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Quantitative Structural Modelling to Determine a Valid Kinematic Framework for the Cu-Au-Mo Porphyry Mineralisation System at Bingham Canyon, Utah, USA

John Grocott (1), Armelle Kloppenburg (1), David Hutchinson (1,2)

(1) Midland Valley Exploration Ltd., 144, West George Street, Glasgow G2 2HG, United Kingdom (john@mve.com), (2) Australian Research Council's Centre for Excellence in Ore Deposits (CODES), Hobart Campus, University of Tasmania, Private Bag 126, Hobart, Tasmania 7001, Australia

Cu-Au-Mo porphyry-type and Cu skarn-type mineralization in the Bingham District in Utah are temporally and spatially related to a suite of quartz monzonite and quartz monzonite porphyry intrusions comprising the Bingham complex. Structural control on mineralization at the Bingham Canyon Mine has been described at the scale of individual large-scale folds and fracture sets but no integrated concept for the syn-mineralization deformation structures, or for the porphyry emplacement mechanism, has emerged from earlier research.

In this research we use kinematic structural modelling to investigate the hitherto largely unrecognized role of active interconnected faults in creating space for the emplacement of many cubic kilometers of granitic rocks of the Bingham district. We have used both the local 3d static mine model and the regional context in digital 2d and 3d restoration and forward modelling, to identify a geometrically valid and admissible fault framework and a kinematic solution for this framework through time.

The results indicate that porphyry intrusive rocks of the Bingham district and the associated mineralization system were emplaced during progressive reactivation of a basement-controlled, linked system comprising two sets of NW- and NNE-trending strike-slip faults. These faults operated as transfer faults during extensional collapse of the Sevier orogen in Eocene time. Each fault set is characterized by consistent overstep geometries with relay ramps breached by faults reactivated in extension. Strike-slip was accompanied by progressive dilatation of both sets of extensional faults in fault oversteps to permit emplacement of a series of NW and NNE trending dikes to collectively form a composite stock-shaped complex.

The 3D kinematic structural framework provides a predictive context for the porphyry- and skarn-type mineralization at Bingham Canyon, with potential for linking mineralizing fluid flow to 3d structure and the development of that structure through time.