Proposed Research Studentship

New methods for maximising shale permeability and minimising risk during hydraulic fracturing

Supervisor(s): Agust Gudmundsson, Peter Burgess, Philip Meredith(UCL).

Project Description:
Within the framework of rock-fracture mechanics, rock physics, and sedimentology there are three aspects of hydraulic fracturing of gas shales that need to be addressed: (1) how to maximise the surface area, interconnectivity, and permeability of the induced fracture network; (2) how to confine the network within the target layers (e.g. so that fractures do not propagate up into aquifers); and (3) how to assess and mitigate induced earthquake risk. All three relate to the composition and lamination/layering (fissility) of the shales and adjacent rocks. More specifically, hydraulic fracturing of gas shales requires that fluid-driven fractures propagate through numerous contacts of laminated/layered rocks. Field studies show that such contacts commonly arrest or deflect fractures, thereby decreasing the chances of forming well-interconnected, extensive, and highly permeable fracture networks. This project will provide field and laboratory tested theoretical tools for maximising the chances of forming an extensive high-permeability fracture network that is confined to the target layer and minimises seismic risk.

Aims:
To use field, analytical, numerical, and experimental studies of fracture propagation in different types shale to maximise the efficiency of the induced fracture network while minimising the risk of fractures propagating towards aquifers and/or inducing significant earthquakes.

Approach:
(1) Field studies of fracture propagation, linkage, arrest, deflection, and size (length, height, aperture) distributions in laminated shales of different sedimentary textures, mode of formation, and composition. The focus is on shales in the UK (e.g., the Bowland Shales). (2) Analytical modelling of fracture arrest and deflection. (3) Numerical modelling (finite and boundary element) of fracture-network development (density, spread, and confinement to the target layer). (4) Rock-physics experiments on hydraulic fracture propagation, arrest, and deflection. (5) Test the results on shales with different fissility, mode of formation, and composition (e.g. clay content).

Originality:
Unique combination in a single project of field, sedimentological, analytical, numerical, and experimental studies to forecast fracture-network development and confinement.

Deliverables:
(1) A field-and-laboratory tested theoretical framework for forecasting the development and hydraulic efficiency of fracture networks in different types of shale for various boundary conditions. (2) A field-and-laboratory tested theoretical framework for assessing the risk of (a) hydraulic fracture propagation out of the target layer (and possibly into aquifers, causing pollution), and (b) significant induced earthquakes.

Research theme:
Theme: Effective production of unconventional hydrocarbons. Challenges: (1) Maximise the extent and hydraulic efficiency of the induced fracture network; (2) Confine the network to the target layer. (3) Assess and mitigate earthquake risk.

Research context:
Four of Gudmundsson's PhD students work on fracture propagation and fluid transport in layered/laminated rocks; two on fractured hydrocarbon reservoirs. All use field, analytical, and numerical methods, and one uses rock-physics experiments. Burgess has 3 PhD students currently working on sedimentological outcrop analysis.

Career routes:
(1) Expert on hydraulic fracturing of gas shales and other rocks. (2) Expert on permeability development and fluid transport in fractured reservoirs, particularly unconventional reservoirs (e.g., basement rocks, plutons, and gas shales). (4) Expert on risk assessment and mitigation (e.g., pollution of aquifers, induced earthquakes) related to hydraulic fracturing.

The closing date for applications is 23.59h on Thursday 20th February 2014

*Details on how to apply can be found here **www.rhul.ac.uk/studyhere/postgraduate/applying***
*Please contact the Postgraduate Programmes Co-ordinator, if you have additional questions about the department or application procedures (email: **pgadmin@es.rhul.ac.uk** ; fax: 01784-471780; tel: 01784-443581).*
Applicants are requested to send an additional copy of their CV directly to the lead supervisor of the project in which they are interested. Please also contact the supervisor if you have any questions about the project itself