Why are Non-Volcanic Passive Margins Not Volcanic?

Prof. Tim Reston and Dr Stephen Jones

Background Two important unsolved questions concerning non-volcanic passive margin evolution are how to avoid generating magma during plate separation and how to explain the transition from initial non-volcanic seafloor spreading to generation of 6–8 km thick oceanic crust by 10 million years after plate separation. The goal of this project is to investigate whether evolution from an initial broad, slow mode of mantle upwelling to a mature focussed, rapid upwelling mode can explain these questions. Divergence of two tectonic plates at a mid-ocean ridge draws the underlying mantle upward so that it melts by depressurisation to form new oceanic crust. The width of the melting region remains poorly known because traditional observations (the thickness, structure and chemical composition of oceanic crust) do not constrain the rate of upwelling in the mantle beneath. However, diachronous ridges of thickened oceanic crust, which form near hotspots when melting anomalies propagate along a mid-ocean ridge through time, provide a new direct constraint on the width of the melting region. Initial work on these ridges suggests that upwelling and melting are focussed within a narrow zone beneath mature mid-ocean ridges. In contrast, observations of rifting at non-volcanic passive margins suggest that mantle upwelling occurred at a lower rate over a much wider area.

Work Plan The project will involve collating observations of crustal age, thickness, structure and chemical composition from mature mid-ocean ridges, and stratigraphy, crustal thickness and structure from non-volcanic passive margins. Each set of observations will be modelled using in-house software to find the shapes of the upwelling and melting regions. The geometry of upwelling beneath mature mid-ocean ridges will be constrained using data from the oceanic crust surrounding Iceland and the Azores. The geometry of upwelling during the pre-breakup stage of non-volcanic passive margins will be determined beginning with data from the conjugate margins of Iberia and Newfoundland. The final task will be to investigate what happens when the melting model is forced to evolve from the broad, slow upwelling mode at break-up to the mature, focussed, rapid upwelling mode.

Methods & Training This project will suit a geologist or a geophysicist interested in both mid-ocean ridge processes and continental extensional tectonics. Training in the use of all software will be provided. It is anticipated that the student will have the opportunity to participate in research cruises and fieldwork in Iceland on related projects involving mid-ocean ridge processes and continental extensional tectonics. The project can be focussed on particular geographical areas depending on the interest of the successful student. Birmingham is an ideal location for a project on non-volcanic passive margin evolution. This project will benefit from a major UK-US collaboration beginning summer 2013 and lead by Tim Reston that has collected 3D seismic data over the Galacia non-volcanic passive margin.

References

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Applicants with BSc, MSci or MSc in Earth Science, Geophysics or Physics are invited to contact Stephen Jones (s.jones.4@bham.ac.uk) and Tim Reston (t.j.reston@bham.ac.uk) to discuss the project

Applicants should apply via http://www.birmingham.ac.uk/postgraduate/courses/research/gees/earth-sciences.aspx where they should click on 'Apply now' and choose the option 'PhD in Department of Earth Sciences' and give the PhD title in the 'Funding details' section of the online application.