

Robert McCarley Holder

Department of Earth and Planetary Sciences
Johns Hopkins University
Olin Hall, 3400 N. Charles St.
Baltimore, MD 21218
holder@jhu.edu

Department of Earth and Environmental Sciences
University of Michigan
1100 North University Avenue
Ann Arbor, MI 48109-1005
rohholder@umich.edu

Education

2018: **PhD** in Earth Science, University of California, Santa Barbara.

Dissertation title: “What causes ultrahigh-temperature metamorphism? A case study from southern Madagascar.” Advisor: Bradley R. Hacker. Committee: John Cottle, Roberta Rudnick, Frank Spera

2016: **Summer Teaching Institute for Associates**, University of California, Santa Barbara.

Higher-education teacher training program: “The STIA program provides graduate student instructors with...teaching orientation...based on principles of interactive, collaborative learning...designed to assist...with the planning, conduct and assessment of...undergraduate courses.”

2014: **MS** in Earth Science, University of California, Santa Barbara.

Thesis title: “Monazite trace-element and isotopic signatures of (ultra)high-pressure metamorphism: examples from the Western Gneiss Region, Norway.” Advisor: Bradley R. Hacker. Committee: John Cottle, Frank Spera

2012: **BA *summa cum laude*** double major in Geology and Scandinavian Studies, Gustavus Adolphus College, Minnesota. Geology thesis title: “Strain analysis in the Virginia Horn area, northeastern Minnesota.” Advisor: James Welsh. Scandinavian Studies colloquium title: “On Masculinity in Scandinavia: creating a more gender-equal society.”

Employment History

2020– : **Assistant Professor**, University of Michigan, Ann Arbor, MI

2018–2020: **Postdoctoral Fellow**, Johns Hopkins University, Baltimore, MD

2012–2018: **Teaching Assistant** and **Graduate Student Researcher** as MS and PhD student, University of California, Santa Barbara

2016: **Instructor of Record**, University of California, Santa Barbara

2009–2012: **Teaching Assistant** as BA student, Gustavus Adolphus College, MN

2010: **ICP-MS student technician**, Gustavus Adolphus College, MN

2009: **Field Technician**, Great Basin Unified Air Pollution Control District, Inyo County, CA

Undergraduate Student Mentoring

- Carl Swindle, 2017–2018 (senior thesis): Phase equilibria & regional metamorphic field gradients in granulites from Madagascar
- Adam Kershner, 2016–2017 (research credits toward major): Ti- and Al-in-quartz thermobarometry of granulites from Madagascar
- Alex Guzman, 2016–2017 (research credits toward major): U–Pb zircon dating of igneous rocks of southern Madagascar

Awards, Grants, & Honors (UCSB = University of California, Santa Barbara)

- NSF-EAR Instrumentation and Facilities grant 1831766. Acquisition of a laser-based system for trace-element mapping and large- N geochronology by inductively coupled plasma mass spectrometry (ICP-MS). Roles: Co-author and Senior Personnel
- Most Helpful Graduate Student (awarded by vote of Earth Science graduate students at UCSB), 2018
- UCSB Doctoral Student Travel Grant, 2017
- Outstanding Student Poster Award, EGU 2017
- UCSB Alumni Graduate Award in Research Excellence, 2017
- UCSB Earth Science Graduate Student Opportunity Award, 2017
- UCSB Earth Research Institute Summer Research Fellowship, 2017
- Tanya Atwater Global Field Travel Fund, UCSB, 2016
- George Tunell Memorial Fellowship, UCSB, 2016
- Microanalysis Society Early Career Scholar Award, 2016
- United States Antarctic Service Medal, 2015
- Lloyd & Mary Edwards Field Studies Fellowship, UCSB, 2015
- Tanya Atwater Global Field Travel Fund, UCSB, 2015
- Imperial Barrel Award Competition, UCSB team, PSAAPG, 2014
- UCSB Earth Science Graduate Award for Research Excellence, 2014
- Sigma Xi Scientific Research Society, 2012
- Undergraduate Speaker, Phi Beta Kappa Annual Meeting, Gustavus Adolphus College, 2012
- Phi Beta Kappa Academic Honor Society, 2011
- Chester O. Johnson Geology Scholarship, Gustavus Adolphus College, 2010

Research Fieldwork

- United States, Nevada, 2019. Paleoproterozoic granulites in the McCullough Range, 2 weeks
- United States, Upper Midwest, 2019. Archean gneisses of the southern Superior province. 3 weeks
- United States, Maryland, 2019. Baltimore Mafic Complex & felsic plutons near Baltimore. 1 week
- United States, California, 2019. Neoproterozoic dolomites in the Death Valley region, 1 week
- Scotland, 2018. Shetland ophiolite and mafic-ultramafic bodies in the Portsoy shear zone, 2 weeks
- United States, Nevada, 2018. Paleoproterozoic granulites in the McCullough Range, 1 week
- Austria & Czech Rep., 2017. UHP & UHT rocks of the Bohemian Massif, Variscan Orogen, 2 weeks
- Antarctica, 2015. High-K magma suites of the McMurdo Dry Valleys, 7 weeks
- Madagascar, 2014. UHT metamorphism and magmatism in the East-African–Kuunga Orogen, 4 weeks
- Norway, 2013. UHP metamorphism in the Western Gneiss Complex, Caledonian Orogen, 3 weeks
- Canada, Ontario, 2010. Stromatolites in the Gunflint Formation, 1 week

- United States, Minnesota, 2010. Sediment provenance in the Le Sueur River watershed, 1 week
- United States, California, 2009. Mapping modern aeolian sediments, Keeler Dunes, 3 weeks

Professional Fieldtrips & Classes

- Lower-crustal deformation in the Bohemian Massif, Austria, 2 days, EGU Assembly 2017
- Metamorphic rocks of the Picuris & Tusas Ranges, New Mexico, 5 days, GSA Annual Meeting 2016
- Hydrothermal features of Yellowstone, Wyoming, 5 days, GSA Annual Meeting 2016
- Igneous & metamorphic rocks of the Namaqua Metamorphic Complex, Namibia, 1 week, Granulites & Granulites Conference 2015
- Sequence stratigraphy with ExxonMobil at UCSB, 1 day, 2014
- Indiana University Summer Field Camp in southwest Montana, 6 weeks, 2012

Synergistic Activities beyond Academic Collaboration

- Book reviewer for *Reviews in Mineralogy and Petrology, Volume 83, Petrochronology: Methods and Applications*, eds. Matthew J. Kohn, Martin Engi, and Pierre Lanari. *American Mineralogist*
- Convener and Chair of AGU Fall Meeting 2017 session *Petrochronology and microstructural geochronology* (V022) with D. Moser, K. Tait, and J. Darling
- Convener and Chair of GSA Annual Meeting 2019 session *Metamorphic Petrology Past, Present and Future: Preparing for the next 100 years with the Mineralogical Society of America* with S. Penniston-Dorland and M. Caddick
- Manuscript reviewer for: *Geology, Contributions to Mineralogy and Petrology, Journal of Metamorphic Geology, Precambrian Research, Episodes, Lithos, Computers and Geosciences, and Geoscience Frontiers*. 14 manuscripts reviewed since 2017

Laboratory Experience

- Inductively coupled plasma mass spectrometry: U/Th–Pb dating and trace-element analysis on multi-collector and single-collector instruments. Analyte introduction by laser ablation and solution
- Scanning electron microscopy: back-scattered-electron, secondary-electron, and cathodoluminescence imaging; energy-dispersive spectrometry
- Electron probe microanalysis: major- and trace-element wavelength-dispersive spectrometry spot analyses and compositional maps
- Isotope ratio mass spectrometry: bulk $\delta^{18}\text{O}$ of silicates by laser-fluorination
- Rock crushing, mineral separation, and polishing

Visiting Lectures/Seminars

6. Metamorphism and the evolution of plate tectonics. University of Maryland. April 26, 2019
5. Metamorphism and the evolution of plate tectonics. Pennsylvania State University. April 5, 2019
6. Reevaluating old paradigms and exploring new frontiers in U–Pb dating of titanite and calcite. Cornell University. February 12, 2019
5. Metamorphism and the evolution of plate tectonics. Cornell University. February 11, 2019

4. Petrochronology Part 1: Titanite, thermo- or petrochronometer? | Part 2: Carbonate petrochronology, a new frontier. University of Florida. February 5, 2019
3. Ultrahigh-temperature metamorphism: The hottest rocks in the crust and how they form. Amherst College. December 3, 2018
2. The progressive emergence of modern plate tectonics: A metamorphic perspective from the Archean to today. University of Michigan. November 9, 2018
1. Petrochronology Part 1: Titanite, thermo- or petrochronometer? | Part 2: Carbonate petrochronology, a new frontier. University of Michigan. November 8, 2018

Publications

13. **Holder RM**, Viete DR, Brown M, Johnson TE (2019) Metamorphism and the evolution of plate tectonics. *Nature*. doi:[pending]
12. **Holder RM**, Hacker BR, Seward GGE, Kylander-Clark ARC (2019) Interpreting titanite U–Pb dates and Zr thermobarometry in high-grade rocks: empirical constraints on elemental diffusivities of Pb, Al, Fe, Zr, Nb, and Ce. *Contributions to Mineralogy and Petrology*. doi:10.1007/s00410-019-1578-2
11. Hacker BR, Kylander-Clark ARC, **Holder RM** (2019) REE partitioning between monazite and garnet: Implications for petrochronology. *Journal of Metamorphic Geology*. doi:10.1111/jmg.12458
10. **Holder RM**, Hacker BR (2019) Fluid-driven resetting of titanite following ultrahigh-temperature metamorphism in southern Madagascar. *Chemical Geology*. doi:10.1016/j.chemgeo.2018.11.017
9. **Holder RM**, Sharp ZD, Hacker BR (2018) LinT, a simplified approach to oxygen-isotope thermometry and speedometry of high-grade rocks: An example from ultrahigh-temperature gneisses of southern Madagascar. *Geology*. doi:10.1130/G40207.1
8. **Holder RM**, Hacker BR, Horton F, Rakotondrazafy AFM (2018) Ultrahigh-temperature osumilite gneisses in southern Madagascar record combined heat advection and high rates of radiogenic heat production in a long-lived high-temperature orogen. *Journal of metamorphic Geology*. doi:10.1111/jmg.12316
7. Peřestý V, Lexa O, **Holder RM**, Jerabek P, Racek M, Štípská P, Schulmann K, Hacker B (2016) Metamorphic inheritance of Rheic passive margin evolution and its early Variscan overprint in the Teplá-Barrandian Unit, Bohemian Massif. *Journal of Metamorphic Geology*. doi:10.1111/jmg.12234
6. Štípská P, Powell R, Hacker BR, **Holder RM**, Kylander-Clark ARC (2016) Uncoupled U/Pb and REE response in zircon during the transformation of eclogite to mafic and intermediate granulite (Blanský les, Bohemian Massif). *Journal of Metamorphic Geology*. doi:10.1111/jmg.12193
5. Horton F, Hacker BR, Kylander-Clark ARC, **Holder RM**, Jöns N (2016) Focused radiogenic heating of middle crust caused ultrahigh temperatures in southern Madagascar. *Tectonics*. doi:10.1002/2015TC004040
4. **Holder RM**, Hacker BR, Kylander-Clark ARC, Cottle JM (2015) Monazite trace-element and isotopic signatures of (ultra)high-pressure metamorphism: examples from the Western Gneiss Region, Norway. *Chemical Geology*. doi:10.1016/j.chemgeo.2015.04.021
3. Hacker BR, Kylander-Clark ARC, **Holder RM**, Andersen T, Peterman E, Walsh E, Munnikhuis J (2015) Monazite response to ultrahigh-pressure subduction from U–Pb dating by laser-ablation split-stream ICP–MS. *Chemical Geology*. doi:10.1016/j.chemgeo.2015.05.008
2. Štípská P, Hacker BR, Racek M, **Holder RM**, Kylander-Clark ARC, Schulmann K, Hasalová P (2015) Monazite Dating of Prograde and Retrograde P–T–d paths in the Barrovian

Terrane of the Thaya Window, Bohemian Massif. *Journal of Petrology*.
doi:10.1093/petrology/egv026

1. Broussole A, Štípská P, Lehmann J, Schulmann K, Hacker BR, **Holder RM**, Kylander-Clark ARC, Hanžl P, Racek M, Hasalová P, Lexa O, Hrdličková K, Buriánek D (2015) P–T–t–D record of crustal-scale horizontal flow and magma assisted doming in the SW Mongolian Altai. *Journal of Metamorphic Petrology*. doi:10.1111/jmg.12124

Invited Conference Talks

3. **Holder RM**, Yakymchuk C (2019) Monazite Eu anomalies: Beyond feldspar. EGU General Assembly
2. **Holder RM**, Hacker BR, Ryb U (2018) Linking high- and low-temperature processes in the crust with U–Pb dating of carbonate rocks and minerals. Goldschmidt
1. **Holder RM**, Hacker BR, Kylander-Clark ARC, Nuriel P, Roberts N (2017) Directly dating deformation by U–Pb carbonate LA-ICP-MS. Goldschmidt

Other Conference Abstracts

17. **Holder RM**, Hacker BR (2018) Prolonged fluid-driven resetting of titanite following ultrahigh-temperature metamorphism in southern Madagascar. AGU Fall Meeting
16. Swindle C, **Holder RM** (2018) Mechanisms of granulite formation in an archetypal accretion-to-collision orogen: pseudosections and monazite petrochronology from southern Madagascar. AGU Fall Meeting
15. Viete DR, **Holder RM** (2018) Geodynamics of (U)HT granulite metamorphism: a view from ‘accessory’ terranes. Granulites and Granulites Conference
14. **Holder RM**, Hacker BR (2018) Interpreting titanite U–Pb dates and Zr temperatures in granulites: Empirical estimates of elemental diffusivities. Granulites and Granulites
13. **Holder RM**, Hacker BR (2017) Titanite chronology, thermometry, and speedometry of ultrahigh-temperature (UHT) calc-silicates from south Madagascar: U–Pb dates, Zr temperatures, and lengthscales of trace-element diffusion. AGU Fall Meeting
12. **Holder RM**, Hacker BR (2017) Titanite petrochronology of ultrahigh-temperature (UHT) calc-silicates from southern Madagascar: laser-ablation split-stream ICP-MS spot analyses, depth profiles, and quantified trace-element x-ray maps. EGU General Assembly
11. **Holder RM**, Hacker BR (2016) The importance of intracrustal magmatic heat advection in large hot orogens: the Ediacaran-Cambrian ultrahigh-temperature domain of southern Madagascar. AGU Fall Meeting
10. Hacker BR, Kylander-Clark ARC, **Holder RM**, Nuriel P (2016) U–Pb dating of Calcite by LA-ICPMS. AGU Fall Meeting
9. **Holder RM**, Hacker BR, Kylander-Clark ARC, Everson A (2016) Development of calcite reference materials for *in-situ* U–Pb dating and trace-element analysis. GSA Annual Meeting
8. **Holder RM**, Hacker BR (2016) Intracrustal magmatic heat advection in the Ediacaran UHT domain of Madagascar. GSA Annual Meeting
7. **Holder RM**, Hacker BR, Horton F (2015) Protracted high-grade metamorphism in southern Madagascar: P–T–t paths of the Anosyen, Androyen, and Ikalamavony domains. Granulites and Granulites Conference

6. **Holder RM**, Hacker BR, Kylander-Clark ARC, Cottle JM (2014) Monazite trace-element and isotopic signatures of high-pressure metamorphism: examples from the Western Gneiss Region, Norway. AGU Fall Meeting
5. Perestý V, **Holder RM**, Lexa O, Racek M, Jerábek P (2014) Petrochronological and structural arguments for upper plate thickening and relamination of the lower plate buoyant material in the Variscan Bohemian Massif. EGU General Assembly
4. **Holder RM**, Hacker BR, Kylander-Clark ARC (2013) Monazite Petrochronology from the UHP Western Gneiss Region, Norway. AGU Fall Meeting
3. **Holder RM**, Hacker BR, Kylander-Clark ARC (2013) Monazite Petrochronology from the UHP Western Gneiss Region, Norway. GSA Annual Meeting
2. Perestý V, **Holder RM**, Lexa O, Racek M, Hacker BR (2013) Polyphase tectonometamorphic evolution of the Teplá Crystalline Complex: New structural, petrological, and geochronological data. GeoPilsen Conference
1. Hacker BR, Kylander-Clark ARC, Horton F, **Holder RM** (2013) Applying U/Th-Pb and trace-element LASS petrochronology to understanding high-temperature metamorphism. GSA Annual Meeting