Centre for Doctoral Training (CDT) in Oil and Gas

NERC SCIENCE OF THE ENVIRONMENT

PhD Project: Modelling of Geo-mechanical – Hydro-mechanical Coupling in Fractured Reservoirs

Supervision

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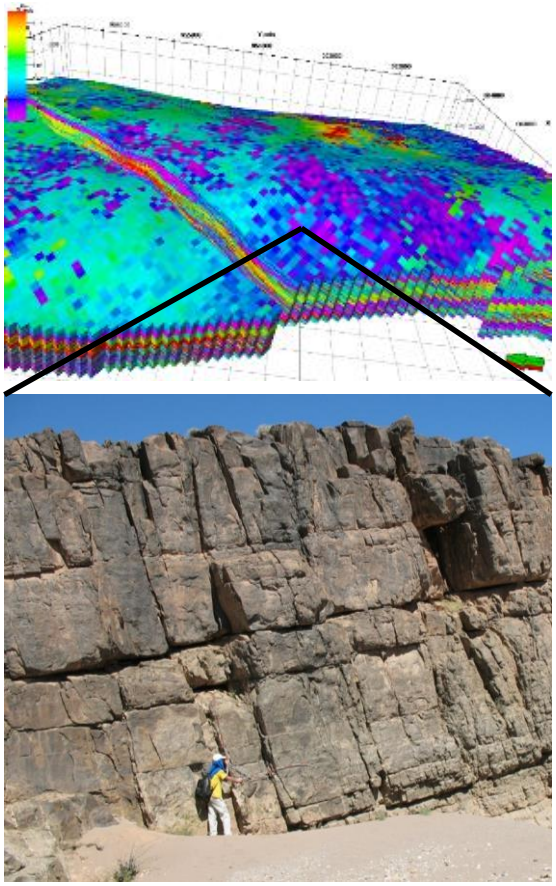
Background

More than 60% of world's remaining conventional hydrocarbon reserves reside in fractured (carbonate) reservoirs. Many of them have been produced for decades at usually low recovery factors and high water cuts. Fractured reservoirs continue to pose many challenges on reservoir characterisation, modelling, and simulation. Innovation in this field will comprise key technological advances for the oil and gas industry. To this end, an often neglected but important technology, are better modelling and simulation approaches that allow us to estimate how changes in reservoir pressure open or close of fractures, and how this impacts production rates and water cut.

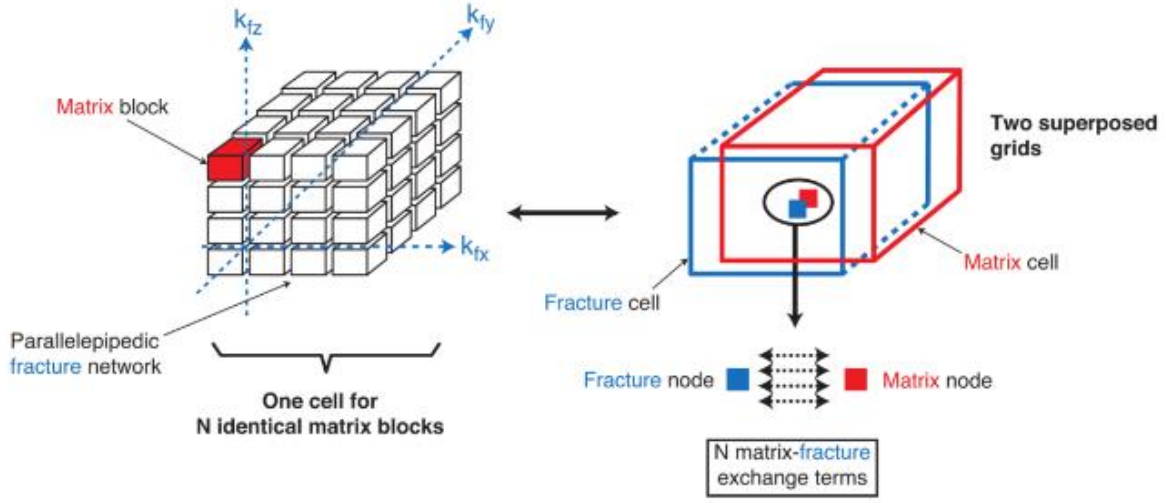
Robust model concepts and simulation technology that allow the investigation of the strongly coupled geo- and hydro-mechanical processes pertinent to fractured geological formations are not available commercially. Recently, however, new approaches to tackle this challenge have been proposed, including contributions from our group where we take a leading role in developing and applying efficient model concepts and simulators for fractured carbonate reservoirs (see our feature articles in JPT 07/2015).



Reservoir model and an outcrop example of a fractured carbonate formation. The properties of this fractured need to be averaged so that they can be represented by a single grid block in a reservoir simulation

Technical Description

In this project we will combine and adapt novel tools into an integrated framework that allows us to represent the coupling of geo-mechanical and hydro-mechanical phenomena in sufficient detail while keeping computational costs low. More specifically, we will investigate under which regimes simple relationships that link local pore-pressure changes to variations in fracture aperture are viable. We will use our novel finite-volume discretisation for geo-mechanics [1] together with a full-pressure coupling approach [2] to



Dual-porosity concept to represent a fractured reservoir in field-scale numerical simulations (from [3])

study the coupled response of fractured rocks masses in representative geometries. Thanks to our novel numerical framework, we can, for the first time, seamlessly incorporate the strong heterogeneities pertinent to a fractured reservoir. The results is expected to lead to the development of new dual-continua models that account for fracture aperture dynamics. Dual-continua are the industry standard for field-scale simulations of fractured reservoirs [3]. However, only very few groups have attempted to incorporate geomechanical concepts in dual-continuum representations. Hence there is great potential for novel science that has direct implications for the oil and gas industry and leads to high impact publications [4, 5]. We will demonstrate our novel method by simulating hydrocarbon production and CO2 storage in both, a synthetic model of a fractured reservoir and a real fractured reservoir.

Research Context

This unique and innovative project builds on and relates to activities of the carbonate reservoir group (http://carbonates.hw.ac.uk/) at the IPE at HW. In our group several PhD students are currently working on various aspects with respect to code and model development as well as distinct simulation applications for of fractured carbonate reservoirs. The project also aligns with our successful international collaborations with SINTEF and University of Bergen, Norway and Princeton University and offers the opportunity to spend extended time at these universities.

Potential Career Routes

This project will train the student in next-generation reservoir modelling and simulation technologies for the O&G sector, provide links to world-class research institutions, and equip the candidate unique skills for the upstream sector. Positions include but are not limited to technical expert positions in O&G companies, R&D branches, or service providers.

Application Procedure

This project is one of nine advertised in the doctoral training centre one of which is fully funded by NERC. The NERC funding scheme is only available for UK candidates or EU citizens who have a minimum residency period in the UK of 3 years prior to the start of the PhD programme. A further two positions are fully funded by the University and these are open to UK citizens and EU candidates who do not meet the prior UK residency requirement. Please include in your application a personal statement demonstrating motivation and a match for the project skills needed. More information about the NERC CDT and its unique training programme can be found at http://www.nerc-cdt-oil-and-gas.ac.uk/scholarships.html.

The closing date for application is Sunday, 31st January 2016 but we strongly urge applicants to apply as soon as possible.

For more information about the project, please contact Florian Doster (florian.doster@pet.hw.ac.uk) and Sebastian Geiger (S.Geiger@hw.ac.uk).

References

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[3] Lemonnier, P., & Bourbiaux, B. (2010). Simulation of Naturally Fractured Reservoirs. State of the Art - Part 2. *Oil & Gas Science and Technology – Revue de l'Institut Français Du Pétrole*, *65*(2), 263–286

[4] Bagheri, M., Settari, A., & Calgary, U. (2005). Modeling of Geomechanics in Naturally Fractured Reservoirs. *Society of Petroleum Engineers*, *SPE 93083*, 1–12.

[5] Liu, H.-H., & Rutqvist, J. (2012). Coupled Hydro-mechanical Processes Associated with Multiphase Flow in a Dual-continuum System: Formulations and an Application. *Rock Mechanics and Rock Engineering*, *46*(5), 1103–1112.