



Simulation of Non-linear Fault-Fracture Processes and the Stress-Strain History in the Brittle Continental Crust

Supervisor: Jürgen Adam

This PhD project will apply an overall integrative physical simulation concept to simulate non-linear fault and fracture processes and mechanism during brittle deformation in the upper continental crust on all relevant spatial and temporal scales ranging from discrete deformation events to geological time scales.

Analogue material development and mechanical testing in combination with 4D physical modelling with innovative high resolution 3D deformation monitoring will be applied to bridge the gap between structural-scale and fracture-scale process simulation in scaled analogue experiments..

Geological, geophysical field studies and lab-based material tests demonstrate that brittle deformation structures in sediments and rocks reflect a very complex strain history. For example at outcrop scale, individual faults and their associated fracture patterns may be so variable and complex that the underlying fundamental physical processes cannot be properly analysed. To solve this problem, we must realise brittle deformation processes as a dynamic system, where the complexity of fault structures and associated fracture systems emerges from the interaction of a large number of discrete elements (small rock volumes or particles) under simple, non-linear "mechanical" rules. In brittle rocks and soft sediments, non-linear deformation with contrasting modes of strain accumulation (mechanical rules) is governed by the transient strain-dependent material strength and the total strain that is accumulated in discrete material volumes (strain memory). The complexity of the brittle deformation structures results from the spatial and temporal highly variable strain memory, as well as from stabilising and de-stabilising feedback mechanism between sub-processes.

Well-established mechanical models with a Coulomb rheology, as well as numerical continuum (FE) modelling techniques are limited in simulating stress accumulation and strain localisation in brittle rocks beyond structural scale. However, flexible physical fault models, that simulate the complex fault dynamics (formation, propagation, reactivation) and associated strain pattern on different spatial and temporal scales, are essential for our understanding of how complex brittle deformation structures form. The better understanding of these non-linear material behaviour and deformation mechanism is of major importance for the analysis, simulation and monitoring of major geohazards like submarine slides, landslides, and repetitive earthquake faulting and is of major relevance for applied problems (hydrogeology, basin modelling, HC exploration).

Project aim is to develop new elastic-plastic analogue materials for coupled fault-fracture simulations in scaled high-resolution 4D physical deformation/flow experiments using material design, dynamic material testing and optical high resolution 3D-DIC deformation monitoring techniques (Digital Image Correlation) capable to simulate and analyse the

stress-strain history, strain localisation and fault-fracture formation in brittle rocks in an integrative physical simulation approach.

How to Apply:

Please use the **online application system** (<http://www.rhul.ac.uk/studyhere/postgraduate/applying/home.aspx>) to submit an application for this project. Applications will require 2 letters of reference, plus a cover letter and CV- applicants are also requested to email a copy of their CV directly to the lead supervisor of this project (j.adam@es.rhul.ac.uk). **Please ensure you complete your application by mid-December. Suitable candidates will be invited for interviews, which will take place in February/March, and offers are made by the end of March.**

For any queries please contact the Postgraduate Programmes Co-ordinator (email: pgadmin@es.rhul.ac.uk or tel: 01784-443581) and further information can also be found on the Department's Website (<http://www.rhul.ac.uk/earthsciences/home.aspx>).