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1 3D Numerical Modelling of Strain Localization, Fluid flow and Reactive Transport related to Hydrothermal Mineralization at Mount Isa, Australia

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The giant Proterozoic Cu deposit in Mount Isa, Australia, is hosted by a layered meta-sedimentary rock unit, the Urquhart shale, which attracted deformation and fluid flow during several stages of hydrothermal mineralisation. 3D numerical simulations of mechanical deformation help to constrain how the characteristic layering of the host rock, the orientation of this layering to the regional deformation geometry, and the proximity to major fault systems controlled brecciation at the Mount Isa mine site. In our simulations a deformation pattern similar to the observed extent of the fracture breccia occurs in the case of east-west shortening, and top-to-east simple shearing. In the model, the steeply dipping Urquhart shale is loaded by a flat-lying shear zone located at its base. Models on a smaller scale predict strain to be partitioned into ductile shearing in carbonaceous fine-grained layers, while coarser grained siltstone layers deform by brittle fracturing. The fracture veins are filled by a paragenesis of quartz, calcite, dolomite, and chalcopyrite. When an oblique strike-slip geometry is applied instead of shortening or simple shear, deformation is predicted to localise in large parts of steeply dipping pre-existing fault zones, and, again, in the mechani-

cally anisotropic Urquhart shale. A change from regional contraction, or simple-shear to strike-slip would have changed the hydraulic architecture significantly, with the former favouring upward flow, overpressure and hydraulic fracturing, and the latter providing better access to surface-derived fluids during Cu mineralisation. In a second stage of numerical analysis we have carried out reactive transport modelling to predict the flow geometry and mineral alteration patterns during the syn-contractional upward flow event. It can be shown that both free convection in faults and fractured rock masses, and forced upward flow through the faults generate depositon patterns similar to location, size and shape of the observed silica alteration We conclude that the distribution of dynamic permeability in the architecture of the hydrothermal plumbing system at Mount Isa was the key control on the localisation of metal deposition.