Hydrogeologic formation of the world's largest Pb-Zn-Ba deposit.

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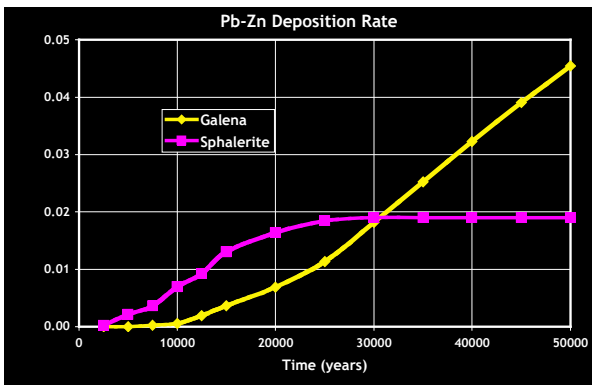
The Kuna Formation in the Brooks Range, Alaska, is host to the largest deposit of zinc yet discovered in the Earth's crust, containing ore reserves in excess of 140 Mt, averaging about 16% Zn and 5% Pb at Red Dog. The hydrothermal ores are thought to have formed in the late Paleozoic, within an anoxic mud-rich rift when adjacent carbonate platforms were drowned by extension and tectonic subsidence [1].

We present hydrogeologic simulations of reactive flow to test hydrochemical models for fluid venting along faults at Red Dog. A finite element grid was adapted for a geological section of the basin, structurally restored to latest Mississippian time. Clastic aquifers and older metasedimentary basement rocks appear to be the principal reservoirs for metal-bearing brines that ultimately discharged near the seafloor within slightly permeable, highly porous and petroleum-bearing mud, in which fluid mixing and TSR processes helped formed massive zinc-lead sulfide ores. Thermally driven convection cells drive fluid migration to km-depths in the submarine basin, at rates of ~ 10 m/yr within permeable normal faults, which focus metal discharge. Mostly lateral brine flow is predicted to occur in the deep clastic formations of the Kuna basin. Paleoheat flows up to 300 mW/m^2 and focused fluid discharge along normal faults are required to explain mineralization below and within massive deposits of barite that served as a caprock. The reactive-flow simulations help quantify the duration (see Figure) of mineralization associated with fluid mixing, cooling, and mineral replacement in this giant ore district.



References

[1] Leach D.L., Marsh, E., Emsbo, P., Rombach, C.S., Kelley, K.D., and Anthony, M. (2005). *EconGeol* **99,** 1449-80.