The Reflections Under the Scottish Highlands (RUSH) EXPERIMENT: Mapping Fine-Scale Heterogeneities within the Continental Mantle Lithosphere Beneath Scotland, Combining Active- and Passive-Source Seismology

Eugenio Asencio • University of Puerto Rico
James H. Knapp, Thomas J. Owens • University of South Carolina
George Helffrich • University of Bristol

The structure and evolution of the continental mantle lithosphere constitute a fundamental frontier of continental tectonics. Developments in the field of seismology over the last decade in recording technology, data volume, and analysis techniques have led to a potentially powerful capability to integrate active- and passive-source seismology to image upper mantle structure across a spectrum of observational scales. Northern Scotland offers the opportunity to explore this integrated seismological approach due to the variety of observations suggesting fine-scale upper mantle layering. Toward this end, we tapped the BIRPS database of upper mantle reflections identified on near-vertical deep seismic reflection profiles and we deployed 24-broadband PASSCAL seismographs during the summer of 2001 (Asencio et al., 2001, 2003) across the Scottish Highlands (Figure 1).

We analyze new observational evidence for seismic velocity discontinuities in teleseismic receiver functions in comparison to well-documented discontinuities observed in marine reflection profiles and wide-angle reflection-refraction profiles in northern Scotland. Our study establishes the viability of mapping small amplitude P-to-S (Ps) converted phase arrivals from the upper mantle generated in the P-wave coda of teleseismic earthquakes using well-known receiver function methods (Figure 2).

This investigation (Asencio, 2003) represents the joint use of two different approaches to seismic mapping of lithospheric structures and addresses the utility of correlating active- and passive-source seismology for understanding the tectonic significance and evolution of upper mantle structures. Application of this combined analysis provides some insight into the origin and lateral extent of upper mantle velocity discontinuities beneath Scotland.


This work was funded in part by grant EAR0074002 from the US National Science Foundation, grant GR9/04304 from the UK Natural Environment Research Council. We would like to thank the NERC Geophysical Equipment Pool and PASSCAL for providing the equipment and logistical support in the field and the IRIS Data Management Center and the British Geological Survey for making available the data through their automatic data server.