ENUF
15 Exploration horizontal sill and break-out experiment carried out
18 Horizontal horizontal sill and break-out experiment, incl. flow visualization carried out
21 Systematic exploration/measurement of horizontal sill & break-out experiment carried out
24 Plasticity models for CCS applications completed
24 Mathematical models of dislocations and fractures during CCS completed
36 Improved 3D image reconstruction of X-ray microtomography data of reservoir rocks
36 SPH, network and Lattice Boltzmann simulations of CO₂ flow in pore space with validation against experiments completed
36 Bionomineralization experimental systems with rock cores and synthetic materials completed
36 Photoelasticity experiments completed
36 Shear band formation models for CCS applications completed
48 MDEM validation for CCS applications completed
48 Visualization of SPH simulations of CO₂ flow in pore space placed on project web site
48 Numerical tool comparison campaign completed
48 Statistical models completed
48 Experimental bionomineralization studies integrated with meso-scale modeling of fracture
48 BEM/FMM model for CCS applications completed

1.3.1 WP1: Laboratory fracturing experiments. Partners: UT, UNITN, SINTEF[SBI], SPR
The objective of this WP is to generate reliable experimental data under controlled laboratory conditions that will serve as a validation basis for fracturing models developed in WP2 and 3.
The experiments will be performed on transparent models (blocks) made of artificial materials (UT), on real rocks and soils (SPR, SINTEF[SBI]) and on photoelastic materials (UNITN). Some experiments will include fluid injection into the models in accordance with the pre-defined injection schedule, while monitoring the injection parameters, fracture generation and propagation in such way that these data can further be used for calibration of numerical models. SINTEF will contribute with knowledge and experience of soil and rock materials in engineering applications involving fluid migration in seabed sediments (de Vries et al., 2007). Experiments on outcrop rock materials with CO₂ injection and different loading regimes, incl. true triaxial loading, will be performed at the Formation Physics Laboratory in SPR in order to study fracture propagation and the effect of CO₂ on rock mechanical properties and behavior.

Fracturing experiments on transparent materials – University of Twente, The Netherlands (UT)
The goal of WP1 is to develop and perform detailed 3D laboratory experiments for fluid-driven cracks in solids as a proxy for CCS applications. The aim is to make one-to-one comparisons between these idealized laboratory experiments and mathematical and numerical models. This validates the models at least in a controllable laboratory reality and gives them grounding for further use in geotechnical applications, in particular CO₂ sequestration in underground reservoirs.

Fig. 1.3.1. Fluid injection in a transparent model material delivers data that are essential for validation of numerical models and for understanding of the in-situ processes. Displacement in time of a red fluid outlining the crack in a transparent gelatin by a green fluid entering the gelatin block from below. Times t0+(0,10,20)s. Side view. Courtesy: Kiyosugi, Connor & Bokhove. More images and information are available online.

The macro-scale dynamics of liquid-filled cracks will be investigated using gelatin-liquid laboratory experiments (e.g., Takeda 2004, Kavanagh et al. 2006, Touvet et al. 2010) in the Physics of Fluids (PoF) group.
(a) A first series of experiments concerns the precise measurement of steady state flow and 3D crack geometry, which is required for validation of the modeling (Fig. 1.3.1). Two techniques will be investigated and used to determine the interior 3D crack shape via a special scanning apparatus and via freezing techniques (pers. comm. Profs. Olivier Masbernat and Martine Meireles, FERMaT, Toulouse). We will use high-speed imaging techniques