

BSRG funding application: Joanne Venus (2nd Yr PhD student, The University of Leeds)

Joanne Venus

Proposed thesis title:

Heterogeneity in Permo Triassic fluvial successions to determine suitability of subsurface saline aquifers as sites for CO₂ storage and for characterisation of marginal pay hydrocarbon reserves

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I would like to be considered for both the Gill Harwood and Steve Farrell funds and I enclose my application, including research outline and budget below. I am a second year PhD student at the University of Leeds and am requesting these funds to carry out work that will add considerable value to my research; it is an area that I will not be able to cover without funding.

I will, of course, present the results arising from this proposed research at the December 2010 BSRG Annual Meeting in poster and/or oral presentation form.

Current and ongoing research:

My ongoing research has two principal aims: (i) the development of techniques with which to quantify stratigraphic heterogeneity at a variety of scales within fluvial successions and (ii) the establishment of criteria with which to demonstrate the existence (or otherwise) of coeval flow within multiple distributary fluvial channel systems, so as to establish the likely architectures present in ancient preserved examples of such systems.

Objectives relating to the quantification of heterogeneity: what influences and controls the development of heterogeneity in such successions? Given the advantage of well exposed outcrop successions, is it possible to develop widely applicable quantitative techniques (predictive facies models) that can be applied to similar subsurface examples where only limited 1D core and well log data are available? Is it possible to predict the type and impact of such heterogeneity given only limited vertical core data in terms of the likely lateral extent of a particular facies or facies associations. What are the likely range of expected fluvial architectures? Can we use key indices as indicators for use in predicting presence, proximity and extent of facies?

Objectives relating to the prediction of sedimentary architecture within distributary systems: what is the range of forms and channel morphologies present in modern dryland fluvial distributary systems? Are present-day examples of these systems really suitable as analogues with which to develop models to account for the architecture of ancient successions? What techniques can be used to relate the morphology of modern systems to the preserved stratigraphic architecture of equivalent ancient successions? What is the nature and effect of interactions between penecontemporaneous mixed fluvial and aeolian systems in terms of both allogenic and autogenic influences and controls?

The field-based data collection associated with my PhD research is centred around a detailed sedimentological and stratigraphic investigation of the Permian Cutler Group in the Paradox Basin, SE Utah, USA. To date, one full summer field season has been completed. In addition, I have also undertaken two short training field seasons investigating the Helsby Sandstone and Chester Pebble Beds formations of the Sherwood Sandstone Group in the Cheshire Basin, UK, which are comparable in terms of sedimentology and palaeoenvironment to the Cutler Group succession. Results from both field areas have been presented at three conferences (at BSRG 2008 as a poster, at the 7th Annual Petroleum Geoscience Conference 2009 as a poster/core workshop, and at BSRG 2009 as both a poster & oral presentation).

Key results to date include the development of detailed facies schemes for two arid-climate fluvial successions). For each formation, detailed architectural correlation panels have been constructed to constrain the geometry of architectural elements present and a suite of both regional and detailed high-resolution 1D sedimentary logs have been measured to serve as a framework within which to place detailed architectural observations. In the Cutler Group case study, every bed within each log has been scored for a series of key indices including mica content, degree and type of burrowing and bioturbation, extent of rhizolith development, water mottling and root mottling. These data, which are considered to be significant palaeoenvironmental indicators, are represented graphically alongside both logs and panels and serve to highlight trends within the formation. On-going work is being carried out to determine the relationships between these indicators and the lateral extent of key facies and architectural elements within the Cutler Formation. The plan is to develop this

technique further for use as a down-well predictive tool for inter-well correlation and the prediction of heterogeneity in subsurface successions.

Rationale for funding request:

In order to further develop the technique of using a range of palaeoenvironmental indicators that are readily observable in 1D log sections to predict likely 2D and 3D architectural geometries, it is imperative that the technique is applied, tested and refined using a second case study succession that contrasts with the Permian Cutler Group succession. I therefore intend to apply the techniques to the Sherwood Sandstone Group in the Cheshire Basin, for which I have already developed a useful stratigraphic framework as part of my introductory PhD field training programme. Importantly, the funding provided as part of my PhD studentship covers the costs associated with two fieldwork seasons in Utah but does NOT provide any additional funding for fieldwork elsewhere (namely the Cheshire Basin). This proposal to conduct a study in the Triassic succession of the Cheshire Basin is timely because the onshore Triassic of the UK has received scant attention from sedimentologists in recent decades, yet is one of the most likely candidates for large scale and longterm underground CO₂ sequestration and storage. Techniques to assist the prediction of subsurface architecture and heterogeneity of this succession are therefore timely. This proposed additional fieldwork will therefore add considerable value to my research project and will also significantly broaden my personal sedimentological experience. It has applied value

Research outline:

To collect field data from a UK fluvial succession (Triassic Chester Pebble Beds Formation and laterally equivalent Kidderminster Conglomerate Formation of the Sherwood Sandstone Group, Cheshire and Staffordshire basins) that is comparable to the ephemeral fluvial succession of the Permian Cutler Group, USA.

To make this study truly comparable to the study of the Cutler Group succession I am requesting funding to support fieldwork that will enable me to extend this work into the more proximal Sherwood Sandstone succession of the Midlands basin (Kidderminster Conglomerate Formation). This proposed fieldwork will involve a facies assessment, collection of 20 sedimentary logs and 10 architectural panels (recording ~3 km of outcrop) from previously identified sites. These data will be used to define the stratigraphic architecture for the succession and then to establish the 3D nature of the inherent heterogeneity. Key indices and facies trends will be compared with those of the Cutler Group. This proposed UK fieldwork will test the predictive methods developed from the work on the Cutler Group on a second outcrop succession and will therefore enable the developed model to be tested. The Sherwood Sandstone work would act as a interim step between full outcrop and down hole borehole core data, and thus would not only validate the methods used for prediction but would also serve as the basis for extending and refining the input data used within the model by utilising a second case study example. The incorporation of data from an additional basin will also improve the understanding of heterogeneity relationships within ephemeral fluvial successions.

The data collected from this work will be collated with that from the Cutler Group in Utah and together these case studies will provide a series of indices, facies associations and predictive models that can be applied to down hole well data to aid well-well correlation in laterally heterogeneous subsurface mixed dryland fluvial-aeolian reservoir successions. This work will be carried out in July-September 2010. Results will be presented at the December 2010 BSRG Annual Meeting.

Budget Breakdown:

The finds requested here are entirely for fieldwork relating to the study of the UK Sherwood Sandstone Group. This proposed fieldwork programme has been designed by me personally and is independent of the fieldwork built into my original PhD proposal. This proposed fieldwork is therefore not covered by my existing studentship budget.

Travel Expenses	£150
Accommodation and subsistence	£200
Lab expenses (thin sectioning)	£150
Total requested	£500