Geophysical Research Abstracts
Vol. 20, EGU2018-15061-1, 2018
EGU General Assembly 2018

Fluid-flow control of clay-bearing faults

Felipe Orellana (1), Christophe Nussbaum (2), Yves Guglielmi (3), Luiz Grafulha (4), and Marie Violay (1)

(1) EPFL, IIC, LEMR - ENAC, Lausanne, Switzerland (felipe.orellana@epfl.ch), (2) Federal Office of Topography (Swisstopo), Wabern, Switzerland., (3) Earth and Environmental Science Area, Lawrence Berkeley National Laboratory, Berkeley, CA, USA, (4) Scientific Centre of Optical and Electron Microscopy, ETH Zürich, Zürich, Switzerland

There is a general scientific consensus that shales are advantageous rocks for the concept of deep nuclear waste repositories thanks to their favourable chemo-hydro-mechanical properties (i.e. low permeability, self-sealing capacity, others.). One of the main obstacles of these repositories is to secure its barrier integrity over geological times. Indeed, is fundamental to ensure isolation of radioactive contamination from the environment and population. However, the presence of fault systems intersecting the geological formation, or within its surroundings, put the long-term safety of these repositories into question.

Extensive research has shown that the mechanics of the brittle faults zones, their architecture and permeability structures are key parameters controlling the fault-related fluid flow. Despite this, very few studies have investigated the impact of clay-bearing faults on the integrity of nuclear waste repositories, i.e. the potential migration of radionuclides. In this project, we study the fault structure and the potential hydrogeological regimes of clay-bearing tectonic systems crossing the Opalinus Clay (OPA) formation at the Mont Terri Laboratory (MTL). At the MTL, the Main Fault is thrust fault dipping 55-60° to the SSE. The Main Fault is characterised by a highly fractured zone that extends up to ∼3 m in thickness. At the fault-core assemblage, we find undisturbed rocks, ubiquitous fractures, calcite veins, scaly clays, and fault gouges.

To examine the relationship between the fault structure, mineralogy, permeability, and porosity, we have: 1) performed SEM and FIB-SEM microstructural analyses, 2) carried out XRD analysis to get insight on the fault mineralogy, and 3) measured connected porosity, grain density, pore size, and permeability in different sections of the fault, including non-deformed material, scaly clays and fault gouge.

Main results suggest that the porosity of the non-damaged rock is ∼14 %, the average pore size is of about 16 nm, and the grain density is in average equal to 2.69 g/cm3. On the other hand, the porosity of the fault gouge is ∼21 % porosity and is dominated by small pores of a size of about ∼12 nm. The grain density is around 2.62 g/cm3 for the fault gouge.

The mineralogy analysis indicates that fault gouge has a content of calcite of about ∼2%. Au contraire, the calcite content in the non-damage rock is near to ∼ 14%. For normal stresses ranging between 3 and 12 MPa, permeability results show values in the order of 1e-19 and 1e-20 m2 for intact rock far from the fault core. A proposed calculation predicts values of permeability around ∼ 1e-18 in the fault gouge. Together, the field and the laboratory data suggest that calcite was removed by the action of fluids flowing through the fault gouges.

Based on this results, we present a model on the hydrogeological regime of the tectonic fault system within the OPA formation. In addition to the strong structural heterogeneity of the fault zone, we have evidence of combined conduit-barrier fault system for fluid. Thus, we suggest that fault gouges might have strong control over the migration of fluids.