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The Significance of heterogeneous Permeability in Faults and fractured Rock Masses on free Convection for the hydrothermal System at Mount Isa, Australia

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The Mount Isa province is one of the premier mineral exploration regions in Australia and hosts several giant ore deposits. With extensive data and a long history of exploration and mining, the Mount Isa region offers a great opportunity for re-engineering hydrothermal mineralization processes.

Free thermal convection in fluid-saturated fault zones and fractured parts of the host rock has been investigated with three dimensional numerical finite difference models, using the computer code SHEMAT. Models were set up to simulate coupled fluid flow and heat transfer processes, taking into account the permeability structure of the complex 3D geologic architecture around the Mount Isa copper mine. Homogeneous and heterogeneous permeability distributions were assigned to stratigraphic units and faults to investigate how different distributions affect flow fields and temperature patterns.

Major outcomes of the numerical investigations are that (1) the behaviour of a system with heterogeneous permeability can be approximated by a model with averaged homogeneous permeability. (2) The dipping, wedge shaped portion of a major, highly permeable stratigraphic unit governs fluid flow and spatially attracts a convection cell, irrespective of the volume of adjacent permeable units. (3) Even in a complex and heterogeneous system with patches of low permeability along the fluid pathways, the Rayleigh number can be used to determine whether free convection will occur or not.

These results show that free convection patterns in hydrothermal systems are highly

sensitive to the 3D permeability distribution in the geological architecture.