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Deformation and failure in dry and wet Colli AlbaniTuff

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The Colli Albani are an explosive Quaternary volcanic district, which may pose a threat for the city of Rome, Italy. Recent seismic swarms and hydrothermal activity suggest that the main faults, affecting the volcanic complex are cyclically active. A 350 m scientific borehole was therefore drilled into this volcanic area to elucidate its inner structure for the first time (Mariucci et al., 2008). Sonic logs and petrophysical investigations carried out at increasing/decreasing effective pressure (Vinciguerra et al., 2008) revealed how, within the same lithology, the different degree of lithification and presence of clasts can affect significantly physical property values. Microstructural analyses also revealed that the pressurization and depressurization cycle generate inelastic crack damage/pore collapse and permanent reduction of voids space. Here we selected the most representative unit drilled, i.e. Tufo Pisolitico di Trigoria unit, a fine-grained, matrix-supported pyroclastic deposit with rare lithic lava clasts and sparse pumice. We then investigated the deformation and failure mechanisms both in hydrostatic and triaxial tests and the impact of the different loading conditions and presence of fluids in the microstructures. Samples of 38 mm in length and 18 mm in diameter were cored in the vertical direction from two cores from the Colli Albani site. Our blocks of tuff had a nominal connected porosity (measured by water saturation) of 32 and 37%, respectively. We performed a series of hydrostatic, uniaxial, and conventional triaxial compression experiments on dry and water saturated samples. The wet samples were deformed in drained conditions with 10 MPa pore pressure at room temperature. Under hydrostatic condition, the onset of grain crushing and pore collapse P* occurred in the less porous material at an effective pressure of 41 MPa. Intense microcracking was observed in the deformed sample which failed by cataclastic flow. Shear-enhanced compaction was observed in all samples deformed at effective pressures between 5 and 30 MPa. In the stress space, the resulting yield envelope mapped out an elliptical cap comparable to previous observations on porous sandstones and carbonate rocks. In the triaxially deformed samples we observed pore collapse and microcracking. We quantified the weakening effect of water in both blocks of Tuff. Ongoing microstructural analysis will elucidate the micromechanics of deformation over a wide range of effective pressures.