Combined sulfur, carbon and redox budget constraints on genetic models for clastic-dominated base-metal sulfide deposits: Examples from the Here's Your Chance Pb-Zn deposit, Australia

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A common explanation for the occurrence of base metal sulfide deposits in organic-rich sediments is that reduction of sulfate by oxidation of organic matter provides the necessary sulfide. Genetic models for the Here's Your Chance (HYC) Pb-Zn deposit differ in the timing, location and temperature of sulfate reduction, which has been regarded to occur primarily through syngenetic biological sulfate reduction (BSR) in the water column or through syndiagenetic BSR and/or thermochemical sulfate reduction in sediments. To date, inorganic and organic analyses, and textural and isotopic evidence have led to conflicting conclusions about the relative importance of these models.

An additional line of evidence, previously not reported for HYC, is consideration of carbon, sulfur and redox budget balances. These mass balance constraints can be quantified by comparison of the sulfide mineral content and organic carbon content and H/C ratios of mineralised and non-mineralised rocks representative of the ore and protolith, respectively. Our calculations suggest that the organic matter present at HYC is insufficient for formation of the known mineral resource by sulfate reduction coupled to oxidation of organic matter within the protolith. Inclusion of pyrite replacement in the model also does not lead to the observed amounts of Pb,Zn-sulfide minerals.

The calculations indicate that externally derived reducing capacity and/or reduced sulfur is required to account for the observed metal resource. Possible sources include methane-rich fluids from deeper parts of the sedimentary sequence, or production of BSR sulfide before the influx of metal-bearing fluids and subsequent transport into the ore zone from nearby sediments. These results imply that models having a single major source of redox budget for sulfate reduction may not be consistent with all available evidence.