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Fluid-induced rupture on heat-treated andesite

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The aim of this study is to investigate the mechanical behavior, the acoustic emissions (AE) and the evolution ofultrasonic wave velocities during the deformation and failure of andesite samples induced by fluid injection under triaxial stresses.

The cylindrical specimens employed in these experiments are andesite samples from Guadeloupe (Geotreff project) (40mm in diameter and 80mm in length). Intact samples have a porosity of 2% and a very low permeability of 10-21 m^2. Thus, samples were heat-treated to induce a pre-existing crack network. Different heat treatments were tested (from 200°C et 900°C). Our result show that a minimum heat-treatment of 800°C was necessary to induced a connected crack network (crack density of 0.1), associated with an increase in permeability (10-17 m^2). In the following, mechanical experiments were performed on samples heat-treated at 930°C.

Mechanical experiments were performed in a conventional triaxial cell (installed at ENS). Four axial strain gauges and four radial strain gauges were glued on the surface of the sample to measure the axial and the radial strain while 16 ultrasonic sensors were glued to measure the ultrasonic velocity and record the acoustic emission activity.

A first set of triaxial experiments were performed in order to get the Mohr-Coulomb envelop. Then, the fluid-induced rupture experiment were done as follow: The sample was first saturated under 5MPa confining pressure with 2MPa fluid pressure, then the hydrostatic loading was increased up to 40MPa, followed by an increase in the differential loading to a value close to the dilation point. The sample was maintained under this stress state for 12 hours to make sure there was no creep. Finally, pore fluid was injected from the bottom of the sample at 35MPa and the fluid pressure at the top of the sample was measured (fluid could not escape at the top).

Our results show that rupture occurs 1 hour after the fluid injection. A clear sequence of P wave velocity decrease -from the bottom to the top of the sample- was observed, denoting the effect of the fluid diffusion through the sample. Finally, AE were located prior and after the failure, and the number of AE per second follows Omori's law.