

# DANIEL ANDREW FROST

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## Education

- Ph.D.                    The University of Leeds                    2010-2014  
Thesis: "Seismic observation of the Earth's small-scale structure"  
Structure of lower mantle using scattered seismic waves and relation to large-scale features  
Detecting the edge of the Pacific Large Low Shear Velocity Province using P-waves
- MEarthSci            The University of Oxford                    2006-2010  
Earth Sciences 2.1 Classification  
Masters thesis: "A marine geophysical study of the Tonga Trench-Louisville ridge collisional system in the South-West Pacific Ocean"

## Employment

- Assistant Project Scientist            University of California, Berkeley            2019-present  
Funded by NSF grant 1829283: Resolving the influence of mantle heterogeneity on estimates of inner core anisotropy, and NSF grant 2027181: Collaborative Research: Towards improved imaging of the outermost core through determination of the effects of lowermost mantle heterogeneity and anisotropy  
Understanding structure and tectonics of mantle beneath Alaska  
Implementing regional box tomography  
Improving resolution of deep Earth by understanding shallow mantle influence
- Postdoctoral Scholar                    University of California, Berkeley            2016-2019  
Funded by NSF grants 1135452 and 1829283: Resolving the influence of mantle heterogeneity on estimates of inner core anisotropy  
Inner core anisotropy using exotic seismic phases and seismic arrays and mineral physics  
Supporting the research output and organisation of the Cooperative Institute for Dynamic Earth Research (CIDER) program  
Preparing educational reports on multidisciplinary topics for CIDER  
PDRA: Barbara Romanowicz
- Postdoctoral Scholar                    Arizona State University                    2014-2016  
Funded by NSF grant PVS0695: Deep mantle cycling of oceanic crust  
Distribution of small-scale heterogeneities throughout both the upper and lower mantle and their relation to mantle dynamics and subduction  
The influence of broad lower mantle heterogeneities on deep-travelling S-waves and the effect on analysis of outer core structure  
PDRA: Edward Garnero

### Research Interests

Whole Earth structure, earth evolution, cross-disciplinary studies, influence of convection on mantle structure, seismic scattering, core structure, anisotropy, chemical heterogeneity,  $D''$  complexity, array seismology, tomographic inversion, developing seismic methodologies

### Publications

**Frost, Daniel A.**; Romanowicz, Barbara; Lasbleis, Marine; Chandler, Brian: Dynamic history of the inner core constrained by seismic anisotropy, *1*, *in review for Nature*

**Frost, Daniel A.**; Romanowicz, Barbara; Roecker, Steve: Upper mantle slab under Alaska: contribution to anomalous core-phase observations on South Sandwich to Alaska paths, *Phys. Earth. Planet. Int.*, 2020, 299, 106427

**Frost, Daniel A.**; Romanowicz, Barbara: On the orientation of the fast and slow directions of anisotropy, *Phys. Earth Planet. Int.*, 2019, 286, p. 101-110

**Frost, Daniel A.**; Garnero, Edward J.; Rost, Sebastian, Dynamical links between small- and large-scale mantle heterogeneity: seismological evidence, *Earth Planet. Sci. Lett.*, 2018, 482, p. 135-146

**Frost, Daniel A.**; Romanowicz, Barbara, Constraints on Inner Core anisotropy using array observations of  $P'P'$ , *Geophys. Res. Lett.*, 2017, 44, p. 10,878-10,886

**Frost, Daniel A.**; Rost, Sebastian; Garnero, Edward J.; Li, Mingming; Seismic evidence for Earth's crusty deep mantle, *Earth Planet. Sci. Lett.*, 2017, 470, p. 54-63

Rader, Erika; Emry, Erica; Schmerr, Nicholas; **Frost, Daniel A.**; Cheng, Cheng; Menard, Julie; Yu, Chunquan; Geist, Dennis, Characterization and Petrological Constraints of the Midlithospheric Discontinuity, *G-Cubed*, 2015, p. 3484-3504

Rost, Sebastian; Earle, Paul S.; Shearer, Peter M.; **Frost, Daniel A.**; Selby, Neil D; Seismic Detections of small-scale heterogeneities in the deep Earth, Springer Monograph, 2015, in *The Earth's Heterogeneous Mantle*, c. 12, p. 367-390

**Frost, Daniel A.**; Rost, Sebastian; The P-wave Boundary of the Large-Low Shear Velocity Province beneath the Pacific, *Earth Planet. Sci. Lett.*, 2014, 403, p. 380-392

**Frost, Daniel A.**; Rost, Sebastian; Selby, Neil D.; Stuart, Graham W., Detection of a tall ridge at the core-mantle boundary from scattered PKP energy, *Geophys. J. Int*, 2013, 195, p. 558-574

### Publications - in preparation

**Frost, Daniel A.**; Avery, Margaret S.; Buffett, Bruce A.; Chidester, Bethany A.; Deng, Jie; Dorfman, Susannah M.; Li, Zhi; Liu, Lijun; Lv, Mingda; Martin, Joshua F: Multidisciplinary constraints on the thermal-chemical boundary between Earth's core and mantle

**Frost, Daniel A.**; Romanowicz, Barbara: Upper mantle structure beneath Alaska: implications for inner core anisotropy studies from analysis of PKP<sub>df</sub>, bc, ab absolute and differential measurements

**Frost, Daniel A.**; Garnero, Edward J.: The influence of lower mantle structure on resolution of the Earth's core

**Frost, Daniel A.**; Waszek, Lauren: The sharpness of the inner core hemispheres: assessing the impact of the upper mantle on PKiKP

Rost, Sebastian; **Frost, Daniel A.**: Hawaiian plume structure from Pdiffracted ray-path anomalies

**Frost, Daniel A.;** Rost, Sebastian: Physical properties of scattering heterogeneities throughout the mantle

### Non-peer reviewed work

**Frost, Daniel A.;** Romanowicz, Barbara: On the different flavours of seismic reference models, <https://escholarship.org/uc/item/7wb6377n>

### Invited Presentations

2017 European Geophysical Association General Assembly Vienna

**Frost, Daniel A.\*;** Rost, Sebastian; Garnero, Edward J.; Romanowicz, Barbara; The dynamic connection between small and large-scale mantle heterogeneity

2015 American Geophysical Union Fall Meeting San Francisco

**Frost, Daniel A.\*;** Rost, Sebastian; Garnero, Edward J.; Seismic detection of oceanic crust in Earth's lower mantle and its relation to large-scale mantle structure

2013 European Geophysical Association General Assembly Vienna

**Frost, Daniel A.\*;** Rost, Sebastian; Selby, Neil D.; A global study of the lowermost mantle using scattered PKKP waves (PK●KP)

2012 Faculty of Environment Conference Leeds

**Frost, Daniel A.\*;** Rost, Sebastian; Selby, Neil D.; Stewart, Graham W.; The Earth in detail: Seismology as a tool for studying the Earth's fine-scale structure

2012 Congres de Doctorants IGP, Paris

**Frost, Daniel A.\*;** Rost, Sebastian; Selby, Neil D.; Stuart; PKP Scattering: Detecting a Heterogeneous Ridge Above the Core-Mantle Boundary

### Campus Presentations

2019 Berkeley Seismological Laboratory Seminar UC Berkeley

**Frost, Daniel A.\*;** Dynamic history of the inner core constrained by seismic anisotropy

2019 Origins Seminar UC Davis

**Frost, Daniel A.\*;** Seismological evidence of the dynamical links between small- and large-scale mantle structure

2019 Seismology and Tectonics Seminar UCLA

**Frost, Daniel A.\*;** Inner core dynamics from patterns of seismic anisotropy

2018 Seismological Laboratory Seminar California Institute of Technology

**Frost, Daniel A.\*;** Seismological evidence of the dynamical links between small- and large-scale mantle structure

2018 Department of Physics Colloquium New Mexico State University

**Frost, Daniel A.\*;** The dynamical links between small- and large-scale mantle structures: seismological evidence

2016 Deep Thoughts Earth and Life Science Institute, Tokyo

**Frost, Daniel A.\*;** Seismically mapping kilometre-scale structures throughout the mantle

2016 Berkeley Seismological Lab Seminar University of California, Berkeley

**Frost, Daniel A.\***; Seismically mapping kilometre-scale structures throughout the mantle

### **Proposals - funded**

2020 National Science Foundation Geophysics program

Value: \$72,612 *Collaborative Research: Towards improved imaging of the outermost core through determination of the effects of lowermost mantle heterogeneity and anisotropy*

Myself as CoI with Edward Garnero (Arizona State University) as PI, and CoIs Ebru Bozdogan (Colorado School of Mines) and Maureen Long (Yale University).

2018 National Science Foundation Geophysics program

Value: \$152,142 *Resolving the influence of mantle heterogeneity on estimates of inner core anisotropy*

Co-authored with Barbara Romanowicz. Named researcher.

2014 National Science Foundation Cooperative Studies Of The Earth's Deep Interior program

Value: \$550,121 *Deep Mantle Cycling of Oceanic Crust*

This proposal was authored by PIs at ASU, but the seismological investigations (one third of the proposed activities) were built around my skill base, to specifically fund my involvement in the multidisciplinary research

2014 Preparatory Commission for the Comprehensive Nuclear Test-ban Treaty Organization (CTBTO)  
Young Scientist Research Award

Value: 9 months *Characterisation of small-scale heterogeneities beneath IMS arrays for improved source location and magnitude estimation*

Authored proposal and the project was awarded, but I turned this down to accept a postdoctoral position at Arizona State University

### **Proposals - in preparation**

2020 National Science Foundation Geophysics program

*Investigating the Upper Mantle Structure of Alaska and the Yakutat terrain by full waveform inversion*

Myself as PI, with Barbara Romanowicz (UC Berkeley) as CoI.

2020 National Science Foundation CSEDI program

*Collaborative Research: Investigating the dynamics and composition of the inner core through multi-scale seismic inversion*

Myself as PI with Scott Burdick (Wayne State University), Lauren Waszek (New Mexico State University) as CoI, and Marine Lasbleis (Universite de Nantes, France), as a collaborator.

### **Teaching Experience**

University of California, Berkeley

Postdoc Teaching Opportunities Program Learner-centered teaching course (May 2020)

Pathways to Scientific Teaching training course (Feb 2020)

Guest instructor: Earthquake of the week EPS 256 (2018, 2019) - Graduate level

Guest lecturer: Physics of the Earth's Interior EPS122 (2017)

Arizona State University

Undergraduate student pitching workshop (2015)

The University of Leeds

Teaching assistant: Global Seismology (2011, 2012, 2013)

Guest lecture on graduate research: Global Seismology (2013)



- 2019 Supported the organisation of CIDER summer program
- 2015-2019 American Geophysical Union Fall Meeting OSPA Judge
- 2018 Volunteered as an student mentor at the American Geophysical Union Fall Meeting
- 2018 Organised CIDER pre-AGU workshop
- 2018 Supported the running and organisation of CIDER summer program
- 2017 Volunteered as an student mentor at the American Geophysical Union Fall Meeting
- 2017 Co-organised CIDER pre-AGU workshop
- 2017 Assisted with running CIDER summer program
- 2016 Organised student pitching competition at Arizona State University
- 2012 Assisted with delegate services for the SEDI 2012 meeting held in Leeds
- 2012 Co-organised the British Geophysical Association Postgraduate Research in Progress Meeting held in Leeds

### **Service to University**

- 2019 Co-organised Berkeley Seismological Lab seminar series
- 2018 Organised lab-wide discussion meetings on recent seismicity and professional development
- 2017 Postdoc representative on UC Berkeley Seismological Lab web design committee
- 2016 Co-organised Berkeley Seismological Lab seminar series
- 2015 Organised research group-wide social meetings at Arizona State University
- 2013 Postgraduate student representative at both the research institute and school level at University of Leeds

### **Outreach**

- February 2020 Presented research and about science careers at Berkeley City College
- 2019 Popping the Science Bubble - public research talk at Berkeley Public Library
- 2019 Remotely taught seismology to 3rd and 4th grade students at school in central Kansas
- 2019 Presented research and basic seismology lesson to 7th grade students visiting from local school
- 2019 Presented at UC Berkeley CalDay on Earth's core to advertise geophysics research to prospective students
- 2019 Support Berkeley Seismological Laboratory at UC Berkeley CalDay
- 2019 Taught tectonics to 6th grade students with Bay Area Science in Schools
- 2019 Remotely engaged with third grade students at a rural school to discuss earthquake hazards and research
- 2018 Engaged with the public at a question and answer session at The Bay Area Science Festival
- 2018 Presented on behalf of UC Berkeley Seismological Lab at the City of Berkeley ShakeOut
- 2018 Presented at UC Berkeley Compass to advertise geophysics research across campus
- 2018 Presented at UC Berkeley CalDay on Earth's core to advertise geophysics research to public

- 2018 Supported Berkeley Seismological Laboratory at UC Berkeley CalDay
- 2018 Taught statistical analysis to students for science fair projects in a Bay Area middle school
- 2018 STEM mentor for Be A Scientist program in a Bay Area middle school
- 2017 Taught seismology to 6th grade students with Bay Area Science in Schools
- 2017 Presented on behalf of UC Berkeley Seismological Lab at the Bay Area Science Festival

### Professional Development

- 2018 University of California, Beyond Diversity lectures  
Discussion of inclusion in STEM education
- 2016 University of California, Berkeley Postdoctoral Development Courses  
Management and Python programming
- 2015 Arizona State University Postdoctoral Development Course  
Pitching and application writing
- 2015 IRIS Webinars  
Programming skills and career development

### Presentations

- 2019 American Geophysical Union Fall Meeting San Francisco  
**Frost, Daniel A.\***; Romanowicz, Barbara; Lasbleis, Marine; Chandler, Brian; Seismic evidence of slow translation of the iron-nickel inner core
- 2019 American Geophysical Union Fall Meeting San Francisco  
**Frost, Daniel A.\***; Romanowicz, Barbara; Roecker, Steve; Upper mantle slab beneath Alaska: major contribution to the South Sandwich to Alaska anomalous PKP<sub>df</sub> observations
- 2019 IUGG General Assembly Montreal  
Frost, Daniel A.; **Romanowicz, Barbara\***; Chandler, Brian; Lasbleis, Marine; Seismic evidence of slow translation of the inner core
- 2018 American Geophysical Union Fall Meeting Washington D.C.  
**Frost, Daniel A.\***; Romanowicz, Barbara; Lasbleis, Marine; Chandler, Brian; Inner Core Dynamics From Patterns of Seismic Anisotropy
- 2018 American Geophysical Union Fall Meeting Washington D.C.  
Roecker, Steven; **Frost, Daniel A.\***; Romanowicz, Barbara; Structure of the Crust and Upper Mantle beneath Alaska Determined from the Joint Inversion of Arrival Times and Waveforms of Regional and Teleseismic Body Waves
- 2018 American Geophysical Union Fall Meeting Washington D.C.  
Mingda Lv, Margaret S Avery, Xiaoran Chen, Bethany Chidester, Jie Deng, Benjamin J Farcy, **Frost, Daniel A.\***, Zhi Li, Joshua F Martin, Bruce A Buffett, Susannah Dorfman, and Lijun Liu: ; A multidisciplinary assessment of heat flux at the core mantle boundary
- 2018 American Geophysical Union Fall Meeting Washington D.C.  
Waszek, Lauren; Burdick, Scott; Lasbleis, Marine; **Frost, Daniel A.\***; Anandawansha, Rashni; Combining global tomographic inversions with geodynamical growth models to constrain the origins of Earth's inner core features
- 2018 Study of Earth's Deep Interior Edmonton

- Frost, Daniel A.\***; Romanowicz, Barbara; Axially dependent Inner Core anisotropy from low order inner core convection
- 2018 Dynamics and evolution of Earth's coupled core-mantle system Royal Astronomical Society
- Frost, Daniel A.\***; Romanowicz, Barbara; Axially dependent Inner Core anisotropy from low order inner core convection
- 2017 American Geophysical Union Fall Meeting New Orleans
- Frost, Daniel A.\***; Romanowicz, Barbara; Investigating the source of anomalous PKP travel times on South-Sandwich to Alaska paths
- 2017 Gordon Research Conference: Interior of the Earth Mount Holyoke
- Frost, Daniel A.\***; Romanowicz, Barbara; Constraints on Inner Core structure from P'P' array-based observations
- 2017 Gordon Research Seminar: Interior of the Earth Mount Holyoke
- Frost, Daniel A.\***; Romanowicz, Barbara; Constraints on Inner Core structure from P'P' array-based observations
- 2017 European Geophysical Association General Assembly Vienna
- Frost, Daniel A.\***; Romanowicz, Barbara; Constraints on Inner Core structure from P'P' array-based observations
- 2016 American Geophysical Union Fall Meeting San Francisco
- Frost, Daniel A.\***; Romanowicz, Barbara; Constraints on Inner Core structure from P'P' array-based observations
- 2016 American Geophysical Union Fall Meeting San Francisco
- Ko, Byeongkwan; Holt, Adam; Gao, Chao; **Frost, Daniel A.\***; Karaoglu, Haydar; Lai, Hongyu; Yuan, Kaiqing; Li, Mingming; Campbell, Siobhan M.; Shim, Sang-Heon; Irving, Jessica C. E.; Kellogg, Louise H.; Miller, Samantha M.; Probing the lower mantle composition and thermal structure: Insights from D'
- 2016 Study of Earth's Deep Interior Nantes
- Frost, Daniel A.\***; Garnero, Edward J.; Rost, Sebastian; Connection across scales of seismic heterogeneity throughout the mantle
- 2015 American Geophysical Union Fall Meeting San Francisco
- Frost, Daniel A.\***; Garnero, Edward J.; TA sub-array measurements of SmKS ray parameters to determine lower mantle influence
- 2014 American Geophysical Union Fall Meeting San Francisco
- Frost, Daniel A.\***; Rost, Sebastian; Garnero, Edward J.; A dynamical context for small-scale heterogeneity throughout the mantle beneath subduction
- 2014 Study of Earth's Deep Interior Kanagawa, Japan
- Frost, Daniel A.\***; Rost, Sebastian; Selby, Neil D.; A global study of the lowermost mantle using short and long period scattered PKKP waves (PK●KP)
- 2013 American Geophysical Union Fall Meeting San Francisco
- Frost, Daniel A.\***; Rost, Sebastian; Selby, Neil D.; A global study of the lowermost mantle using short and long period scattered PKKP waves (PK●KP)
- 2013 American Geophysical Union Fall Meeting San Francisco
- Frost, Daniel A.\***; Rost, Sebastian; Constraining lower mantle anomalies using USArray



- 2013 American Geophysical Union Fall Meeting San Francisco  
Rost, Sebastian; **Frost, Daniel A.\***; The distribution of small-scale heterogeneity at the core-mantle boundary
- 2013 BGA Postgraduate Research in Progress Meeting Cambridge  
**Frost, Daniel A.\***; Rost, Sebastian; Selby, Neil D.; A global study of the lowermost mantle using scattered PKKP waves (PK●KP)
- 2013 Gordon Research Conference: Interior of the Earth Mount Holyoke  
**Frost, Daniel A.\***; Rost, Sebastian; Selby, Neil D.; A global study of the lowermost mantle using scattered PKKP waves (PK●KP)
- 2013 Gordon Research Seminar: Interior of the Earth Mount Holyoke  
**Frost, Daniel A.\***; Rost, Sebastian; Selby, Neil D.; Stewart, Graham W.; PKP Scattering: Detecting a Heterogeneous Ridge Above the Core-Mantle Boundary
- 2012 Structure and Dynamics of Earth's Deep Mantle College de France  
**Frost, Daniel A.\***; Rost, Sebastian; Selby, Neil D.; PKKP Scattering: A tool for the global study of the Core-Mantle Boundary
- 2012 BGA Postgraduate Research in Progress Meeting Leeds  
**Frost, Daniel A.\***; Rost, Sebastian; Selby, Neil D.; PKKP Scattering: A tool for the global study of the Core-Mantle Boundary
- 2012 Study of Earth's Deep Interior Leeds  
**Frost, Daniel A.\***; Rost, Sebastian; Selby, Neil D.; PKKP Scattering: Towards a global study of the Core-Mantle boundary
- 2011 American Geophysical Union Fall Meeting San Francisco  
**Frost, Daniel A.\***; Rost, Sebastian; Selby, Neil D.; Stuart, Graham W., PKP Scattering: Detecting a heterogeneous ridge about the Core-Mantle boundary
- 2011 BGA Postgraduate Research in Progress Meeting Oxford  
**Frost, Daniel A.\***; Rost, Sebastian; Selby, Neil D.; Stuart, Graham W., PKP Scattering: Detecting a heterogeneous ridge about the Core-Mantle boundary