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Evolution, architecture and hierarchy of distributary deep-water deposits: a high-resolution outcrop investigation of submarine lobe deposits from the Permian Karoo Basin, South Africa

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Generic Research Problem: a better understanding of terminal lobe deposits

Terminal lobes form the down-dip depositional record of sediment bypassed through incisional channel systems on the slope and upper fan, and can form important and prolific hydrocarbon reservoirs. As a consequence, it is essential to have a better understanding of their internal geometry and facies distribution to construct their three dimensional architecture.

My PhD is a field based project, which aims to better quantify the internal architecture, lateral variation and evolution of lobe deposits. For the last two years, I have successfully completed four field seasons in the Karoo Basin, South Africa, where two main field areas, the Tanqua and the Laingsburg depocentre, have been targeted for their excellent outcrop extent.

Recently published data from modern / recent systems, using high-resolution seismic and side scan sonar data sets, provide information on the map-pattern hierarchy and stacking patterns of depositional elements that comprise lobe deposits. High-resolution outcrop datasets, however, allow lithofacies distributions to be documented across a hierarchy of elements in lobe deposits, which cannot be attained by other means.

Aims and Approach: a field based project

Work in the Tanqua depocentre has allowed the identification of a hierarchy of depositional elements for the first time from terminal lobe deposits at outcrop. The hierarchy consists of four elements: bed, lobe element, lobe, and lobe complex. Intervals between successive lobes do not show lithofacies changes over several kilometers, and are therefore identified as different architectural elements. The well exposed Tanqua depocentre, SW Karoo Basin, South Africa has also allowed us to place constraints on the shape and dimensions on the kilometers-scale geobodies, and the distribution of lithofacies. These results were presented at BSRG2007, and form the basis for a paper accepted in *Sedimentology*.

During the summer 2009, I will have the opportunity to complete a summer internship with Chevron. I would like to use this opportunity to be in California to conduct a comparative study using the Miocene deep-water distributive strata exposed along the coastline, and to integrate this work into my thesis. The findings will be presented at BSRG2009. More than translating other people's work and figures, I will be able to draw my own conclusions from visiting the outcrops.

Outcrops along the Californian coastline, especially between San Francisco and San Diego, are easily accessible and offer good 2D exposures. Ten days of fieldwork, conducted during weekends and/or after my internship, will allow collection of sedimentary logs and photographs to illustrate stacking patterns, lateral lithofacies variation and vertical connectivity of lobe deposits.

Scientific Significance: comparative analyses of different distributives systems

From published data, I was able to compare and contrast several modern and recent distributive systems with different allogenic controls, such as basin configurations, sediment supply (grain-size range and rate), tectonic setting, seabed topography, age, and delivery system: the Golo Fan System, Northern margin of East Corsica; the Cenozoic Kutai Basin, Indonesia; the Amazon fan, North Brazil. Despite these differences the results show that lobe deposits are characterised by two distinct planform shapes that is believed to be due to amplitude of basin floor topography. Secondly, average volumes of lobes from the different systems are not influenced by the size of the system, which indicates a (probably autogenic) control on the size of a lobe before a new one is generated. Finally, compensational stacking patterns between different elements of the hierarchy is common but the exact organisation of individual elements seems to be specific to a system. I presented these findings at BSRG2008.

However, what is required is a test of the architectural hierarchy and lithofacies distributions. The former is defined based on the character and geometry of fine-grained units that bound the sand-prone bodies. It would therefore be essential to study the grain size and thickness relationships between the fine-grained units and the sand-prone bodies in the Miocene lobe deposits of California. The latter is nicely documented for the Tanqua depocentre and show that four distinct environments of deposition exist with no sharp boundary between them. Using large photomontages and key sedimentary logs, accurate lithofacies maps can be drawn from 2D outcrops and can be used to better understand lithofacies relationship in the Tanqua depocentre. Comparing stacking patterns, vertical connectivity and lateral variation in lithofacies from different systems is a key aspect of my PhD and visiting outcrops along the coastline of California would give me a solid set of data.

Justification for Funding Request:

I am applying to the BSRG Gill Harwood Memorial Fund for a contribution towards the costs of a field season in California as this was not part of the initial PhD fieldwork. The opportunity to undertake a new field season will be of significant benefit to my personal and academic development. By getting to know the sedimentology of a new field site and comparing the stratigraphy and depositional architecture, I will develop a better understanding of the wider context of the results of lobe deposits.

On this basis, I hope that the committee will recognise that this work is of a suitably original nature to warrant recognition.

Regards,
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