PROJECT TITLE: Novel probes of upwelling mantle in the Southern Pacific Ocean using floating and land-based seismic data

DTP Research Theme(s): Dynamic Earth

Lead Institution: University of Bristol

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Project keywords: Mantle, Deep Earth, Seismic Observation

![Figure 1 - Seismic raypaths (black lines) for MERMAID records in the South Pacific Ocean. Stars are earthquakes, and triangles are seismometers. Adapted from Simon, Simons & Irving (in review) by J. Simon.](image1)

![Figure 2 - Locations where multiple seismic models agree that the lowermost mantle is seismically slow (from Cottaar & Lekic 2016), with potential mantle plume locations (from King & Adam, 2014) superimposed as orange circles.](image2)

Project Background

Upwelling hot mantle material — plumes — and downwelling cold material — slabs — are prominent features of convection in Earth’s mantle. They can be probed by seismic waves travelling from distant earthquakes. However, the distribution of seismic stations is not ideal, and the distribution of seismic sources is worse. Using all possible seismic signals is therefore vital to understanding the dynamic mantle. MERMAID (Mobile Earthquake Recorder in Marine Areas by Independent Divers) records signals from floating seismic detectors, and is helping to provide novel seismic paths in the mantle. Additionally, permanent and temporary seismic stations provide records of both direct and reflected mantle phases which can be combined to probe the mantle. Signals recorded in the ocean by MERMAID must be treated carefully to ensure that the effects of varying bathymetry do not mask the information seismic waves transmit about the deep earth. In the South Pacific Ocean, MERMAID has returned seismic records which sample the deep and shallow mantle (Figure 1). The LLVP (Large Low Velocity Province) beneath the Southern Pacific is thought to be the location of the deep roots of mantle plumes (Figure 2) which feed volcanic activity, and lead to the hotspot tracks visible at the surface.

Project Aims and Methods

This project will use MERMAID records gathered in the Southern Pacific Ocean, together with land-based seismic data, to investigate the mantle beneath both hotspots and ‘normal’ seafloor. Standard methods must be extended to better make use of the limited MERMAID and land-based data. This will include using non-traditional phases to assess the bulk mantle and mantle transition zone under the islands, and employing state-of-the art computational methods to assess how signals from structures in the mantle may be masked by very shallow structure. This project will involve the use of observational seismology and computational forward modelling using models of mantle upwellings provided by the project partner.
Candidate requirements
We seek an enthusiastic student with broad interests in seismology and geophysics. A first degree in geophysics, physics, maths, computer science, engineering, geology or other quantitative subject is needed. The ideal candidate may have some experience, and will have an interest, in both observational and computational seismology. The student will present results at national and international conferences and to publish findings in international journals, requiring excellent communication and written skills. We welcome and encourage student applications from under-represented groups. We value a diverse research environment.

Collaborative partner
Collaborative partner Professor Huw Davies has substantial expertise in the modelling of mantle dynamics, and will support the project by providing models of possible mantle plumes to be used in simulations and insights into the mantle dynamics at work under the Pacific Ocean. The partner is lead PI on the NERC Large Grant (~£3.8M FEC) MC2 (Mantle Convection Constrained) investigating mantle upwellings. This studentship would benefit from MC2 including opportunities to interact with its cohort of PhD students.

Training
The project will be based around working with existing seismic data and simulating seismic waveforms. Training in all the software and techniques needed to conduct this research will be provided to the student. The student will be encouraged to attend local and international workshops where appropriate.

Background reading and references
Please contact Dr Irving for a copy of “Simon, Simons & Irving - Recording earthquakes for tomographic imaging of the mantle beneath the South Pacific by autonomous MERMAID floats”, which is in review, or any other paper below.


Useful links
http://www.bristol.ac.uk/earthsciences/courses/postgraduate/

NERC GW4+ DTP Website:
For more information about the NERC GW4+ Doctoral Training Partnership please visit
https://www.nercgw4plus.ac.uk

Bristol NERC GW4+ DTP Prospectus:
http://www.bristol.ac.uk/study/postgraduate/2022/doctoral/phd-great-western-four-dtp/

How to apply to the University of Bristol:
http://www.bristol.ac.uk/study/postgraduate/apply/

The application deadline is Monday 10 January at 2359 GMT. Interviews will take place during the period 23 February – 9 March 2022.

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