Cecilia B. Sanders

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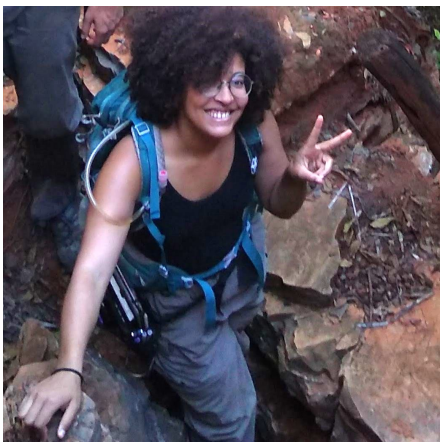
Morton K. Blaustein Postdoctoral Fellow

The Johns Hopkins University Dept. of Earth & Planetary Sciences



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

2022 – present **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

1. **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

2. **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

3. Wordsworth, R., Kalugina, Y., Lokshtanov, S., Viagasin, 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

4. **Sanders**, **C. B.**, Eiler, J., & Grotzinger, J. (in prep). Sulfur geochemistry of the salitre formation phosphorites: Implications for the role of sulfur cycling in phosphogenesis on an ediacaran carbonate platform. *TBD*.

Conference Proceedings

1. **Sanders**, **C. B.**, & Grotzinger, J. (2020). Invited oral presentation: Sedimentary context and diagenetic history of phosphatic microbialites, Ediacaran Una-Bambuí carbonate platform, Eastern Brazil, In *American Geophysical Union Fall Meeting (ICEEE 2020)*, Virtual.

2. **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.

3. **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.

4. **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.

5. **Sanders**, **C. B.**, & Wordsworth, R. (2016). Oral presentation: Impact gardening as a mechanism for hydrothermal alteration and atmopspheric evolution on Noachian Mars (Abstract 2634), In *47th lunar and planetary science conference*, The Woodlands, TX.

6. **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 (ICEEE 2014)*, San Francisco, CA.

Research Experience

2022 – present — **Characterizing different styles of phosphate mineralization in Ediacaran and Lower Cambrian sedimentary rocks of Western Mongolia, 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 (Δ_{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.

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.

Research Experience (continued)

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 possble 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

2022 – present — **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*.

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.

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*.

Teaching, Outreach, and Science Communication (continued)

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; IR Spectroscopy; SIMS/nanoSIMS; IRMS for Δ_{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

- **John P. Grotzinger**, *Harold Brown Professor of Geology, Ted and Ginger Jenkins Leadership Chair*

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  1200 E California Blvd, MC 170-25
  Pasadena, CA 91125

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- **John Eiler**, *Robert P. Sharp Professor of Geology and Geochemistry*

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  1200 E California Blvd, MC 100-23
  Pasadena, CA 91125

  E-mail: **eiler@gps.caltech.edu**
  Phone: +1 (626) 395 6942

- **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*

  Caltech Division of Geological and Planetary Sciences
  1200 E California Blvd, MC 100-23
  Pasadena, CA 91125

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- **Kathryn "Kitty" Cahalan**, *Outreach Program Manager*

  Caltech Center for Teaching, Learning, & Outreach
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  Pasadena, CA 91125

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