AGU San Francisco 2004 - Abstract

Cyclical Stress Field Switching and (Total?) Relief of Fault Shear Stress Recorded in Quartz Vein Systems Hosted by Proterozoic Strike-Slip Faults, Mt Isa, Australia

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The Proterozoic Mt Isa inlier (~50,000 km^2) in NW Queensland, Australia, underwent a complex tectonothermal history involving multiple episodes of intracontinental rifting, sedimentation, and magmatism that culminated in the Isan Orogeny (1590-1500 Ma) where strong E-W shortening led to compressional inversion of former rift basins. The resulting metamorphic complex of subgreenschist to amphibolite facies assemblages is disrupted by brittle, late-orogenic (1500-1450 Ma?) strike-slip faults. The faults occur in two mutually cross-cutting sets; a set of dextral strike-slip faults striking NE-SW to NNE-SSW with offsets <20 km, and a conjugate set of sinistral faults striking NW-SE to NNW-SSE. The two contemporaneous fault sets therefore lie at ±45-60° to inferred E-W maximum compression, approaching the expected lock-up angle for 'Byerlee' friction coefficients.

The faults commonly outcrop as linear blade-like ridges extending for many kilometres across the semi-arid terrain. Transects across the NE-SW Fountain Range and Overlander Faults which crosscut Corella Formation amphibolite facies assemblages and granites have shown that the fault zones are about 100 m in width with a composite brittle fabric comprising: (1) subvertical silicified cataclastic shear zones (cataclasites plus microbreccias containing vein fragments); (2) innumerable subvertical quartz-veins (cm to m thickness) lying subparallel to the principal shear zones (some retain purely dilational textures; others are multiply recemented fault-breccias with wallrock fragments); (3) highly irregular non-systematic veins; and (4) a systematic set of predominantly extensional, steep planar quartz veins oriented 080-120° at moderate angles to the main faults. Mutual cross-cutting relationships occur between all structural components, indicating broad contemporaneity. Recorded dextral separations along shear fracture components are commonly of the order of 1-10 cm, consistent with small-moderate seismic slip increments.

A preliminary interpretation is that the differently oriented systematic vein-sets reflect changing orientations of the local stress field at different stages of the earthquake stress cycle. Minimum compressional stress oblique to the fault through the interseismic interval alternates with minimum compression oriented subperpendicular to the fault immediately postfailure, suggesting that each slip episode was accompanied by near-total relief of shear stress along the fault. The presence of amethystine quartz, open-space filling textures, and calcite-quartz intergrowths in the vein sets are consistent with hydrothermal precipitation occurring within 1-2 km of the former ground surface. Consequently, it is not yet clear whether these extensive vein systems developed under hydrostatic or overpresssured fluid conditions.