Structural analysis of hyperextended crust

Supervisors: Professor Tim Reston and Dr Carl Stevenson

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Abstract: Rifted margins are the trailing broken edges of the continents that form during continental breakup and the opening of new oceans. However the mechanism of extreme extension (hyperextension) of the crust to the point where its thickness is zero is much debated. This project will focus on restorations of structures observed on seismic data from rifted margins and related basins. The data include a 3D seismic dataset collected across the Galicia margin (west of Spain) in summer 2013. Key issues include the extension discrepancy (the amount of extension measured from faulting is generally less than that required to explain the thinning), the role of detachment faulting in extension towards breakup, and the mechanics of eventual crustal separation and mantle unroofing.

Project description

Aim: To develop a kinematic model for the hyperextension of continental crust leading to the formation of an ocean basin.

Objectives: The objectives will focus mainly on examining the mechanics of extension with special reference to the extension discrepancy –why the amount of observed faulting is insufficient to explain the observed thinning of the crust. Established theories that are used to explain the extension discrepancy will be tested using our kinematic modelling. These theories include (1) depth-dependent crustal thinning, (2) subseismic faulting and (3) polyphase faulting (including sequential faulting). The first requires the removal of excess crust; the others both propose that the crustal volume has not been reduced, but that the extension is not readily interpretable. Distinguishing between these and other possibilities will greatly enhance our understanding of the process of breakup.

Project specific training: The principal method to be used will be structural interpretation of the available seismic data including the recently collected 3D seismic data across the Galicia margin, using the Kingdom Suite followed by restoration of the seismic data using the commercial software MOVE, provided by Midland Valley Exploration Ltd. Training in both of these industry standard software packages will be provided, although some experience in one or both would be advantageous.

Project management and logistics: The project will form part of a large international research effort and so will involve collaborative work with partners in the US (Rice, Lamont-Doherty), the UK (Southampton, Royal Holloway), Spain (Barcelona) and Germany (Kiel). Most of the work will be carried out at Birmingham supervised by Reston as the Galicia Margin Project PI and Stevenson as the lead structural geologist on the project. Both Stevenson and Reston are experienced in seismic interpretation and Stevenson is an experienced MOVE user.

Applicants with BSc or MSci in Geoscience are invited to contact Tim Reston (t.j.reston@bham.ac.uk) or Carl Stevenson (c.t.e.stevenson@bham.ac.uk) to discuss potential directions that the project may take

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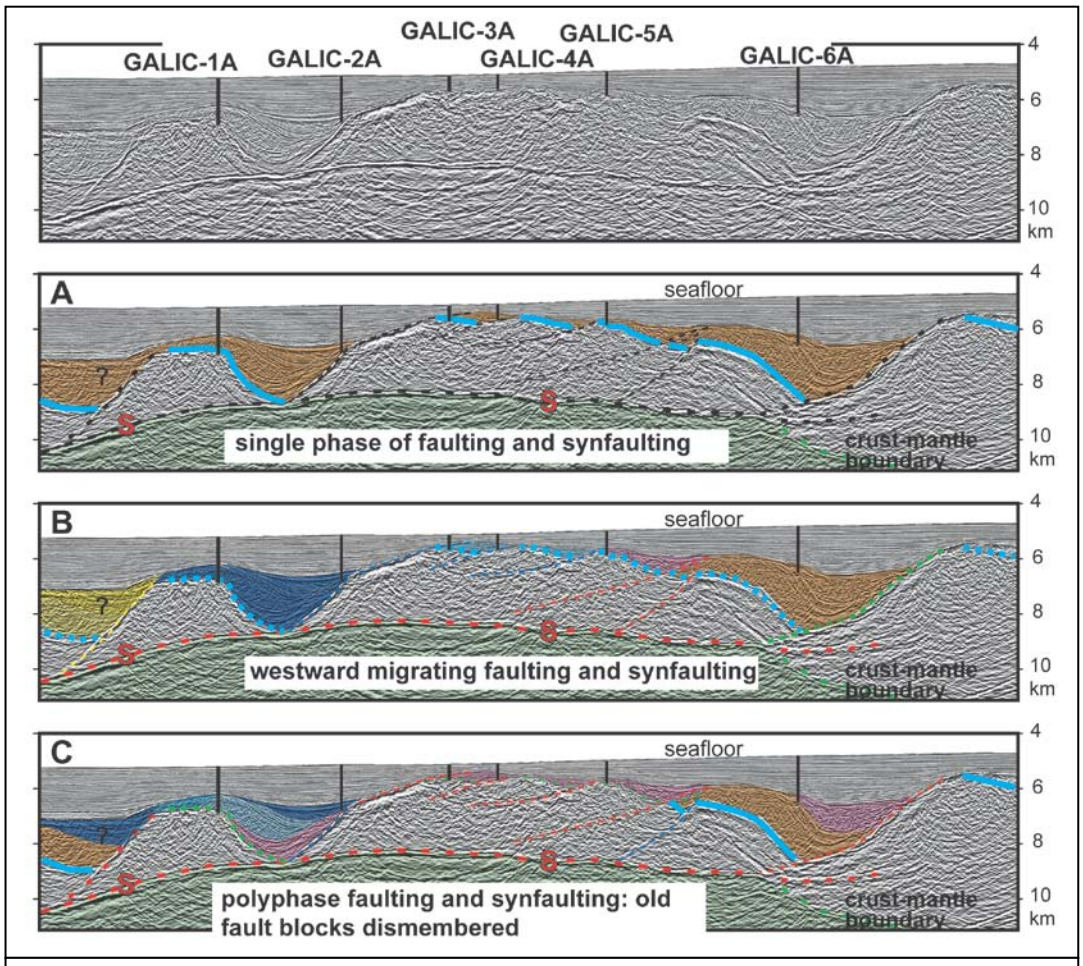

Example of seismic data from the region. Top pre-stack depth migrated image, below various interpretations that have been proposed: a single phase of faulting, sequential faulting (rolling hinge model), and polyphase crosscutting faulting. The project will use the new 3D data to help distinguish between these models and refine the proposed drill locations shown.

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.