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{Linking permeability and mechanical damage for basalt from Mt Etna Volcano, Italy}

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Volcanic edifices, such as Mt. Etna volcano (Italy), are affected from repeated episodes of pressurisation due to magma emplacement from deep reservoirs to shallow depths. This mechanism pressurizes the large aquifers within the edifice and increases the level of crack damage within the rocks of the edifice over extended periods of times.

In order to improve our understanding of the complex coupling between circulating fluids and the development of crack damage, we performed flow-through tests using cylindrical cores of Etna Basalt (Etna, Italy) to evaluate permeabilty changes as a function of approach to failure under non-hydrostatic stresses at confining pressures from 5 to 60 MPa.

Samples were loaded to failure by increasing increments of axial stress or by cyclic stresses of increasing amplitude. Both intact samples and pre-drilled samples (1.18mm) were tested.

Under hydrostatic stresses, the permeability values of the intact sample decrease linearly with the increments of pressure and range between $5.2*10^{-17}$ $m^2$and $1.5*10^{-17}m^2$Under non-hydrostatic conditions, at low deviatoric stresses from (up to 18 MPa), the permeability values ranged between $5.5*10^{-17}$ $m^2$and $4*10^{-17}m^2$ and tended to completely recover the initial value each time the sample was unloaded, indicating an elastic regime.

At higher deviatoric stresses (up to 60 MPa) the permeability values range between $2*10^{-17}$ m^2 and $0.6*10^{-17}m^2$. We hypothesize that from 5MPa to 40MPa axial stress, anelastic deformation mechanisms start to occur, with progressive pore collapse and opening of microfractures, resulting in a change of permeability.

Under incremental uniaxial cyclic loading up to peak stresses of 160 MPa permeability decreases up to 2 orders of magnitude from initial values of $1*10^{-15}$ m^2 to $2*10^{-14}m^2$ Higher initial permeability values are related to the presence of an open fracture in the sample. We interpreted the reduction as a result of progressive closure of the voids space, as the axial load is incremented.

Overall it is shown that permeability on Etna basalt rocks is strongly dependent on the loading conditions. Ongoing work is expected to elucidate the mechanisms relating increasing damage mechanical damage to changes of permeability.