Centre for Doctoral Training (CDT):

Geoscience and its Role in the Low Carbon Energy Transition

PhD Project at Newcastle University

Implications of uncertainty in fault geometry from seismic interpretations for modelling reactivation

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Overview

The decarbonization of energy systems to achieve net zero carbon emissions will likely see the rapid development of carbon capture and storage, underground energy storage and geothermal energy. The interpretation of faults is a vital part of the subsurface characterisation, particularly when the subsurface is perturbed as the result of fluid production or injection and there is potential for fault reactivation (e.g. Vilarrasa et al., 2019; Kumari & Ranjith, 2019). Traditionally deterministic fault interpretations are used to model the likelihood of fault reactivation. However, uncertainty in fault interpretation is strongly dependent on seismic data quality (e.g. Scaaf & Bond, 2019) and therefore fundamentally linked to the ability to accurately model the likelihood of fault reactivation reliably (e.g. Gamboa et al., 2019).

This study aims to investigate the sensitivity of fault reactivation models to uncertainty in structural interpretations using different vintages of both 2D and 3D seismic reflection data. The project will use consider faults at reservoir targets and in the overburden with the following example applications from onshore and offshore: i) a CCS site on the UKCS, ii) a hydrogen storage site on UKCS, iii) a geothermal site onshore the UK. The project will:

- Investigate sensitivity of reactivation models to seismic interpretations of fault geometries
- Investigate sensitivity of fault reactivation models to lithologies interpreted from seismic data
- Develop methodology for using probabilistic fault interpretations as part of reactivation modelling

This project will inform best practice for site characterisation ahead of activities which perturb the subsurface and optimise the value of existing seismic reflection data.

Data and Focus Areas

The project will interpret and integrate geophysical and geological data from the UKCS. The project will use 2D and 3D seismic data already released and available through the OGA NDR or UKOGL, with data from the following areas:

1) Offshore - East Irish Sea Basin

2) Offshore - Southern North Sea

3) Onshore - Cleveland Basin

All areas will make use of well data available from NDR and UKOGL for well-seismic ties. Well data will also be used to constrain in-situ stress orientations for reactivation modelling.

The student will be part of the energy geosciences research group at Newcastle working alongside other researchers across a range of geo-energy projects and have the opportunity to be involve with Newcastle University's Centre for Energy.

Training & Skills

During this project, the candidate will have the opportunity to learn how to use subsurface interpretation software packages for both geological and geophysical data. The student will receive training in the interpretation and analysis of seismic reflection data and well data. In addition Newcastle University has a faculty run postgraduate research development programme (http://www.ncl.ac.uk/sage/learningandteaching/postgraduateresearch/postgraduateresearcherdevelopmentprogramme/#creditrequirement) that follows the Vitae Researcher Development Framework (http://www.vitae.ac.uk/) focusing on: knowledge and intellectual abilities, personal effectiveness, research governance and organization, and engagement, influence and impact.

References:

Vilarrasa, V., Carrera, J., Olivella, S., Rutqvist, J. and Laloui, L., 2019. Induced seismicity in geologic carbon storage. *Solid Earth*, *10*(3), pp.871-892.

Kumari, W.G.P. and Ranjith, P.G., 2019. Sustainable development of enhanced geothermal systems based on geotechnical research–A review. Earth-Science Reviews, 199, p.102955.

Schaaf, A. and Bond, C.E., 2019. Quantification of uncertainty in 3-D seismic interpretation: implications for deterministic and stochastic geomodeling and machine learning. Solid earth, 10(4), pp.1049-1061.

Gamboa, D., Williams, J.D., Bentham, M., Schofield, D.I. and Mitchell, A.C., 2019. Application of three-dimensional fault stress models for assessment of fault stability for CO2 storage sites. International Journal of Greenhouse Gas Control, 90, p.102820.