Centre for Doctoral Training in Oil & Gas (2018 start)

Project Title:
A slippery slope… Controls of mass wasting on sedimentation processes and heterogeneity in slope mudstone reservoirs.

Host institution: University of Manchester

Supervisor 1: Rhodri Jerrett

Supervisor 2: Ian Kane

Additional Supervisor (s): Kevin Taylor (Manchester), Matthew Watkinson (Plymouth)

Project description: Submarine slope successions are predominantly fine-grained stratigraphic packages that are both economically and environmentally significant. Prograding shelf successions are the primary sink for terrigenous sediment delivered to the oceans, and are therefore economically important as unconventional reservoirs, and as seals and source rocks in conventional reservoirs. Additionally, because the bulk of these sediments lie below the typical limit of sea-level regression during global sea-level cycles, they form unrivalled archives of sedimentary and environmental change. Despite their importance, there remains a significant lack of understanding of the fundamental sedimentary process, and their controls, operating to transport and deposit fine grained sediment on the slope. Recent improvements in the understanding of transport and depositional processes in mud-dominated successions, led by research at the University of Manchester, has driven the development of process-based models, but our understanding still lags behind that for coarser-grained systems. This hampers our ability to (1) utilise these successions to understand long term sediment delivery and carbon burial, and (2) predict mudstone architecture and composition. The latter is critical for both shale reservoir exploration, development and production, and for our understanding of source rocks and seals for conventional reservoirs. This project will use sedimentological, petrological and geochemical techniques to investigate a well-exposed mud-rich slope succession.

The Eocene Lower Hecho Group, in the Pyrenean Foreland Basin, represents a complete mudstone-dominated slope succession, interstratified with sandstone-filled slope channel deposits and overlain by shelf marls, which prograded over the basin floor. Preliminary work suggests the slope was subject to extensive and large-scale sliding and slumping, generating an irregular topography which exerted a major control on the (sites of) accumulation of muddy turbidites and debrites on the slope.

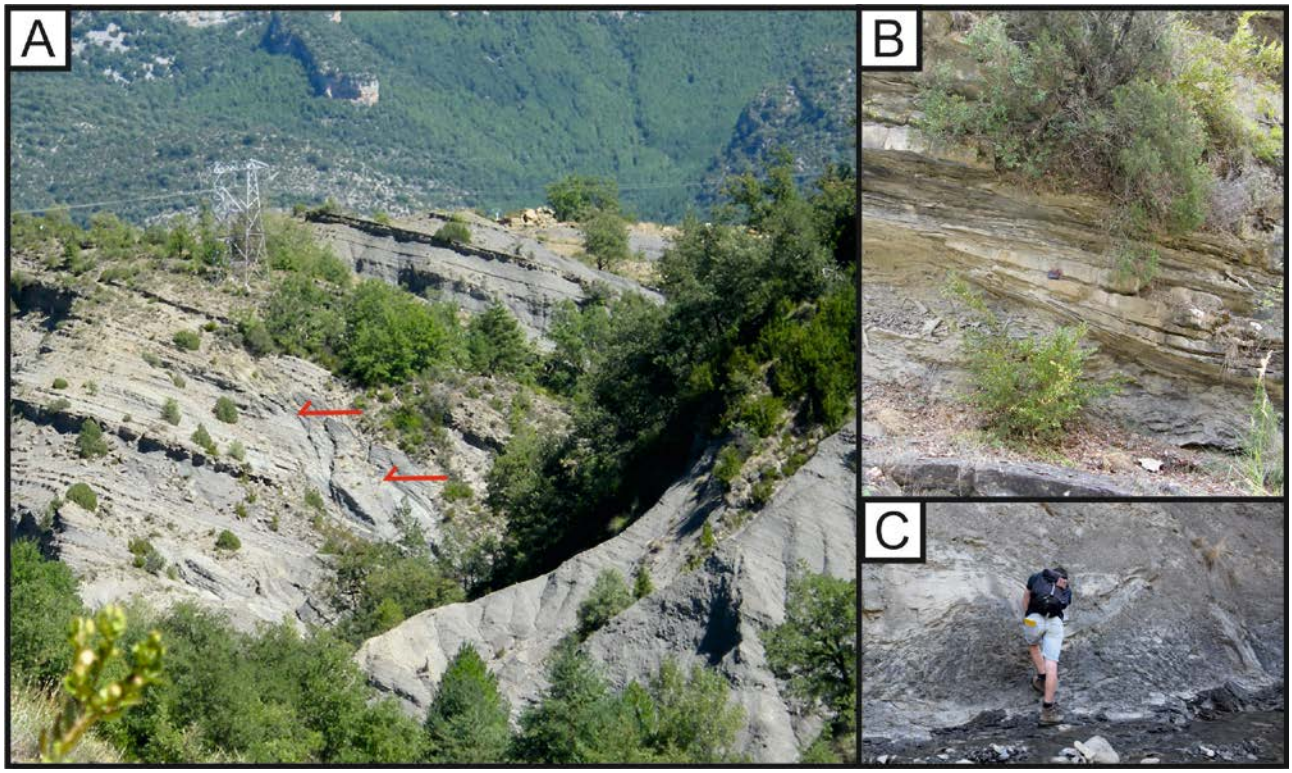
The student will undertake geological mapping, logging and sampling of the slope succession. Data collection will focus on description of variations in lithology, textures, sedimentary and soft-sediment deformation structures, palaeoslope and palaeoflow indicators, which will be used to generate a slope facies classification schem to, haracterise lower-, mid- and upper-slope processes. The 3D nature of the exposure will permit across slope changes to be evaluated too. Ultra-thin polished thin sections will be manufactured from the samples, and analysed using optical and scanning electron microscopy and EDS element analysis, in order to describe and interpret microscale sedimentary structures, and subtle variations in grainsize. Carbon isotope analysis will be utilised to identify the (land or marine) source of organic material. These techniques have been pioneered at the University of Manchester, with collaborators.

Using these data, the student will produce a generic, predictive model for the mudstone processes and their products, and their spatial distributions, during the progradation of a complete basin floor-to shelf-top slope succession.

CDT Research theme(s): Unconventional Oil and Gas Resources and Extending the life of mature basins

Research context: This project will yield results directly applicable to the CDT themes of Unconventional Oil and Gas Resources and Extending the life of mature basins. The principal results should be an enhanced understanding of fine-grained slope successions, and provide a valuable insight into the stratigraphic packaging and the distribution of sedimentary facies on slopes, their rock properties and the distribution of reservoir quality spatially and within stratigraphy. The study

will provide the student with much sought-after field-analogue study skills. The generic outcomes could also be applied to early-life, and future hydrocarbon plays.



(A) Onlap (red arrows) of the darker slope mudstones (right) against shelf marls (right). The contact represents a scalloped failure of the shelf edge which was later onlapped by the aggrading slope. (B) Slope channel sandstones in-filling relict topography on a slope debris flow. (C) Downslope vergence of sediment folds in slope muds.

Research costs: Approx £1500 p.a. for fieldwork and associated costs (sample preparation etc). Any additional funds needed will be sought via AAPG and IAS (etc) student grants, at which Manchester PhD students have an excellent track record in winning.

Career routes:

The student will gain experience in traditional field-based geological techniques incorporating structural and sedimentological data collection, together with the use of digital outcrop data, petrological and geochemical techniques. The student will develop a wide range of skills directly applicable to exploration and development geology, as well as the potential to pursue an academic career. The PhD student will join a large group of PhD students, post-docs and academic staff in the Basin Studies Group at Manchester University, within the sedimentology and stratigraphy research cluster which has an active research programme spanning outcrop and subsurface studies with particular relevance to hydrocarbon industry.