Steven Sholes, PhD

PLANETARY SCIENTIST

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EDUCATION

2019 **PhD, Earth and Space Sciences & Astrobiology** (dual-title)
University of Washington, Seattle, WA (advisor: David Catling)

2013 **BA, Astronomy** (mathematics minor, cum laude)
Cornell University, Ithaca, NY

PROFESSIONAL EXPERIENCE

2021 – Pres. Postdoctoral Scholar, Jet Propulsion Laboratory (advisor: Kathryn Morgan Stack)
2013 – 2019 Graduate Research Assistant, Univ. of Washington (advisor: David Catling)
2016 Summer Graduate Research Assistant, Univ. of Washington (advisor: Eric Agol)
2015 – 2019 Teaching Assistant, University of Washington
2012 NSF Summer Research Intern, Univ. of Arkansas (advisor: Vincent Chevrier)
2011 – 2013 Undergraduate Research Assistant, Cornell University (advisor: Peter Thomas)
2010 – 2012 Collections Assistant, Paleontological Research Institute (advisor: Greg Dietl)
2009 – 2011 Substitute Teacher & District Tutor, Hannibal Central School District

AREAS OF EXPERTISE

- Mars geology and geomorphology, remote sensing of terrestrial planets
- Geospatial analysis, geologic mapping, digital elevation map development
- Astrobiology, planetary evolution and habitability
- Atmospheric photochemistry and modeling
- Analysis with Python, Fortran, ArcGIS, MATLAB, ENVI, JMARS, ISIS3, IDL
- Machine learning (e.g., linear/logistic regression, neural networks, K-means clustering)
- Science communication and research management

PEER-REVIEWED PUBLICATIONS: ACCEPTED

[5] **Sholes, S.F.**, D.R. Montgomery, and D.C. Catling. 2019. "Quantitative High-Resolution Re-examination of a Hypothesized Ocean Shoreline in Cydonia Mensae on Mars." *Journal of Geophysical Research: Planets* 124: 316-336. doi:10.1029/2018JE005837 | Press

[4] **Sholes, S.F.**, J. Krissansen-Totton, and D.C. Catling. 2019. "A Maximum Subsurface Biomass on Mars from Untapped Free Energy: CO and H_2 as Potential Antibiosignatures." *Astrobiology* 19(5): 655-668. doi:10.1089/ast.2018.1835 | Press

[3] **Sholes, S.F.**, M.L. Smith, M.W. Claire, K.J. Zahnle, and D.C. Catling. 2017. "Anoxic Atmospheres on Mars Driven by Volcanism: Implications for Past Environments and Life." *Icarus* 290: 46-62. doi:10.1016/j.icarus.2017.02.022 | Press

[2] Misra, A., J. Krissansen-Totton, M.C. Koehler, and **S. Sholes**. 2015. "Detecting Volcanism on Exoplanets using Transient Sulfate Aerosols." *Astrobiology* 15(6): 462-477. doi:10.1089/ast.2014.1204 | Press

[1] Thomas, P.C., W. Calvin, P. Gierasch, R. Haberle, P.B. James, and **S. Sholes**. 2013. "Time Scales of Erosion and Deposition Recorded in the Residual South Polar Cap of Mars." *Icarus* 225(2): 923-932. doi:10.1016/j.icarus.2012.08.038

PEER-REVIEWED PUBLICATIONS: IN REVIEW OR IN PREPARATION

[4] **Sholes, S.F.**, Z.I. Dickeson, D.R. Montgomery, and D.C. Catling. 2021. "Where are Mars' Hypothesized Ocean Shorelines? Large Lateral and Topographic Offsets Between Different Versions of Paleoshoreline Maps." *Journal of Geophysical Research: Planets* (in revision). preprint doi:10.1002/essoar.10502868.1

[3] **Sholes, S.F.**, D.R. Montgomery, and D.C. Catling. 2021. "Global Investigation of Hypothesized Ocean Shoreline Sites on Mars." prepared for *Planetary Science Journal* (fully drafted)

[2] Hood, D.R., **S.F. Sholes**, S. Karunatillake, C.I. Fassett, and J.P. Brothers. 2021. "The Martian Boulder Automatic Recognition System: MBARS." prepared for *Journal of Geophysical Research: Planets*. (fully drafted).

[1] **Sholes, S.F.** and F. Rivera-Hernandez. 2021. "Constraints on the Uncertainty, Timing, and Magnitude of Potential Mars Oceans from Topographic Deformation Models." prepared for *Icarus Letters*. (in preparation).

SELECTED CONFERENCE ABSTRACTS (6 talks, 8 first-author)

[11] Hood, D.R., C.I. Fassett, S. Karunatillake, **S.F. Sholes**, and R. Ewing. 2020. "Large-Scale Assessment of Polygon-Edge Boulder Clustering in the Martian Northern Lowlands." *51st Lunar and Planetary Science Conference*, Abstract #2620. (poster) ads:2020LPI....51.2620H (meeting cancelled)

[10] **Sholes, S.F.**, D.R. Montgomery, and D.C. Catling. 2019. "Reassessing Mars' Global Ocean Shorelines." *9th International Conference on Mars*, Abstract #6282. (**talk**) ads:2019LPICo2089.6282S

[9] Hood, D.R., S. Karuantillake, C. Fassett, and **S.F. Sholes**. 2019. "Verification of Automatically Measured Boulder Populations in HiRISE Images." *50th Lunar and Planetary Science Conference*, Abstract #1893. (poster) ads:2019LPI....50.1893H

[8] **Sholes, S.F.,** J. Krissansen-Totton, and D.C. Catling. 2019. "Biomass Limits on Subsurface Martian Life from Atmospheric Gases." *Mars Extant Life: What's Next*? Abstract #5019, (**invited talk**) ads:2019LPICo2108.5019S (meeting cancelled)

[7] Hood, D.R., S. Karuantillake, C. Fassett, and **S.F. Sholes**. 2018. "Automated Boulder Detection and Measuring in HiRISE Images." *49th Lunar and Planetary Science Conference*, Abstract #2437, (poster) ads:2018LPI....49.2437H

[6] **Sholes, S.F.**, A. Mushkin, and D.C. Catling. 2017. "Boulder-size Distributions as Indicators for Depositional Process on Earth and Mars." *Geological Society of America Annual*, Abstract #304073, (**talk**). doi:10.1130/abs/2017AM-304073

[5] **Sholes, S.F.**, J. Krissansen-Totton, and D.C. Catling. 2017. "How Many Blue Whales on Mars? Obtaining a Maximum Extant Biomass Using CO Antibiosignatures." *Astrobiology Science Conference 2017,* Abstract #3189 (**talk**) hou.usra.edu/meetings/abscicon2017/pdf/3189.pdf

[4] **Sholes, S.F.,** D.C. Catling, and D.R. Montgomery. 2017. "Quantified Identification of Paleo-Terraces Along a Proposed Martian Ocean Contact." *48th Lunar and Planetary Science Conference*, Abstract #1764, (**talk**). ads:2017LPI….48.1764S

[3] **Sholes, S.F.**, M.L. Smith, M.W. Claire, K.J. Zahnle, and D.C. Catling. 2015. "An Anoxic Atmosphere on Early, Volcanically Active Mars and its Implications for Life." *Astrobiology Science Conference 2015*, Abstract #7455, (**talk**). www.hou.usra.edu/meetings/abscicon2015/pdf/7455.pdf

[2] **Sholes, S.F.**, D.C. Catling, R. Pretlow, and D.R. Montgomery. 2014. "High-Resolution Examination of the Geomorphology of Proposed Ocean Shorelines on Mars." *8th International Conference on Mars*, Abstract #1014, (poster). ads:2014LPICo1791.1014S

[1] **Sholes, S.F.**, V.F. Chevrier, and J.A. Tullis. 2013. "Object Based Image Analysis for Remote Sensing of Planetary Surfaces." *44th Lunar and Planetary Science Conference*, Abstract #1527, (poster). ads:2013LPI….44.1527S

DATA SETS

[2] Sholes, S.F. et al. 2020. "Data For: Where are Mars' Hypothesized Ocean Shorelines?" *Journal of Geophysical Research: Planets.* Zenodo. doi:10.5281/zenodo.3743911
- Contains geospatial data for digitized and mapped versions of the historical putative martian ocean paleoshorelines.

[1] Sholes, S.F. et al. 2018. "Data For: Quantitative High-Resolution Re-Examination of a Hypothesized Ocean Shoreline in Cydonia Mensae on Mars." *Journal of Geophysical Research: Planets*. UW ResearchWorks. hdl:1773/42764
- Contains high-resolution digital elevation models, thermal interita maps, and mapped geospatial data for putative marine terraces on Mars. Includes ArcGIS and MATLAB tools for detecting the topographic signature of wave-eroded terraces.

TEACHING EXPERIENCE

Teaching Assistant, Univ. of Washington (9 courses, 11 quarters):
Stratigraphy (ESS 455, 2016), Hydrogeology (ESS 454, 2019), Geological Remote Sensing (ESS 421, 2017), Earth Science Mathematics (ESS 310, 2019), Evolution of the Earth (ESS 213, 2016, 2018), Intro. to Astrobiology (ASTBIO 115, 2016), Living with Volcanoes (ESS 106, 2017), Space and Space Travel (ESS 102, 217), Geology and Society (ESS 101, 2015, 2018)

Student Mentoring: Undergraduate – William Keller (Earth and Space Sciences), Caitlin Schaefer (Electrical Engineering and Information Sciences), Emily Johnson (Earth and Space Sciences), Elizabeth McKinnie (Computer Science and Applied and Computational Mathematical Sciences), Ken Aragon (Aeronautics and Astronautics) **High School** – Arielle Michelman (Univ. Prep).

Guest Lecturer: "Volcanism on Mars" for ESS 106: Living with Volcanoes (Univ. of Washington); "Water on Mars" for ESS 495: NASA Research Seminar (Univ. of Washington); "Planetary Stratigraphy" for ESS 455: Stratigraphy (Univ. of Washington); "Intro. to Mars Research: Questions, Methods, and Missions" for Summer Aerospace Academy (Central Washington Univ.)

Field Trips Led: Evolution of the Cascades (Eastern Washington, Univ. of Washington ESS 213), Turbidites and Stratigraphy (Kitsap Peninsula, Univ. of Washington ESS 213), History of the Columbia Plateau (Eastern Washington, Univ. of Washington ESS 101), Mars Analog Sites (Eastern Washington, Central Washington Univ.), Mt. St. Helens Eruption (Blast Zone, Univ. of Washington ESS 101), Megafloods of Earth and Mars (Eastern Washington, Univ. of Washington Field Work/ESS 590).

Hannibal Central School District, Substitute Teacher & Tutor (K-12, special needs)

SELECTED HONORS

2018	NASA Mars Student Travel Grant ($1,300)
2018	George Goodspeed and Peter Misch Geology Fellowships, Univ. of Washington (1 quarter graduate student salary)
2017	Robert and Nadine Bassett, Howard and Leila Coombs, and the Marie Ferrel Geological Endowments, Univ. of Washington (1 quarter graduate student salary)
2017	"Why do We Care? Presentation Award" Univ. of Washington ($150)
2017	Student Travel Grant, Univ. of Washington College of the Environment ($500)
2016	George Goodspeed and Kenneth Robbins Geology Fellowships, Univ. of Washington (1 quarter graduate student salary)
2015	Best Space/Planetary Oral Presentation, Univ. of Washington ($150)
2015	Robert and Jennifer Winglee Graduate Student Support Fund, Univ. of Washington (Co-I, awarded to Matthew Koehler $800)
2014	NASA Mars Student Travel Grant ($1,000)
2014	Contributed to NASA Mars Fundamental Research Program Grant, Funded as Graduate Student, Grant #NNX10AN67G, PI: David Catling
2013	NYS Merit Scholarship ($6,000)

PROFESSIONAL SERVICE

2021 – Pres.	Mars 2020 Science Team Member
2019 – Pres.	Reviewer for scientific journals e.g., *Geophysical Research Letters*
2017 – 2018	Geological Science of America Member
2017	Univ. of Washington Planetary Sciences Research Asst. Prof. Hiring Committee
2016 – 2017	Science Advisor, Univ. of Washington University Rover Challenge
2015 – 2018	Science Communications Fellow, Pacific Science Center
2014 – 2019	Chair, Prelim Examination Feedback Committee, Univ. of Washington ESS
2015	Integration Team, Human Exploration on Mars, 8th Intern. Conference on Mars

WORKSHOPS ATTENDED

2018	NASA's Jet Propulsion Laboratory (Univ. of Washington Astrobiology Program)
2015	Geology and Microbiology of Yellowstone National Park (Univ. of Washington Astrobiology Program)
2015	Science Communication for the Public (Pacific Science Center)
2015	Water, Ice, and the Origin of Life in the Universe (Nordic Astrobiology Summer School in Reykjavik, Iceland)
2014	Oceanography and Microbiology Techniques in the Pacific (Univ. of Washington Astrobiology Program aboard the R/V *Thomas G. Thompson*)

EDUCATION AND PUBLIC OUTREACH (EPO)

2014 – 2017	**Pacific Science Center Fellow**, 5 events (e.g., Meet a Scientist about water on Mars, astrobiology, spectroscopy)
2014 – 2017	**ESS Rocking Out**, 10 events (e.g., designing a mission to Mars, identifying rocks, Mars rovers)
2014 – 2018	**Univ. of Washington Astrobiology Program Outreach**, 5 events (e.g., talks on astrobiology and water on Mars)
2008 – 2020	**Science Olympiad**, 4 events Division B Regional Expert Judge (astronomy, geography, robots)
2008 – 2013	**Hometown Outreach**, 5 events, 2 summer programs (e.g., classroom Q&As, STEM judge, observational astronomy summer program)
2010 – 2020	**The Sholesonian** (www.sholesonian.com), 2 events, online museum (e.g., symposium talk, Museum of the Earth exhibit)
2016	**Miscellaneous**, 2 events (e.g., Astronomy on Tap, summer camp talks)

SELECTED MEDIA COVERAGE

A New Way to Analyze Evidence of Martian Oceans. *AGU Eos* (2019).
Martian Life Must be Rare as Free Energy Source Remains Untapped. *NewScientist* (2017).
Volcanic Activity on Ancient Mars May Have Produced Organic Life. *Seeker* (2017).
The Red Planet's Blue Past. *The Daily* (2016).
Volcanoes Light Up Atmospheres of Small Exoplanets. *Astrobiology Magazine* (2016).
Atmospheric Signs of Volcanic Activity Could Aid Search for Life. *UW News* (2015).

TECHNICAL SKILLS

Operating systems: Windows, Mac OS, Linux; **Coding**: Python (incl. pandas, numpy, sklearn, arcpy, scipy, matplotlib), Fortran, IDL, MATLAB, USGS ISIS3, R, SQL; **Software:** ArcGIS Desktop, ENVI, JMARS, Microsoft Office (Excel, Word, PowerPoint, Access), NASA Ames Stereo Pipeline (ASP), Google Earth Pro, RiSCAN, eCognition, Photoshop, GIMP, QGIS. **Mission Data Sets:** HiRISE, THEMIS, CRISM, CTX, MOC, MOLA (MEGDR and PEDR), HRSC, Viking, Mariner 9, Magellan, LROC, WFC3 (HST), Kepler

GitHub Code Repository: www.github.com/sfsholes