Contrasts in Fracture Array Intensity, Connectivity and Porosity Associated with Faults in Tight Fluvial and Marine Sandstones

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Small oblique-slip faults that cut outcrops of low-porosity marine and fluvial sandstones have associated fracture arrays that vary in spatial arrangement and porosity preservation depending on sandstone composition. Steeply dipping faults have displacements of ~ 1 m to tens of meters; in the subsurface these faults would likely be near or below seismic detection. Cement textures in fractures in Late Proterozoic Applecross Formation and Cambrian Eriboll Formation sandstones match those found in cores from producing tight gas sandstones, showing that the youngest fractures in these well exposed rocks are useful reservoir analogs. Faults have narrow cores of breccia surrounded by disseminated mostly opening-mode fractures. Older fluvial sandstone have halos of long, straight fractures that increase in length and abundance near fault cores. Halos are meters to tens of meters wide; width is fairly uniform along fault traces. In contrast, younger marine sandstones cut by the same faults have more abundant fractures that have a wider range of strikes and greater trace connectivity. Simple fracture halos are absent; instead, wide patches and irregular zones of high but fairly uniform fracture intensity are present along or between fault traces. Fracture arrays in both types of sandstone arise in part from development and evolution of subsidiary fractures at a range of scales. Applecross and Eriboll sandstones differ in composition (subarkose vs. quartzarenite) and, consequently, propensity for fractures to seal readily under the influence of the same thermal history. Although quartzose Eriboll sandstones contain more fractures, these are mostly narrower and are more likely to be quartz filled compared with those in the lithic and feldspar-rich Applecross, where quartz cement growth is impaired by the widespread presence of non-quartz substrate (feldspar, clay minerals) on fracture walls.