

Claire Richardson, Ph.D. (she/her)

Curriculum vitae, last updated Feb. 2025
School of Earth and Space Exploration (SESE)
Arizona State University (ASU); Tempe, AZ

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I am an observational and computational seismologist interested in the 3D multi-scale structure and dynamics of the mantle. I have experience with 1D ray theoretical wave modeling and forward methods for global Earth modeling, as well as high-performance computing and scientific software development in Python, C, and SQL. I seek to improve seismic images of the interior of the Earth through the application of both 1D and 3D methods and to increase the efficiency and accuracy of full waveform modeling by improving model input data quality and selection.

Education

Ph.D – Geological Sciences, Arizona State University (ASU) **Oct. 2019 – May 2025**

- Dissertation: “New methods for improving global and regional seismic models of Earth’s mantle”
- Primary advisor: Dr. E. Garnero
- NSF Graduate Research Fellow

B.S. – Geology, University of Nebraska-Lincoln (UNL) **Aug. 2014 – Dec. 2018**

- Research advisors: Dr. C. Burberry, Dr. I. Filina
- Minors in Mathematics and Physics
- Degree conferred with Honors and Highest Distinction

Research Experience

Ph.D. projects

- Developed and validated a systematic forward modeling update method for global, whole-mantle tomographic models in Python (SITRUS: Seismic Iterative Tomography Update Scheme)
- Applied SITRUS to several published models using the ASU Sol Supercomputer to investigate lowermost mantle structure, and to quantify and analyze relative effects of variable input parameters on solution models
- Developed a Pythoninc workflow with a Jupyter interface for prioritized event selection for application to regional seismic modeling efforts
- Investigated mantle controls on arc-scale volcanic diversity in Cascadia via a compilation of reported geophysical variables to be used in modeling efforts of mantle basalt generation
- Deployed nodal seismometers in a dense array around the San Francisco Volcanic Field as part of an active source experiment to image the underlying magmatic system with applications to hazard assessment for nearby communities, including Flagstaff, AZ

B.S. projects

- Analyzed gravitational and magnetic potential fields data with seismic refraction and reflection profiles to produce integrated geophysical models of the New Caledonia Trough region
- Performed a spatial analysis of the Zealandia region in combination with geophysical models to determine changes in crustal thickness and regional geological history
- Built and ran sandbox analog models to investigate patterns in accommodation of penetrative strain across contractional orogenic belts

Incorporated Research Institutions for Seismology (IRIS) internship (2017)

- Measured S and ScS phase arrivals and computed differential travel times for modeling seismic structure in the lowermost mantle
- Advisor: Dr. H. Tkalčić, Institution: Australian National University

Publications

Peer-reviewed articles:

1. Garnero, E. J. & **Richardson, C.** (2024) The mysterious, massive structures in Earth's deep mantle. *Physics Today*. <https://doi.org/10.1063/pt.mzrx.ddag>

In preparation:

1. **Richardson, C.**, & Garnero, E. J. (ant. 2025 submission) SITRUS: a software package to iteratively update seismic tomography models using travel time datasets.
2. **Richardson, C.**, Garnero E. J., Hansen, S. E., Ritsema, J., & Grand, S. P. (ant. 2025 submission) Updating global tomography models with a forward, iterative travel time mapping scheme.
3. **Richardson, C.**, Garnero, E. J., Bozdağ, E. (ant. 2025 submission) EMPRESS: a workflow to optimize event selection for regional seismic modeling.

Honors and Awards

- College of Liberal Arts & Sciences Graduate Completion Fellowship (2024-2025)
- Seismological Society of America Community Grant recipient (2024; \$4,000)
- Seismological Society of America Community Grant recipient (2023; \$5,000)
- NSF Graduate Research Fellowship (2021 – 2026)
- ASU Graduate and Professional Student Association Service Award (2023)
- The College of Liberal Arts and Sciences Graduate Excellence Award (2022, 2023)
- The ASU College of Liberal Arts and Sciences Student Leader (2022)
- Stracher Award for Excellence in Structural Geology and Metamorphic Petrology (2018)
- Outstanding Undergraduate Student award in Geology (2017)
- University of Nebraska-Lincoln Regent's Scholar (2014 – 2018)

Presentations & Science Communication

**denotes invited talk*

2025:

- **Richardson, C.** “New methods for improving global and regional seismic models of Earth’s mantle”, PhD defense
- ***Richardson, C.** “The mysterious, massive structures in Earth’s deep mantle”, Washington State University Physics & Astronomy colloquium

2024:

- **Richardson C.** & Garnero, E. J. “Updating global, whole mantle tomography models with an iterative forward mapping scheme”, Arizona Collaborative Consortium for Earth and Space Sciences, talk
- **Richardson C.**, Garnero, E. J., Hansen, S. E., Ritsema, J., & Grand, S. P. “Comparing lowermost mantle seismic structure of global tomography models updated with a forward, iterative travel time mapping scheme”, Study of Earth’s Deep Interior meeting, poster

2023:

- **Richardson, C.** “Updating global, whole mantle tomography models with an iterative forward mapping routine”, ASU Geophysics Seminar Series
- **Richardson, C.** & Garnero, E. J. “An iterative approach to update global whole-mantle tomography models using a large multi-phase shear wave dataset”, Interior of the Earth Gordon Research Conference, poster
- **Richardson, C.** “Early Career Geoscience Women in STEM”, SESE New Discoveries Lecture Series, panelist
- **Richardson, C.** Keynote by Dr. E. Garnero “A 2023 Journey to the Center of the Earth”, panelist
- **Richardson, C.** & Garnero E. J., “Updating global, whole mantle tomography models with an iterative forward mapping scheme”, American Geophysical Union Fall Meeting, eLightning presentation

2022:

- **Richardson, C.** “‘Seismic tomography: what comes next?’ conference summary and steps forward in Earth modeling”, ASU Geophysics Seminar Series

2021:

- **Richardson, C.**, Lai, H., & Garnero, E. J. “Development of a large, global, high quality dataset from an adaptive empirical wavelet method to sharpen deep mantle imaging”, Lamont-Doherty Seismology Student Workshop, virtual poster
- **Richardson, C.** “Leveling the field: making fieldwork in SESE more equitable and accessible”, ASU SESE colloquium

2020:

- **Richardson, C.** “Cookies for justice: making STEM a better place for all”, ASU Geophysics Seminar Series
- **Richardson, C.** “Toward a comprehensive, high-quality dataset for global mantle imaging”, ASU Geophysics Seminar Series

2018:

- **Richardson, C.**, Burberry, C. M., & Filina, I. “Geologic history of the New Caledonia Trough from potential fields modeling and spatial analysis”, American Geophysical Union, poster

2017:

- **Richardson, C.**, Mousavi, S. S., Tkalčić, H., & Masters, G. “Transdimensional Bayesian tomography of the lowermost mantle from shear waves”, American Geophysical Union, poster
- **Richardson, C.** & Burberry, C. M. “Penetrative strain in a contractional orogenic system with ductile basal and intermediate detachments”, Nebraska Academy of Sciences annual meeting, poster

Technical Skills

- Fluency and extensive experience with Python; familiarity with C, SQL, and shell scripting
 - Usage of standard Python libraries (e.g., Pandas, NumPy, SciPy, Cartopy, pyGMT, etc.), field-specific utilities (e.g., ObsPy, TauP toolkit, SAC, etc.), and self-authored libraries for various applications (e.g., spherical trigonometry, databasing, etc.)
- Software development for a range of project topics and breadths (e.g., individual Jupyter notebooks for demonstrating fundamental best practices for scientific plotting; large software packages for global Earth modeling including scripts and libraries)
- High-performance computing, including software optimization/parallelization
- Version control, repository hosting, and collaborative development with Git and GitHub
- Creation of comprehensive and clear software documentation
- Extensive experience using the command line and accessing/using remote servers
- Handling, processing, and manipulating large multi-dimensional datasets
- Developing, parsing, and solving complex, abstract scientific research questions with mathematical, physical, and computational approaches
- Experience with geophysical data processing, including time-series seismic data and potential fields measurements
- Experience with deployment of geophysical instrumentation (passive broadband seismic stations, nodal seismometers, geophones, gravimeters), and performing active source experiments
- Extensive experience with Adobe Illustrator, familiarity with Adobe Photoshop
- Developing materials for effective science communication of various scientific topics and results for different audiences (e.g., scientific writing for journal publications; writing

Jupyter notebooks for tutorials in undergraduate classes; making presentations about Earth science for elementary school classes, etc.)

Service, Equity, Inclusion, & Advocacy

*denotes ongoing efforts

NB: all of the following activities were performed in collaboration with some or all of the members of the given group. Where relevant, project/initiative lead(s) is listed.

SESE Inclusive Community Committee member

Aug. 2021 – May 2025

- Collaborated with diverse groups (both internal and external) to work on a variety of community-identified initiatives
- Held listening sessions for the graduate student body to get input on current projects
- Regularly solicited community feedback on and update SESE's Strategic Plan
- Co-wrote the SESE code of conduct
- Improved the Ph.D. candidacy exam and overall program experience by developing standardized rubrics (lead: Dr. Christy. Till)
- *Developed a Graduate Student Bill of Rights
- Revised & submitted three proposals for the American Geophysical Union Bridge Program on behalf of SESE

Arizona Collaborative Consortium for Earth and Space Science (ACCESS) organizer and co-chair

Jul. 2023 – Aug. 2024

- Initiated a collaborative geophysics consortium across three major public universities in Arizona (Arizona State University, Northern Arizona University, & University of Arizona)
- Scheduled, planned, & hosted regular monthly meetings, as well as our first annual, in-person meeting in January 2024 with funding from the SSA Community Grants program

SESE Graduate Council President

Sep. 2022 – Aug. 2023

- Organized & facilitated Council interactions with faculty, staff, & other students for community events & student advocacy efforts
- Presided over monthly internal meetings & semesterly open meetings for the student body
- Acted as a liaison between department leadership & graduate students, including attending weekly faculty meetings & meetings with the Associate Director for Graduate Initiatives
- Revised & administered annual Graduate Student Satisfaction Survey
- Compiled & analyzed Survey results to present to the student body & department leadership
- Developed policy for including graduate students on faculty searches & hiring committees
- Co-organized & hosted:
 - Annual Q&A panel for students preparing for their comprehensive exams
 - Various SESE-wide community building events

- SESE alumni career panel (lead: Jayanth Serla)
- Monthly Queer-Trans coffee hour (lead: Alejandro Olvera)
- Prospective graduate student visitation weekend (leads: Heather Hewitt & Ebraheem Farag)
- Analyzed results from a previous TA workload survey to improve TA experiences (lead: Grace Beall)
- Developed an online interface for undergraduate research opportunities (lead: Erin Alexander)

SESE graduate peer mentor

Aug. 2022 – July 2023

- Met regularly with a first year graduate student to familiarize them with academic, professional, social, & cultural aspects of graduate student life in SESE

ASU Graduate & Professional Student Association award reviewer

Aug. 2022 – Dec. 2022

- Attended classes taught by graduate students & reviewed their performance based on a standardized rubric

SESE Geophysics Seminar Series chair

Nov. 2020 – Dec. 2022

- Organized semester-long schedules for both internal & external speakers
- Communicated weekly speaker information & moderated weekly meetings
- Initiated invited speaker program, which targets early career & underrepresented researchers

Miscellaneous service efforts:

- Lead facilitator for “Becoming Active Bystanders” Workshop (2020 – 2022)
- White paper submitted to ASU School of Earth and Space Exploration: “Leveling the playing field: making fieldwork in SESE and CLAS more equitable and accessible” (2020)
- Initiated invited speaker program in weekly Geophysics Seminar Series, with a focus on speakers from marginalized backgrounds & early career scientists (2020)

Teaching and Outreach

- Panelist at Earth and Space Open House (2023)
- Pen-pal with Letters to a Pre-Scientist (2022 – present)
- Prison Education Program geoscience instructor & curriculum developer (2020 – 2022)
 - Worked with a local prison to provide geology & astronomy courses to inmates
 - Certificates awarded upon completion can be used toward parole, etc.
- Teaching assistant
 - Guest lecturer, Introduction to Geology (2025)
 - Introduction to Geology (2021)
 - Geological Natural Hazards (2017)
- Private calculus tutor (2017 – 2018)

- Participated in “Dinosaurs and Disasters” science outreach event for UNL’s natural history museum (2017, 2018)
- General Education Development (GED) math instructor (2016)

Professional Societies

- American Geophysical Union (2017 – present)
- Seismological Society of America (2021 – present)