Sulfur isotope systematics of Mesoproterozoic hydrothermal pyrite tubes, Black Butte Deposit, Meagher County, Montana

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Motivation

MC−ICP−MS sulfate data

SIMS sulfide data

SC11-029, 56m:

SC10-06, 378.31m

Newland Formation at Black Butte, Meagher County, Montana. McGoldrick & Zieg (2004) proposed that these structures represented microbial filaments. If so, these ~1.4Ga structures would represent some of the earliest large multicellular organisms on Earth.

Setting

The Black Butte deposit is a middle Proterozoic massive sulfide deposit in the northern Helena Embayment, so on-erays of the lower Belt Basin.Based on petrographic and trace element petrographic mineralogical evidence, the deposit is hosted by the Newland Formation, a sub-wavebase calcareous shale with dolomite conglomerate debris flows that drape the older Homestake Formation.

Methods

All samples are from Black Butte. All analyses were performed at Caltech. The samples were analyzed for their sulfur isotopic composition using high-resolution electron microprobe analyses. Sulfur isotopic compositions of the samples were measured by conventional mass spectrometry.

Discussion

In black smokers, hydrothermal fluids vent to cold seawater where an initially porous screen of gangue minerals, such as barite, becomes oxidized and/or cemented to form a rigid framework. This process is followed by progressive recrystallization of the gangue minerals and accumulation of new mineral phases.

The paragenesis of the pyrite tubes is consistent with multiple steps of synsedimentary or diagenetic mineralization. The sulfide-sulfur isotopic compositions of the sample tubes were measured by MC-ICP-MS on a Thermo Finnegan Neptune Plus at Caltech (Paris et al., 2013). Precisions are better than 0.4‰ on 5-300nmol of sulfate.

Using open large range (over 45‰) of sulfide-sulfur isotopic compositions on a centimeter scale, which exceeds the range of previously observed values from the Newland Fm. Carbonate Associated Sulfate data is in solid boxes, and barite data is in open boxes. The new MC-ICP-MS data is compared to the existing data with a mean of 10‰. The effect of closed-system enrichment on pore fluid by microbial sulfide reduction may slow the results. In this case, the highest values (10‰) would represent an upper limit for aqueous sulfate.