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Fault Controlled Hydrothermal Systems of the Great Basin, Nevada

Mark Person
New Mexico Tech, Hydrology Program, Socorro, NM, United States (markaustinperson@gmail.com)

Both fossil hydrothermal systems that formed Carlin-type gold deposits and modern geothermal systems across the Great Basin are characterized by fluid circulation along fault zones extending to depths of at least 5 km. Many of these hydrothermal systems deposit significant amount of silica which could shut the flow systems down over time. Some modern, amagmatic geothermal systems such as Beowawe show little fluid-rock isotope exchange suggesting convection is restricted to the fault plane. However, Eocene fluids that formed Carlin gold deposits display a significant degree of fluid-rock isotope exchange suggesting that fluid circulation through Proterozoic siliciclastic units. We have constructed a series of idealized hydrothermal models to investigate the three-dimensional nature of fluids circulation along fault zones and Great Basin strata. The goal of these models is to assess how contrasts in sediment and fault zone permeability variations impact circulation patterns during metalogenesis. Our Great Basin hydrothermal models are composed of series of horst (2) and graben (2) blocks. The two 10 km x 10 km graben blocks that have 1 km of differential throw across them. The graben blocks are separated by a permeable growth fault 20 m wide which strikes at 90o to the two permeable, 20 m wide range front faults. The pre- and syn-rift stratigraphy include a series of thick, volcanic, clastic, and carbonate confining units separated by a thin, permeable karst and sandstone units. We used a highly refined telescoping grid to discretize the fault zones and strata. We varied the permeability of the fault zone and sedimentary strata by three orders of magnitude to see how changes in fault-sediment permeability controlled they style of circulation. Despite the presence of water-tale topographic gradients within the horst blocks, fluid circulation within the fault zones was largely driven by free convection. We found that if fault zone permeability was more than two orders of magnitude greater than the sedimentary units, then circulation was confined to the fault zone.

We have also dated six samples of the sinter deposits using available pollen from the Beowawe sinter deposits. The samples were taken from six locations along the fault zone spanning an elevation of about 500 m. The 14C age dates varied between 2298-14,375 years before present. Two samples (B-6, B-7) collected near the base of the Malpais Fault zone in a 6.4 m high terrace had 14C ages that varied between 10774 years and 10560 years. These samples were separated by 2.4 m and yielded an apparent deposition rate of about 1 cm/yr. Two sinter samples collected near the middle of the Malpais fault escarpment (B-3, B-5) had a 14C ages that varied between 8797 and 14,375 years. These two samples were separated by 2.5 m yielding an apparent deposition rate of 0.4 mm/yr. These two deposition rates suggest that the sinter deposits formed episodically.