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Age and Rate of Accumulation of Volcanogenic Massive Sulfide Deposits: Case Study from the Lucky Strike Vent Field, Mid-Atlantic Ridge

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One of the fundamental questions in ore deposit research is the rate at which mineral deposits form. Often, studies rely on geochronological methods to answer these questions. However, uncertainties of the analytical methods often exceed the timespan of deposit formation (e.g., application of U-Pb zircon dating).

Seafloor massive sulfide deposits offer an opportunity to study the rate of an ore-forming process in situ. Estimates of massive sulfide deposit volumes/tonnages that form at the seafloor are possible where high-resolution bathymetry has been collected. Volume estimates coupled with application of U-series dating to determine the ages of deposits provide constraints into the rate of formation of volcanogenic massive sulfide deposits.

In this study, we present U-series geochronology (^{226}Ra/Ba) of hydrothermal barite and deposit tonnage estimates from the mafic-hosted Lucky Strike vent field, an actively forming volcanogenic massive sulfide (VMS) deposit on the Mid-Atlantic Ridge. Radium-226/Ba dating suggests that venting at this site has been likely continuous for at least 6,500 years and evolved from a widespread, lower-temperature venting to more focused and higher-temperature fluid flow that resulted in the formation of sulfide/sulfate mounds and chimney structures at an average rate of ~200 t/year. This rate, combined with vent fluid composition and flux data, is used to calculate the efficiency of metal accumulation at the seafloor.

The accumulation rate estimates at Lucky Strike are comparable to other well-characterized mid-ocean hydrothermal sites (e.g., TAG and Endeavour). However, it is concentrated within a relatively small area of <2.5 km^2. The emplacement of a segment-centered volcano is likely a key process that has focused fluid flow and metal precipitation in a relatively small area. Results from Lucky Strike suggest that these mafic-dominated deposits can form in under 30,000 years.