospheric evolution on Noachian Mars (ABSTRACT 2634), In *47th lunar and planetary science conference*, The Woodlands, TX.
- 7 **Sanders, C. B.,** & Ciesla, F. (2014). Poster: Explaining the noble gas content of the planets – Theoretical models for argon-trapping by amorphous ices in the solar nebula, In *American Geophysical Union Fall Meeting (ICEE 2014)*, San Francisco, CA.

## Research Experience

- 2022 – present ■ **Characterizing different styles of phosphate mineralization in Ediacaran and Lower Cambrian sedimentary rocks of Mongolia and Kazakhstan, through sedimentology, stratigraphy, petrography, and spatially resolved elemental and isotopic analyses.** Johns Hopkins Department of Earth and Planetary Sciences. Advised by Profs. Emmy Smith and Maya Gomes.
- 2018 – 2022 ■ **Exploring mechanisms of phosphogenesis in Ediacaran Carbonate formations of the São Francisco Craton, Eastern Brazil, through sedimentology, stratigraphy, petrography, and spatially resolved elemental and isotopic analyses ( $\Delta_{47}$ ,  $\delta^{13}C$ ,  $\delta^{18}O$  of carbonate ions in calcite, dolomite, and francolite,  $\delta^{34}S$  of sulfate in calcite, dolomite, and francolite, and  $\delta^{34}S$  of sulfide in pyrite and extracted chromium-reducible sulfur).** Caltech Division of Geological and Planetary Sciences. Advised by Profs. John Grotzinger and John Eiler.

## Research Experience (continued)

- 2016 – 2018    **Cultivation and detection of microbial biosignatures on Mars-analog materials.** Caltech Division of Geological and Planetary Sciences. Advised by Profs. Bethany Ehlmann and Victoria Orphan.
- 2016 – 2019    **SIMS analysis for C-isotopes of microfossils in Gunflint Chert.** Caltech Division of Geological and Planetary Sciences. Advised by Prof. John Grotzinger and Kenneth Williford.
- 2015 – 2016    **Combined petrographic and theoretical study of meteor impacts as drivers of hydrothermal processes on Noachian Mars and analogs.** Harvard University Department of Earth and Planetary Sciences. Advised by Profs. Robin Wordsworth and Francis Macdonald.
- 2014 – 2015    **Modeling of transmission spectra of oxygen- and methane-bearing atmospheres of Earth-like planets around M-dwarf stars.** Harvard-Smithsonian Center for Astrophysics. Advised by Prof. David Charbonneau.
- Summer 2014    **Modeling of argon-trapping by amorphous ices in solar nebulae: a possible mechanism for noble-gas delivery to young planets.** University of Chicago, Leadership Alliance. Advised by Prof. Fred Ciesla.
- 2013 – 2014    **Preparation of samples for rare sulfur isotope analysis.** Harvard University Department of Earth and Planetary Sciences. Advised by Prof. David Johnston.
- Summer 2013    **Characterization of Mars-analog geological samples using remote IR spectroscopy.** Caltech Division of Geological and Planetary Sciences, Jet Propulsion Laboratory, Summer Undergraduate Research Fellowship (SURF) Program. Advised by Prof. Bethany Ehlmann and Glenn Sellar.
- Summer 2012    **Remote detection of methane on Mars via echelle spectroscopy data from Keck2.** NASA Goddard Space Flight Center, Center for Astrobiology. Advised by Geronimo Villanueva.
- Summer 2011    **Characterization of surface ices on Saturn's icy moons via Cassini's Composite Infrared Spectrometer data.** NASA Goddard Space Flight Center. Advised by Terry Hurford.

## Teaching, Outreach, and Science Communication

- 2023 – 2024    **Instructor.** *The Johns Hopkins University Dept. of Earth & Planetary Sciences.* Curriculum design, lecture, and lab instruction for graduate/undergraduate course, *How to Live Forever: The Making of the Geologic Record of Life.*
- 2022 – 2023    **Instructor.** *The Johns Hopkins University Dept. of Earth & Planetary Sciences.* Curriculum design, lecture, and lab instruction for Special Opportunities in Undergraduate Learning (SOUL) Course 23, *Beyond Bones: Microorganisms in the Rock Record.*
- Oct. 2023    **Content Consultant and Interviewee for PBS NOVA.** *PBS NOVA and The BBC.* Scientist appearing in *Ancient Earth: Frozen* television episode.
- 2022 – 2023    **Diversity Postdoctoral Alliance Committee (DPAC) HBCU Mentoring Program.** *The Johns Hopkins Postdoctoral Association.* Mentoring/advising for undergraduate students at Mid-Atlantic HBCUs
- 2017 – 2021    **Visiting Scientist Program.** *Caltech Center for Teaching, Learning, and Outreach (CTLO) and Pasadena Unified School System (PUSD).* Science curriculum design and both in-person and virtual in-class teaching experience with Grades K-5.
- 2017 – 2020    **Science Night Exhibitions.** *Caltech Center for Teaching, Learning, and Outreach (CTLO) and Pasadena Unified School System (PUSD).* Series of extra-curricular STEM expos for K-12 students and families in Pasadena.

## Teaching, Outreach, and Science Communication (continued)

- 2018 – 2019    **Teaching Assistant.** *Caltech Division of Geological and Planetary Sciences.* Ge 11b/104: Introduction to Geobiology.
- 2017 – 2018    **Teaching Assistant.** *Caltech Division of Geological and Planetary Sciences.* Ge 116: Analytical Methods.
- Jul. 2019    **Caltech Astro Virtual Lecture Series.** *Caltech Astronomy.* Virtual public lecture. *You'll know it when you see it: Defining, describing, and detecting life in the universe.* <https://youtu.be/VyzQpk2m5Hk>
- Jun. 2019    **Real Science.** CaltechLive! virtual public talk, discussion mediation for Grades 3-8. *Beyond Bones: Interrogating the fossil record of small, soft, profoundly Earth-shaping organisms in the Precambrian.*
- Nov. 2019    **Southern California Paleontological Society Lecture Series.** Public lecture for all ages. *Micropaleontology: Interrogating the fossil record of small, soft, profoundly Earth-shaping organisms in the Precambrian.*
- May 2019    **Astronomy On Tap – Los Angeles.** Public talk. *Pebbles on the shore: Reconstructing ancient alien habitats on Earth and Mars.*
- Apr. 2019    **Science Symposium Talk.** Lecture at Sequoyah High School Science Symposium. *Geomicrobiology.*
- Reel Science.** CaltechLive! Public talk, discussion mediation for Grades 3-8. *Galapagos: The islands that changed the world.*
- Feb. 2017    **Caltech Astro Lecture Series.** *Caltech Astronomy.* Panelist, facilitating discussion after public lecture. *The Science of Star Trek – Michael Wong, Ph.D.*

## Skills

- Analytical Methods    **SEM/EDS/EBSD; XRF; XRD; Raman Spectroscopy; micro CT; SIMS/nanoSIMS; IRMS for  $\Delta_{47}$ ,  $\delta^{13}C$ , and  $\delta^{18}O$  of carbonate in calcite, dolomite, and francolite,  $\delta^{34}S$  of sulfate in calcite, dolomite, and francolite, and  $\delta^{34}S$  of sulfide in pyrite and extracted chromium-reducible sulfur; optical imaging and characterization of petrographic thin sections; chemical assays for sulfur and iron species, maintenance of microbial cultures; preparation of mineralogical and biological samples for any of the previously listed methods; field geology (campaign logistics, mapping, description, measurement, geological sample collection and archiving); CRS extraction; bulk CAS and PAS extraction and purification; and trace CAS extraction and purification.**
- Coding    **Python, Matlab,  $\LaTeX$**
- Misc.    **Scientific writing, hand and digital illustration, graphic design (logos, posters, documents, infographics), public speaking, in-classroom teaching (K-12, undergraduate, and graduate-level courses)**

## References

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- **Emmy Smith**, *Associate Professor*  
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- **John P. Grotzinger**, *Harold Brown Professor of Geology, Ted and Ginger Jenkins Leadership Chair*  
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- **John Eiler**, *Robert P. Sharp Professor of Geology and Geochemistry*  
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- **Victoria Orphan**, *James Irvine Professor of Environmental Science and Geobiology, Allen V.C. Davis and Lenabelle Davis Leadership Chair, Center for Environmental Microbial Interactions, Director: Center for Environmental Microbial Interactions*  
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- **Kathryn "Kitty" Cahalan**, *Outreach Program Manager*  
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