Speculation on the Role of Low Water Saturation During Layer-Parallel Shortening of the Marcellus Gas Shale

Engelder, Terry [1] (1) Geosciences, Penn State, University Park, PA.

During the Alleghanian Orogeny, the Appalachian Plateau of PA and adjacent states was thrust toward the Appalachian foreland (NW in modern coordinates) along a décollement within the Silurian Salina salt beds. The Plateau detachment sheet accommodated décollement slip through 10% to 15% layer-parallel shortening as indicated by a number of strain markers. Despite this pervasive strain, production decline curves for gas from Devonian black shales within the Plateau detachment sheet including the Marcellus are similar in form to decline curves from the Barnett and Haynesville, neither of which saw comparable tectonic deformation . The implication is that the mechanism for permeability in black shale is unaltered by penetrative strain which may be grossly characterized as a tectonic compaction. Black shales of the Appalachian Basin including the Marcellus have four characteristics that may relate to preservation of a permeability comparable to the relatively undeformed black shale reservoirs elsewhere. First, in the Marcellus cleavage, the primary manifestation of diffusion mass transfer, is weaker than in more calcareous rocks. Second, joints in the Marcellus remain unfilled in deformational environments where vein development is poor. Third, when present bed-parallel slip surfaces in the Marcellus are generally calcite filled. Fourth, vein development is common and joint development is rare when the Marcellus carries slip surfaces. The tradeoff of veins and joints takes place through the transition from a region of pure layer-parallel shortening to a region of fold growth. Cleavage is a manifestation of diffusion-mass transfer (i.e., pressure solution) which requires water as the carrier medium and the lack of a relatively high water saturation may suppress cleavage development. Vein filling and slip surfaces also require water as the carrier medium. Because the matrix of the productive Marcellus has a relatively low water saturation, I speculate that cleavage suppression by low water saturation is key to the preservation of bulk permeability that might otherwise be lost during tectonic compaction.