DANIEL ANDREW FROST

PERSONAL INFORMATION

Date of Birth 7 December 1987

Address: 24 Chell Green Avenue, Stoke-on-Trent, ST6 7JY, UK

E-mail eedaf@leeds.ac.uk

Phone (M) +44 (0)7802 625782 · (W) +44 (0)1133 435658

EDUCATION

2010-Present PhD — The University of Leeds

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

Supervisors: Dr Sebastian Rost, Dr Neil Selby, & Prof. Graham Stuart
Expected completion date: Spring 2014

2006-2010 MEarthSci — The University of Oxford

Earth Sciences 2.1 Classification

- Masters project: A marine geophysical study of the Tonga Trench-Louisville ridge collisional system in the South-West Pacific Ocean
- Extensive geological field experience

Masters supervisor: Prof. Tony Watts Undergraduate tutor: Dr Stephen Hesselbo

2004-2006 A Levels — City of Stoke-On-Trent Sixth Form College

A grades in Geology, Maths with Mechanics, Biology, and Chemistry

1999-2004 GCSEs — St Margaret Ward Catholic School and Arts College

6 A* grades and 4 A grades

PUBLICATIONS

2013 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.*, **195**, 558-574

2014 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*, in press

2014 Frost, Daniel A.; Rost, Sebastian; Selby, Neil D.; A global study of lowermost mantle heterogeneities and their length scales using scattered PKKP waves (PK•KP), in preparation

2014 Frost, Daniel A.; Rost, Sebastian; A high-resolution P-wave study of Pacific mantle structures, in preparation

CONFERENCE ATTENDANCE

December 2013 American Geophysical Union Fall Meeting, San Francisco
Constraining lower mantle anomalies using USArray

December 2013 American Geophysical Union Fall Meeting, San Francisco
A global study of the lowermost mantle using short and long period scattered PKKP waves (PK•KP)

September 2013 BGA Postgraduate Research in Progess Meeting, Cambridge
A global study of the lowermost mantle using scattered PKKP waves (PK•KP)

July 2013 CIDER Summer School, Berkeley
Attended for 1 month
Worked for 2 weeks on the nature, prevalence, and possible explanations for observations of the Mid-Lithospheric Discontinuity with 6 other graduate students and post-docs

June 2013 Gordon Research Conference: Interior of the Earth, Mount Holyoke
A global study of the lowermost mantle using scattered PKKP waves (PK•KP)

June 2013 Gordon Research Seminar: Interior of the Earth, Mount Holyoke
PKP Scattering: Detecting a Heterogeneous Ridge Above the Core-Mantle Boundary

April 2013 European Geophysical Association General Assembly, Vienna
A global study of the lowermost mantle using scattered PKKP waves (PK•KP) *(invited)*

November 2012 Structure and Dynamics of Earth's Deep Mantle, College de France

September 2012 BGA Postgraduate Research in Progess Meeting, Leeds
PKKP Scattering: A tool for the global study of the Core-Mantle Boundary

July 2012 SEDI 2012, Leeds
PKKP Scattering: Towards a global study of the Core-Mantle boundary

May 2012 Faculty of Environment Conference, Leeds
The Earth in detail: Seismology as a tool for studying the Earth's fine-scale structure

March 2012 Congres de Doctorants, IPGP
PKP Scattering: Detecting a Heterogeneous Ridge Above the Core-Mantle Boundary *(invited)*

December 2011 American Geophysical Union Fall Meeting, San Francisco
PKP Scattering: Detecting a heterogeneous ridge about the Core-Mantle boundary

September 2011 BGA Postgraduate Research in Progess Meeting, Oxford
PKP Scattering: Detecting a heterogeneous ridge about the Core-Mantle boundary

WORK EXPERIENCE

September 2013 Field work: Turkey
Assisted in servicing and decommissioning the DANA (Dense Array in Northern Anatolia

2010-Present Teaching Assistant, Leeds
Worked as a teaching assistant in both lab and field based classes:

- Global seismology
- Seismic exploration
- Computing
- Inverse theory
- Petrology
- Map skills
- Geophysical data acquisition (North Wales)
- Field geology (Western Ireland and North-West Scotland)

September 2012 Member of the local organisation committee for the BGA Postgraduate Research in Progress Meeting held in Leeds
Held treasurer position and liaised with catering venues

July 2012 Assisted with delegate services for the SEDI 2012 meeting held in Leeds

Summer 2010 Research Scientist, AWE Blacknest
Analysed seismic scattering using CTBTO data

Summer 2009 Colima University, Mexico
Volunteered as a research assistant for 2 months

- Worked with seismic data and thermal camera images to analyse volcanic activity at Volcan de Colima
- Took part in numerous field trips to observe and sample Volcan de Colima

REFERENCES

Primary PhD Supervisor:	Dr Sebastian Rost
Address:	School of Earth and Environment, University of Leeds, Leeds, LS2 9JT, UK
Email:	s.rost@leeds.ac.uk
Tel:	+44(0) 1133 435212

Secondary PhD Supervisor:	Dr Neil Selby
Address:	AWE Blacknest, Brimpton, Reading, RG7 4RS, UK
Email:	neil@blacknest.gov.uk
Tel:	+44(0) 1189 824293

Research interests and accomplishments of Daniel Andrew Frost

The Earth's interior is known to be heterogeneous, both laterally and vertically, on a range of scales. A suite of seismic imaging technologies can be used to study Earth structure, each able to resolve a certain range of heterogeneity sizes and with varying spatial coverage. To understand the overall history and dynamics of our planet, we must study both small and large-scale structure to track the evolution of the interior. The Core-Mantle Boundary (CMB) is the most significant interface within the Earth in terms of chemical and thermal flux. The termination of convection cells in both the Core and the Mantle and the high heat fluxes involved make many different processes possible: partial melting, chemical substitution, mechanical mixing or, potentially very importantly, lack thereof. I use array based seismological techniques, primarily focusing on small-scale structure imaged through scattered seismic waves, but with additional work on travel-time and waveform studies, to help bridge the gap between large-scale tomographic studies, dynamic models, and chemical and mineralogical prediction.

PKP scattering

Using a small collection of very low magnitude events in deep gold mines in South Africa, I imaged localised structure at the Core-Mantle Boundary [Frost et al., GJI, 2013]. Relatively large amplitude precursors to PKP recorded at Yellowknife Array were extracted from the seismic wavefield using techniques adopted from forensic seismology. Through array processing methods and ray-tracing, I located the causative scatterers in the lowermost 100 km of the mantle, forming a ridge-shaped anomaly on the receiver side of the path. Given the location close to the edge of the African LLSVP and the unusual height of this structure, it is proposed that the constituent heterogeneities are only moderately dense relative to their surroundings which allows the material to be entrained into the upstream associated with LLSVP convection, thus demonstrating the link between small and large-scale structure.

PKKP scattering

I carried out a near-global study of the lowermost mantle using scattered PKKP waves (PK•KP) to better resolve links with larger scale mantle structure and processes [Frost 2014, in prep.]. Using global seismicity recorded at small and medium aperture arrays from the IMS collection, I searched for mantle heterogeneities through observing PK•KP waves. Using array techniques from forensic seismology along with ray-tracing, I determined the distribution of small-scale heterogeneities in the lowermost mantle. I found strongly laterally heterogeneous scattering heights, with near ubiquitous scattering in the lowermost 40 km of the mantle, and laterally discontinuous piles of heterogeneities up to 250 km above the CMB indicating localised concentration of chemically anomalous mantle materials, possibly produced by lower mantle flow. I characterised the anomaly size by analysing the frequency content of global broadband observations of PK•KP energy. Spatial statistics showed that small-scale anomalies concentrate around the edges of LLSVPs and close to slab material at the CMB, and the correlation becomes stronger with scatterer height above the CMB.

LLSVP shape

Taking advantage of the vast spatial extent of USArray and the multitude of sources in both the Western and Eastern Pacific, I used P and P_{diff} travel times to map the V_p structure of the LLSVPs [Frost and Rost, 2014, in prep.]. The V_p/V_s is ratio often used to determine the composition and temperature of mantle anomalies, therefore, having a good, high resolution image of these structures in terms of P-waves is necessary in order to understand them. I find that lower mantle structure has a strong influence on deep rays generating regional patterns in travel-time residuals. The edges of the Pacific LLSVP are particularly sharp and well-defined by P-waves, although do not perfectly track the shape seen in S-wave tomography models.

DANIEL ANDREW FROST

REFERENCES

Primary PhD Supervisor:	Dr Sebastian Rost
Address:	School of Earth and Environment, University of Leeds, Leeds, LS2 9JT, UK
Email:	s.rost@leeds.ac.uk
Tel:	+44(0) 1133 435212

Secondary PhD Supervisor:	Dr Neil Selby
Address:	AWE Blacknest, Brimpton, Reading, RG7 4RS, UK
Email:	neil@blacknest.gov.uk
Tel:	+44(0) 1189 824293