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Are Open Fractures Necessarily Aligned with Maximum Horizontal Stress?

Comparisons of measured stress directions and orientations of open, flow-controlling fractures show that open fractures in the subsurface are not necessarily parallel to maximum compressive stress (SHmax) and that fractures perpendicular to this direction may be open. Examples from the upper Gulf Coast basin, the interior compressional stress province, and western U.S. extensional stress province have stress, fracture, and production data from depths of 2400m to 6400m. The divergence between open fractures demonstrably contributing to fluid flow and SHmax ranges from a few degrees to 90 degrees. Moreover, sealed fractures parallel to SHmax are numerous. Parallelism of modern-day principal stresses and open fractures is not good evidence, by itself, that modern day stress controls the orientation of open fractures. A determining factor for fluid flow is the degree of mineral cement deposited within fractures. This is a function of fracture size and the rock's diagenetic history. In most subsurface opening-mode fracture systems, fractures are partially filled with a synkinematic cement deposited at the time of fracturing. This cement tends to form strong mineral bridges that prop the fracture open. The remaining part of the fracture is open or may be filled with postkinematic cements precipitated after fractures ceased opening. For the many reservoirs where opening mode fractures are the key flow pathways, cement patterns rather than stress data may provide the insight needed to determine which fractures are open to fluid flow.