Permeability Anisotropy in Resedimented Mudrocks

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ABSTRACT

Permeability anisotropy (k_h/k_v) ranges from 1 to 2 over a porosity range of 0.5 to 0.3 for three resedimented mudrocks: 1) Boston Blue Clay (RBBC, an illitic marine mudrock); 2) Eugene Island Gulf of Mexico Mudrock (RGOM-EI, a smectitic mudrock); and 3) San Francisco Bay Mud (RSFBM, a mudrock with intermediate illite and smectite). All mudrocks have similar clay fractions as determined via sedimentation analysis; however their permeabilities vary by more than an order of magnitude. Decreasing the clay fraction increases the permeability.

At a stress of 10 MPa, Gulf of Mexico mudrock has a porosity only 0.04 porosity units lower than RBBC, yet a permeability one and a half orders of magnitude lower (Figure 1). Despite differences in bulk permeability, the permeability anisotropy of these two mudrocks is comparable, in the range of ~2 at 10 MPa (Figure 2). Based on smectite content, we expect RSFBM permeability and anisotropy to fall intermediate between that of RBBC and RGOM-EI. We find that RSFBM permeability satisfies this expectation (Figure 1), but surprisingly, RSFBM is isotropic at all stress levels measured (Figure 2).

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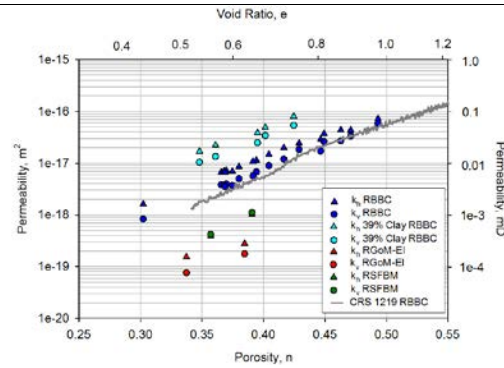


Fig. 1: Vertical (circle) and Horizontal (Triangle) permeability for four resedimented mudrocks: Boston Blue Clay, Gulf of Mexico Clay and San Francisco Bay Mud. Adding silt to reduce the clay fraction increases permeability (compare 39% clay RBBC to RBBC). Increasing smectite content decreases permeability in both the vertical and horizontal directions (compare RBBC, RSFBM, and RGOM-EI).

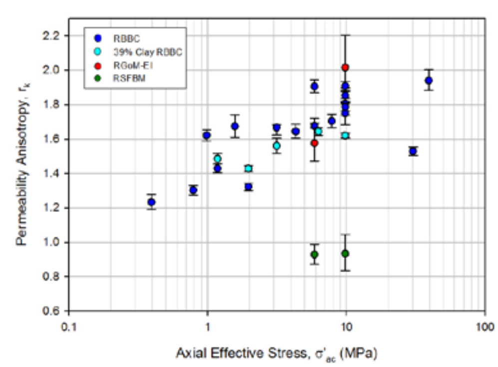
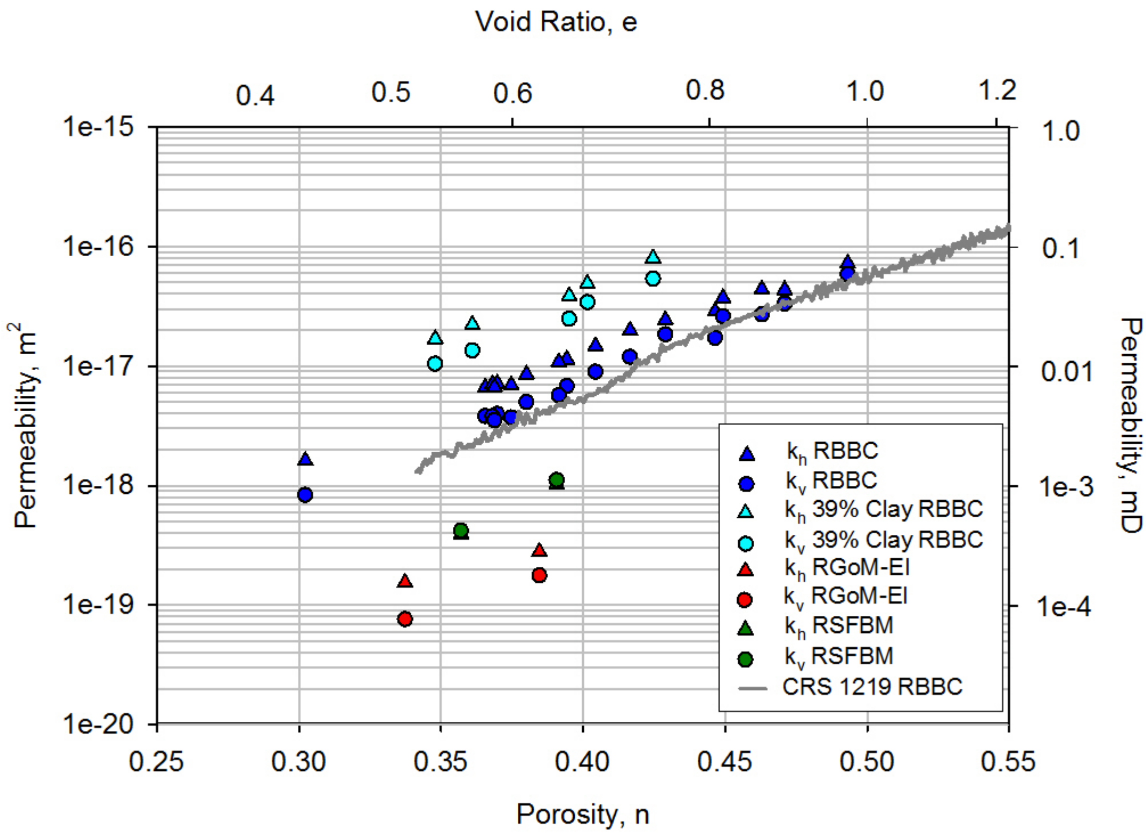


Fig. 2: Permeability Anisotropy for four resedimented mudrocks: Boston Blue Clay (2 clay fractions), Gulf of Mexico Clay and San Francisco Bay Mud. Permeability anisotropy increases with increasing axial compressive stress. Despite variations in clay fraction and smectite content, permeability anisotropy varies from 1-2 over a stress range of 0.4 to 40 MPa.



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Back

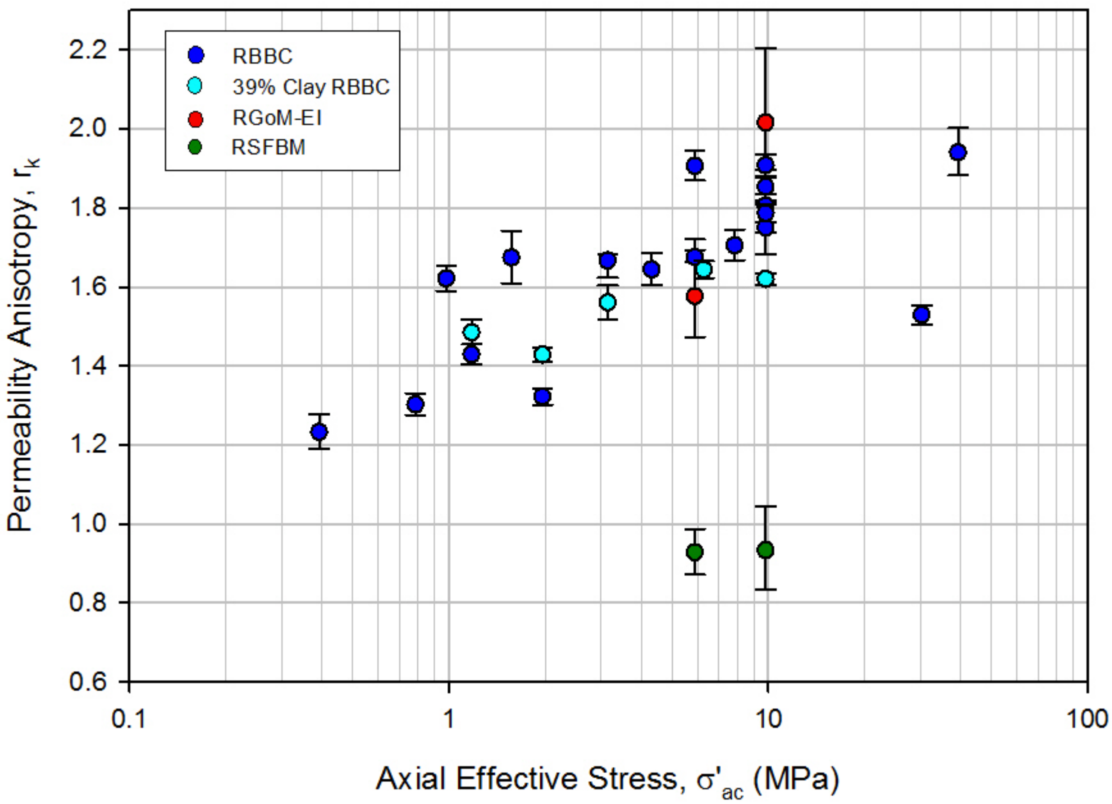

Fig. 2 Permeability Anisotropy for four resedimented mudrocks: Boston Blue Clay (2 clay fractions), Gulf of Mexico Clay and San Francisco Bay Mud. Permeability anisotropy increases with increasing axial compressive stress. Despite variations in clay fraction and smectite content, permeability anisotropy varies from 1-2 over a stress range of 0.4 to 40 MPa. Back