Fracture growth during exhumation in low-permeability rock formations—the role of fluid PVT properties

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Detailed fluid inclusion analyses of fracture cements in tightly cemented hydrocarbon-bearing sandstones and shales reveal that natural fractures tend to form under conditions approaching maximum burial, coinciding with hydrocarbon generation, and during incipient exhumation. Fluid inclusion analyses also reveal that these fractures form under abnormal (above-hydrostatic) pore fluid pressures. While compaction disequilibrium can account for elevated pore fluid pressures that promote fracture growth during early prograde burial, hydrocarbon maturation is likely the primary driver for fracture growth under peak burial conditions. Tectonic processes and thermal stresses provide secondary drivers. Thermal contraction with exhumation and cooling of the rock mass can promote fracture growth depending on the PVT properties of the fluid phase. The possible contribution of hydrocarbon generation after peak burial as a driver for fracture growth during incipient exhumation is discussed.