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Mixing from below in hydrothermal ore deposits

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Unconformity-related hydrothermal ore deposits typically show indications of mixing of two end-member fluids: (a) hot, deep, rock-buffered basement brines and (b) colder fluids derived from the surface or overlying sediments. The hydromechanics of bringing these fluids together from above and below remain unclear. Classical percolative Darcy-flow models are inconsistent with (1) fluid overpressure indicated by fracturing and brecciation, (2) fast fluid flow indicated by thermal disequilibrium, and (3) strong fluid composition variations on the mm-scale, indicated by fluid inclusion analyses (Bons et al. 2012; Fusswinkel et al. 2013). We propose that fluids first descend, sucked down by desiccation reactions in exhumed basement. Oldest fluids reach greatest depths, where long residence times and elevated temperatures allow them the extensively equilibrate with their host rock, reach high salinity and scavenge metals, if present. Youngest fluids can only penetrate to shallower depths and can (partially) retain signatures from their origin, for example high Cl/Br ratios from the dissolution of evaporitic halite horizons. When fluids are released from all levels of the crustal column, these fluids mix during rapid ascent to form hydrothermal ore deposits. Mixing from below provides a viable hydromechanical mechanism to explain the common phenomenon of mixed shallow and deep fluids in hydrothermal ore deposits.

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