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Progressive Diagenesis, Evolving Mechanical Stratigraphy, and Fracture Patterns in Tight Gas Sandstone

Parts of three Permian Canyon sandstone cores illustrate mechanical and fracture stratigraphy in tight gas sandstone and show how an appreciation of diagenesis can improve extrapolation of fracture attributes into areas between wellbores. Mechanical properties evolved during progressive diagenesis in these low porosity deep marine sandstones. Subhorizontal reddish bands are loci of siderite cement formed within a few hundred meters of the sediment-water interface. Early grain-coating siderite prevented quartz and Fe-dolomite from forming in sideritic layers, which retain high porosity. Other cements include quartz and iron-rich dolomite. Near-vertical opening-mode fractures reflect deformation in a foreland basin. Fractures in sideritic layers end at layer boundaries, and their abundance decreases as layer thickness increases. Many sideritic layers are ~ equal in thickness to core diameter, so probability of fracture interception is high. Quartzose layers have greater mechanical thickness, wider fracture spacing, thus fracture sampling is sparse and direct measures of spacing are impossible. Tests show that quartz-cemented rock currently is more prone to fracture than is porous siderite-cemented rock. Thus fractures in siderite-cemented layers end just as they reach what is currently the most fracture-prone rock. Siderite-cemented layers fractured when adjacent sands were uncemented and only partly consolidated. Fractures in sideritic layers are filled with clay minerals and are probably flow barriers whereas younger fractures in quartz-cemented rocks are open in many beds. However, a shift from open to closed fractures reflects cement patterns too. Degradation of quality by postkinematic Fe-dolomite locally seals large fractures.