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A Methodology to Predict Fracture Permeability at Depth in Coalbed Methane Prospects, with the Ferron Coal, Utah as an Example

Coal matrix permeability is effectively non-existent, so secondary permeability from fractures (cleats) that are open to flow is essential to produce gas from coal. A good estimate of open cleat orientations prior to field development enables optimum well spacing that may reduce the time to initial reservoir depressurization (CBM response).

Cleats can form at different periods in the coal's history by a variety of mechanisms such as desiccation, thermal contraction, tectonic extension and release stresses. Local and remote tectonic stresses determine cleat orientations. Desiccation and contraction cleats, while essentially non-tectonic, reflect the orientation of paleo-σ_3. The prediction of the orientation and density of open coal fractures improves by knowing the burial history with respect to paleostress history and the modern stresses. As observed in core and outcrop, coal composition and ash content influence cleat density.

Three primary orientations of Ferron cleats are WNW-ESE, NNE-SSW, and NNW-SSE, consistent with Laramide paleostresses. Thermal contraction of the Ferron during post-Miocene cooling of 80ºC generated insufficient tensile stress to fracture coal. When coupled with tensile release stresses, late cleating would have been possible if the early fractures had annealed. If the early cleats remain, the coal would fail by slip along the existing cleats, rather than opening new fractures. In Ferron outcrops, vertical wing cracks indicate this frictional failure along pre-existing cleats. As permeability should be higher where the maximum horizontal stress (S_H) is parallel to the primary cleats, stresses in the Colorado Plateau favor fluid pathways trending E-W.