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Dilatancy and failure in basalt from Mt Etna under triaxial compression

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The recent history of Mt Etna volcano was marked by several flank eruptions from fractures that opened and fed lava flows. Thermo-hydro-mechanical processes acting at mid (order of months) and short (order of days) are crucial for controlling progressive edifice weakening and promoting pervasive fracturing of rocks. Understanding how the strength of volcanic rock varies with stress state, pore fluid content and pressure is fundamental to understanding the mechanics of faulting in volcanic areas. In this study we investigated the micromechanics of deformation and failure in Mt Etna's basalt. Basalt samples had a bulk density of 2,7 g/cm^3, a connected porosity (measured with a helium pycnometer) of 4,4% and a total porosity of 4,8%. Etna's basalt is composed by a ground mass of fine-grain matrix ($\sim$60%), including mainly crystals of pyroxene (8.5%), olivine (4%) and feldspar (25%). Microstructural observations of the intact material revealed the presence of thin cracks (probably formed during the rapid cooling of the lava) and quasi-spherical voids formed during degassing. We performed 23 conventional triaxial experiments on water saturated samples in drained conditions at confining pressures between 20 and 160 MPa and with 10 MPa of pore pressure. Dilatancy and brittle faulting were observed in all samples. Deviatoric stress contributed to additional porosity change. Several experiments were stopped at different stages of the deformation after dilatancy. Systematic microstructural observations carried out by means of a field emission scanning electron microscope (fesem) are presented in order to assess the evolution of porosity, crack density and the related coalescence mechanisms.