Porosity collapse, deformation band formation and permeability development in sandstones

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Introduction:

As oil fields are produced, the pore pressure reduces sometimes resulting in pore collapse and the formation of compaction bands. Compaction bands are localized features that drastically reduce the bulk permeability of the reservoir. The conditions under which compaction bands form versus distributed pore collapse occur are still poorly understood, despite their importance to the oil industry. Moreover, the stress path that the reservoir takes during pore pressure reduction is not clear. This project will address these issues with a combination of field studies, experiments and data from currently producing oilfields.

Photographs of deformation bands in the Navajo and Entrada sandstones in Utah, USA

Project Summary

The student will conduct fieldwork in the Entrada and Navajo Sandstone Formation on the western USA to map out the density of deformation bands and relate this to the microstructural characteristics of sandstones such as porosity, grain size distribution, and grain angularity. They will also perform high pressure deformation experiments under simulated reservoir conditions to:

(a) Conditions for permanent deformation of samples of sandstones

(b) microstructurally investigate the conditions under which the formation of deformation bands is favoured

(c) determine the stress path followed by the sandstone during pore pressure reduction by controlling the lateral strain and axial stress. This can then be compared with the yield cap and microstructural observations to make predictions about the mode of deformation the sandstone will undergo.

(d) measure the permeability development during the deformation of sandstone under different stress paths (e.g. Faulkner and Armitage, 2013)

The Universities of Liverpool and Manchester house a vibrant and internationally renowned rock deformation grouping in which the student will be based alongside current PhD students and Postdocs. Full training in the measurement and analysis techniques to be used will be provided. The student will regularly interact with both supervisors and learn to use the state-of-the-art facilities independently. They will also participate in a comprehensive postgraduate research programme provided by the School of Environmental Sciences.

The student will have a degree in either geology or geophysics. This project would suit a highly motivated individual, keen to perform fundamental research that has an important application to a key UK industry.

References

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