Material Properties of Mudrocks: Conceptual Insights from a Decade of Experiments

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ABSTRACT

We use resedimentation to study mudrock behavior. This involves incrementally loading a slurry of natural material in a tube to a desired stress. The sample is then extruded and mounted in a test device. Resedimentation reproduces the mechanical behavior of intact rocks that have not undergone diagenesis or cementation. We use resedimentation to study compaction behavior and the ratio of horizontal to vertical effective stress under uniaxial strain.

Particle size controls compaction behavior. Smaller particles have greater surface area and water attracted to particle surfaces do not behave as a liquid. We compare a smectite rich rock ROM-EI (surface area (SSA) ~800 m2/g) with an illite rich mudrock (SSA ~80 m2/g) and a quartz silstrone (SSA ~ .02 m2/g) (Figure 1). The smaller the particle size, the greater the initial porosity and the more rapidly the rock compacts.

The ratio of horizontal to vertical effective stress during uniaxial compression also varies systematically with composition and texture. More silt rich rocks have a lower horizontal effective stress for a given vertical effective stress than do more clay rich rocks (Fig. 2). Furthermore, at high effective stresses, this stress ratio increases markedly (compare red line (10 MPa stress) to the green line (1 Mpa stress).

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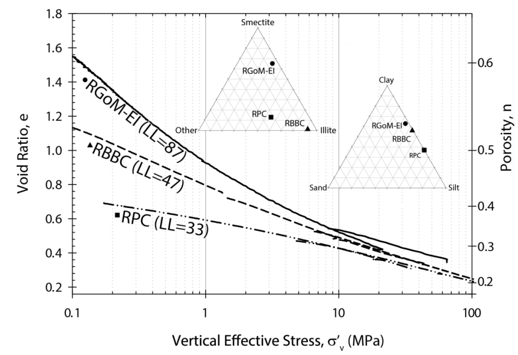

Figure 1: Compaction of three mudrocks. The resedimented Gulf of Mexico mudrock (RGoM-EI) is smectite-rich, fine grained, and has a high liquid limit (LL). It has a high porosity at low effective stresses and compacts greatly with increasing stress. Resedimented Boston Blue Clay (RBBC) has similar same grain size to RGoM-EI, but the clay fraction is dominated by illite; it has a lower initial porosity and compacts less. The resedimented Penobscot Clay (RPC) is a siltstone, has the lowest initial porosity, and compacts the least.

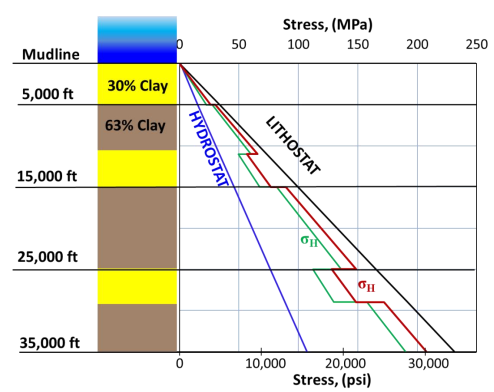

Figure 2: **Figure 2**: Uniaxial K0 consolidation tests show that silt rich material has a lower stress ratio (lower horizontal effective) stress for a given vertical effective stress..

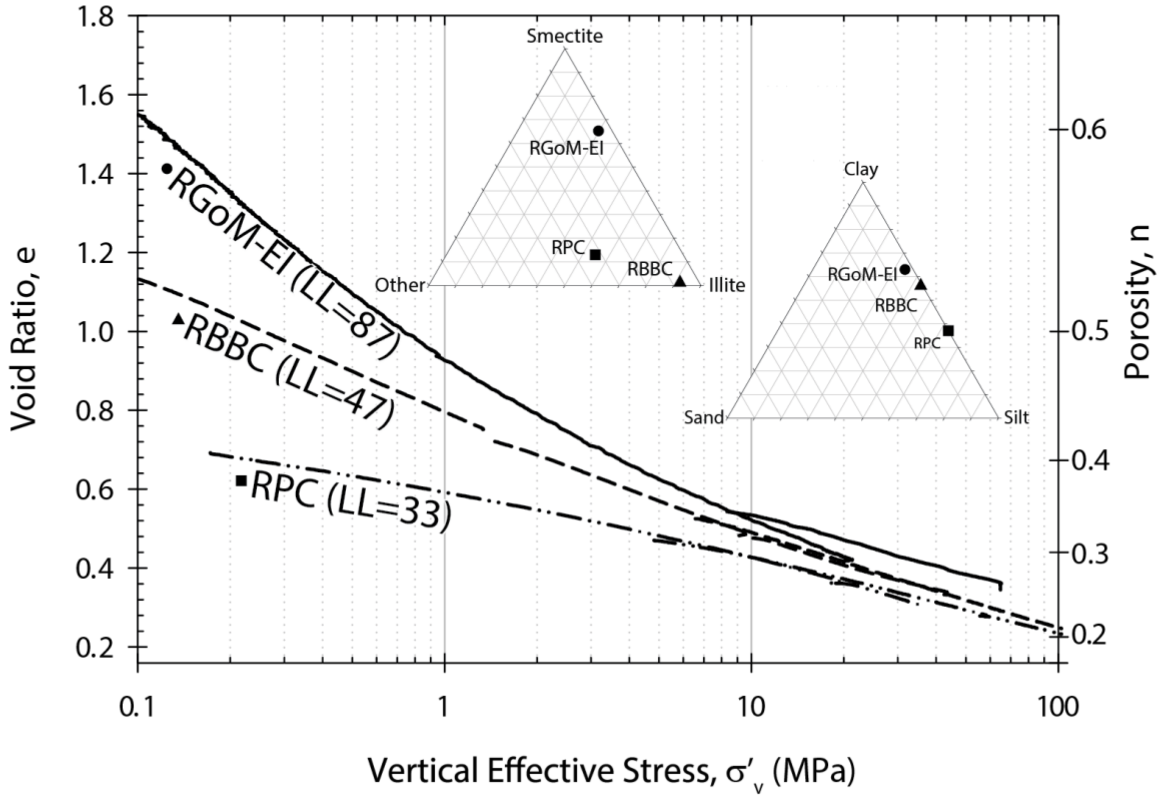

Figure 1: Orientation of maximum principal stress (blue) and minimum principal stress (red) during regional extension. At the shallower parts of the fault, the maximum principal stress on the hanging wall side juxtaposes the minimum principal stress on the footwall side.

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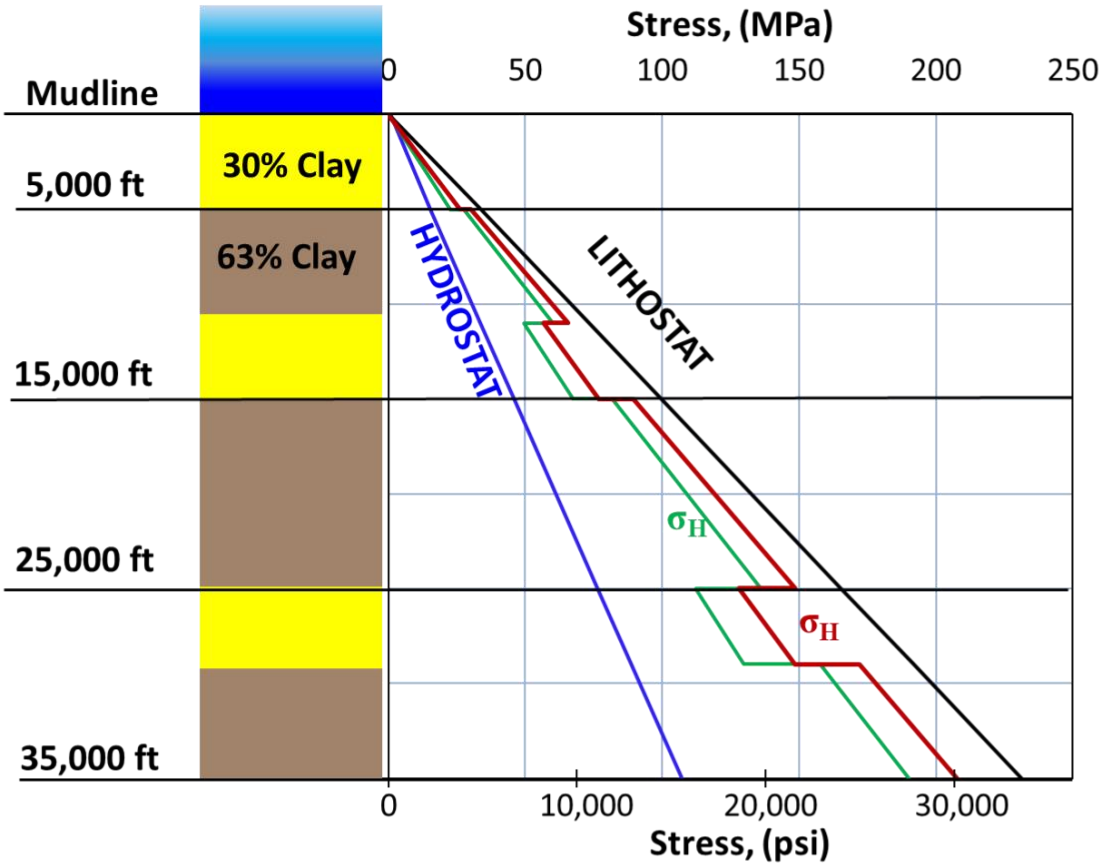

Figure 2: Uniaxial K0 consolidation tests show that more silt rich material is has a lower stress ratio (lower horizontal effective) stress for a given vertical effective stress.

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