Sulfur isotope stratigraphy and the basinal environments of sediment-hosted stratiform Zn-Pb deposits

C.A. JOHNSON[1*], J.F. SLACK[2], J.A. DUMOULIN[3], K.D. KELLEY[1], AND H. FALCK[4]

[1]U.S. Geological Survey, Denver, CO 80225 USA
([*]correspondence: cjohnso@usgs.gov)
[2]U.S. Geological Survey (Emeritus), Reston, VA 20192 USA
[3]U.S. Geological Survey, Anchorage, AK 99508 USA
[3]NWT Geological Survey, Yellowknife, NT X1A 2L9 Canada

Key support for the traditional euxinic-basin model for sediment-hosted stratiform Zn-Pb deposits derives from S isotope profiles of host successions that show enrichment of ^{34}S with stratigraphic height. This pattern is widely considered prima facie evidence for isolation from the open ocean. For Zn-Pb deposits of the Selwyn Basin, Canada, recent studies by us and others have contradicted the traditional interpretation of classic ^{34}S enrichments [1,2]. Are enrichments in ^{34}S truly definitive of basin isolation? We address this question by examining the Ordovician-Silurian Duo Lake Formation, the host succession for the immense Zn-Pb deposits of the Howards Pass district, Yukon/NWT.

Our analyses of unmineralized mudstone layers below, within, and above the ore horizon show up-section ^{34}S enrichment of pyrite (–15 to 30‰, double the enrichment reported previously [1]), but also parallel ^{13}C depletion of carbonate (–3.8±0.4 to –5.5±2.7‰), increase in organic C (1 to 7 wt%), and change in pyrite morphology from dominantly framboidal to dominantly coarse and euhedral. Calcite concretions in and above the ore horizon are ^{13}C poor (–10±2‰) and have rims of pyrite that are ^{34}S rich (up to 34‰).

We propose that the S isotope profile reflects a transition in the location of pyrite formation during diagenesis, from the zone of sulfate reduction to the sulfate-methane transition where SO_4 is reduced via anaerobic oxidation of methane (AOM). Because it does not reflect basin conditions, the profile is compatible with new models of Zn-Pb sulfide formation involving metalliferous brine infiltration of sulfidic sediment beneath an oxygenated water column. As for sediment-hosted stratiform Zn-Pb deposits generally, we conclude: basin euxinia is not required for their formation; some may indeed have recorded (or influenced) the global marine environment rather than restricted environments; and AOM may have furnished reduced S for the Zn-Pb sulfides.

[1] Goodfellow & Jonasson (1984) *Geology* **12**, 583-586. [2] Shanks *et al*. (1987) *Econ Geol* **82**, 600-634.