The (dis)organisation of structural controls on epithermal mineralization

N.H.S. Oliver[1,2], J.V. Rowland[3], J.G. McLellan[4,2] and R.J. Holcombe[1]

1.
Director and Principal Consultant, HCOVGlobal, Alligator Creek, Queensland, 4816. Email: nickoliver@hcovglobal.com

2.
Adjunct Researchers, Economic Geology Research Unit, James Cook University, Townsville, Qld 4811.

3.
Associate Professor, School of Environment, University of Auckland, Auckland, NZ. Email: jrowland@auckland.ac.nz

4.
Director and Principal Consultant, GMEX, Deeragun, Queensland, 4818. Email: John@gmex.com.au

ABSTRACT

A fundamental tool in analysis of shear-fault zones in mid crustal rocks is the analysis of the geometry and paleo-kinematics of m- to 100m-scale structures. The presumption is that there will be sufficient scaling consistency that a geometrically ordered hierarchy can be extracted, with a predictive capacity (e.g. dilatant bends, or consistent regional orientations for local tensile veins). The mechanical basis for this lies in the elevated levels of differential stress in the mid crust during tectonic loading, typically imposing some degree of geometrical order on faults, with local inconsistencies potentially providing favourable sites for metal precipitation.

This style of approach has led to some frustration in the epithermal world. Some Pac-rim epithermal deposits individually show apparently clear relationships to the steep, thickened parts of rifting-related normal faults. However, across these and many other epithermal districts, there are also deposits and prospects of the same timing whose apparent local kinematics are completely incompatible with their neighbours. This type of fault “jostling” behaviour has led to a misconception that epithermal structural controls are too difficult to use predictively. Upper crustal bulk differential stresses can be sufficiently low during rifting that geometrical consistency is not a requirement, and movement can occur at low strains on multiple, irregular fault strands, many of which can be inherited. A partial solution to this problem has been recognition of basement transfer structures that may control some of the organisation (e.g. Taupo, Coromandel); an empirical solution is to employ fault intersection density mapping. A robust solution, including in areas with poor outcrop where geophysics is used to reconstruct fault patterns, has been the application of geomechanical modelling of the complex fault arrays, which can explain the apparent aberrations of local fault kinematics and provide effective exploration targets verified by the position of known mineralization.