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ON THE FORMATION OF AND FLUID PRESSURE WITHIN STRIKE-SLIP DILATIONAL JOGS: CONSTRAINTS ON CRUSTAL STRESSES AT DEPTH

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Dilational jogs on strike-slip faults provide a pathway for enhanced fluid flow and are typically sites for hydrothermal mineral deposition. We describe an excellently preserved strike-slip extensional duplex from the Atacama fault system, northern Chile. The depth of formation of this duplex is constrained to at least 3 km depth. Quartz and calcite veins from the duplex contain fluid inclusions that indicate that during duplex formation boiling occurred, resulting in mineral deposition at temperatures up to 252°C and at pressures between 0.4 and 7 MPa. Vein microstructures indicate mineral growth into open space and hence the least principal stress (σ_3) is constrained to a maximum value of 7 MPa presumably as a result of the overlapping fault geometry. The maximum principal stress (σ_1) in a strike-slip regime must be greater than the overburden pressure (~81 MPa) and hence minimum (σ_1 - σ_3) ≈ 4T where T is the measured tensile strength of the rock, predicting extensional or hybrid extensional shear fracturing, consistent with field observations. The low value for σ_3 at failure suggests that failure might have been promoted as much by reduction of σ_3 as an increase in σ_1 (load strengthening) as is typically assumed for strike-slip faulting. The sub-hydrostatic fluid pressures indicate that the dilatational jog was hydraulically isolated during formation. The data presented provide quantitative constraints on the state of stress at depth within these important tectonic structures.

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