The structural evolution of fold and thrust belts: implications for the development of associated sedimentary basins and their hydrocarbon potential.

Keele University in collaboration with the British Geological Survey

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Overview

Over 700 billion barrels of oil are known to be hosted in traps related directly to compressional settings, but such settings remain some of the most complex and challenging of hydrocarbon exploration environments. The evolving structural framework produces locally complex three-dimensional structures and governs evolution of the geometrical form of the associated foreland and piggy back basins, their sediment supply and their fill. Consequently, it strongly influences the hydrocarbon potential of compressional settings by controlling trap, reservoir and source rock distributions and timings.

In fold and thrust belts, structural development is characterised, and often intensely debated, as being either foreland- or hinterland-propagating in nature. In some cases, structural domains that show early development as foreland-propagating are characterised by later out-of-sequence, or 'break-back', thrusting, and the factors that control 'dominantly foreland' versus 'dominantly hinterland' propagating thrust systems are poorly understood. The geometry and thrust-sheet stacking of the evolving thrust belt itself may exert the dominant control, promoting foreland propagation at key points in the belt's development, and hinterland propagation at other times, perhaps with an oscillatory or cyclic nature throughout the evolution of the thrust belt.

Importantly, the geometry of the evolving thrust sheets and their propagation control both accommodation space and sediment supply to the associated foreland and piggy-back basins. Consequently, in conjunction with sea level, the evolution of the thrust belt exerts a strong control on the sedimentary fill of the basins, which suggests that any oscillatory or cyclic nature to the structural evolution will be apparent in basin fill, providing a structurally driven, sequence-stratigraphical model for interpreting basin fill and predicting hydrocarbon potential.

Methodology

The South Falkland Basin is a submarine, Cenozoic foreland basin to the south of the Falkland Islands that formed with its associated fold and thrust belt as a response to the northward migration of the Burdwood Bank. The northern margin of the Burdwood Bank is represented by a series of northerly verging thrust faults with a sinistral strike-slip component. As successive thrusts have migrated northwards they have not only had a significant influence on sediment distribution and depositional rates, but also produced a series of piggy back basins by encroaching on earlier sequences of foreland basin material.

Recent hydrocarbon discoveries in the passive margin sedimentary succession suggest that this area might become the focus of significant oil and gas exploration in the future. Furthering our understanding of the timing of compressional pulses in the fold and thrust belt and their relationship to sediment supply and the development of accommodating space in the foreland basin will greatly enhance exploration in the area.

In order to investigate these issues, this project will make use of extensive and very high quality, three-dimensional seismic datasets from the East Coast Basin, Raukumara Basin and Northeast Slope Basin of New Zealand: a series of thrust and associated foreland basins also developed in a thrust system with a dominant sinistral offset component. These basins are direct geological equivalents in structural style to those of the Falklands, but they have been drilled previously and provide well and outcrop control with which to

characterise the sedimentology of the basin fill, in addition to its geometry. The results of these studies will be applied to the South Falklands Basin and associated thrust belt, to predict sediment distribution and hydrocarbon potential in a situation where good quality three-dimensional seismic lacks well or outcrop control.

The project will provide a model for the development of the two fold and thrust belts that identifies the style and likely position of structures related to foreland and hinterland propagating thrusts, and characterises their influence on foreland basin geometry, development and sedimentary fill. As such, the model will provide an enhanced understanding of the sedimentary fill, the stratigraphical evolution and the hydrocarbon potential of both of these currently under explored and poorly understood basins.

Generically, the project will also investigate foreland versus hinterland propagation in the thrust belts. If oscillatory structural geodynamics in fold and thrust systems can be demonstrated to be a reality, then the project will provide a basis for interpreting the evolution of accommodation space and sediment supply within related sedimentary basins and within a sequence stratigraphical framework that could be applied to similar basins worldwide.

Skills, training and experience

This project will provide the student with high-end industry training in a variety of industry-standard modelling techniques including, geological / geo-mechanical modelling, structural restoration, seismic interpretation, well log analysis and interpretation; and industry standard software packages including Petrel™ and Move™. Fieldwork forms an extensive part of this project and the student will gain good experience in field techniques for structural data collection and analysis, including modern digital methods of field data capture, as well as experience in fieldwork planning, logistics and execution.

The *Basin Dynamics Research Group* at Keele has a background of experience in structural modelling in a variety of geological settings. Past members of the group have looked at fault and fault block geometry, structural restoration and property modelling, fault relationships, thrust tectonics and geometries, and fracture prediction. Current members of the group work on fracture and fault zone prediction and characterisation in mixed clastic and carbonate successions in response to strike-slip deformation, and fracture and deformation band characterisation in relation to clastic facies. The proposed project provides a natural extension of past and current work within the group, and the group's expertise provide a good grounding for the work.

Funding

This project is currently unfunded

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Further information and application

For further information on the project please feel free to contact the lead supervisor, Stuart Clarke:
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For further information on applying to study at Keele please see:
http://www.keele.ac.uk/pgresearch/howtoapply/

Applications are handled centrally through Keele University's central admissions system:
http://www.keele.ac.uk/researchsubjects/earthsciences