EGU21-2629
https://doi.org/10.5194/egusphere-egu21-2629
EGU General Assembly 2021

From monodisperse to polydisperse: the influence of grain size distribution on the mechanical behavior of porous synthetic rocks

Lucille Carbillet[1], Michael Heap[1], Fabian Wadsworth[2], Patrick Baud[1], and Thierry Reuschlé[1]
[1]Université de Strasbourg, CNRS, ITES UMR 7063, Strasbourg F-67084, France (lcarbillet@unistra.fr)
[2]Department of Earth Sciences, Durham University, Durham, United-Kingdom

Sedimentary crustal porous rocks span a wide range of grain size distributions – from monodisperse to highly polydisperse. The distribution of grain size depends on the location and conditions of rock formation, the chemico-physical processes at play, and is influenced by subsequent geological processes. Well-sorted granular rocks, with a grain size distribution close to monodisperse, and granular rocks with a more polydisperse grain size distribution, have repeatedly been subjected to laboratory experiments. And yet the natural variability from sample to sample and structural heterogeneity within single natural samples all conspire to prevent us from constraining the effect of grain size polydispersivity. While a few studies have focused on the influence of grain size, the control of grain size distribution on the mechanical behavior of rocks has scarcely been studied, especially in the laboratory. In this study, we address this knowledge-gap using synthetic samples prepared by sintering glass beads with controlled polydisperse grain size distributions. When heated above the glass transition temperature, the beads act as viscous droplets and sinter together. Throughout viscous sintering, a bead pack evolves from an initial granular discontinuous state into a solid connected porous state, at which the microstructural geometries and final porosity are known. Variably polydisperse individual samples were prepared by mixing glass beads with diameters of 0.2, 0.5, and 1.15 mm in various proportions, which were sintered together to a final porosity of 0.25 or 0.35. Hydrostatic and triaxial compression experiments were performed for each combination of polydispersivity. The samples were water-saturated, deformed at room temperature, and deformed under drained conditions (with a fixed pore pressure of 10 MPa). Triaxial experiments were conducted at a constant strain rate at effective pressure corresponding to the ductile (compactive) regime. Our mechanical data provide evidence that polydispersivity exerts a significant control on the compactive behavior of porous rocks. Insights into the microstructure were gained using scanning electron microscopy on thin sections prepared from samples before and after deformation. These data allow for the observation of the different deformation features, and by extension the deformation micro-mechanisms, promoted by the different type and degree of polydispersivity. Overall, our data show that, at a fixed porosity, increasing polydispersivity decreases the stress required for compactant failure.