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# Insights into pore-scale controls on mudstone permeability and compressibility through resedimentation experiments

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We show based on uniaxial, constant-rate-of-strain consolidation experiments on resedimented clay-silt mixtures that mudstones become less permeable and more compressible with increasing clay fraction during burial for three reasons: 1) silt-bridging preserves large pore throats and inhibits consolidation; 2) stress bridges inhibit clay particle alignment; and 3) local clay particle compression within the stress bridges alters the pore throat size distribution. We admix silt to a natural mudstone with a broad grain size distribution to describe the systematic variation in permeability and compressibility with clay fraction at different stresses. Vertical permeability declines exponentially with decreasing porosity. At a given porosity or stress, vertical permeability increases by an order of magnitude and volumetric compressibility decreases by a factor of 1.7 for clay contents ranging from 57 % to 36 % clay (< 2 micrometers by mass). 80 % of these differences between the mixtures can be accounted for by silt bridging. The remaining 20 % results from fabric changes such as increased suppression of clay particle alignment and more locally compressed clay particles within the stress bridges. Backscattered Electron Microscope images show that siltier mixtures have larger pore throats and less aligned clay particles compared to clayey mixtures. We develop a general model to describe the evolution of permeability, compressibility, and hence hydraulic diffusivity (coefficient of consolidation) with stress and as a function of grain size of clay-silt mixtures during burial. How permeability and consolidation evolve in realistic sediment mixtures during burial is of critical importance for understanding how mudstones seal $CO_2$ or hydrocarbons, what mudstones can act as a hydrocarbon reservoir, what types of mudstones will generate overpressure, and a range of broader geological processes.