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Geothermal Feedback: Stress, Active Faulting and Fluid Flow
By

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ABSTRACT:
Surface mapping, mineralogical and micro-structural observations on core, cuttings and outcrop samples and borehole image logs indicate that variations in fault zone fluid flow result from: (1) recurrent fracture slip driven by the remote stress; (2) changing fault zone mineralogy resulting from chemical alteration and healing localized along fractures; and (3) fracture connectivity. Brittle fracture and frictional slip in low porosity crystalline rocks produce dilation owing to surface roughness along fracture walls, brecciation, and micro-cracking. However, active precipitation and alteration in the geothermal system implies rapid sealing of fractures. Precipitated calcite and silica retain the brittle dilatant behavior responsible for permeability generation as revealed by crack-seal textures and brecciated cements. Conversely, fault rocks enriched in phyllosilicates demonstrate ductile behavior that minimizes dilation accompanying slip thus mitigating permeability regeneration. Over time, a fault core enriched in phyllosilicates acts as a persistent barrier to cross-fault flow, consistent with the separation of regions of distinct fluid inclusion chemistry, temperature and temperature gradient across major faults. In contrast, continued brittle fracture in the damage zone produces an episodically well-connected, vertically extensive, fracture network conducive to fault-parallel fluid flow consistent with localized temperature anomalies and mud losses in high density fracture networks adjacent to reservoir-scale faults. These variations in fault characteristics correlate with distinct zones of temperature gradient in the Navy's Coso Wash well 58A-10, as an example. The recurrence of fracture slip and its relationship to the geothermal reservoir is consistent with the geomechanical model of stress in the geothermal system constrained from borehole studies and active deformation evidenced by subsidence and induced seismicity.

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