# Sources of S in the Paleoproterozoic Urquhart Shale hosted George Fisher Zn-Pb-Ag deposit, Mt Isa, Australia

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The Proterozoic Mount Isa Inlier hosts several world-class base metal deposits including the George Fisher Zn-Pb-Ag deposit (GF). All economic deposits are hosted by the carbonaceous, pyritic, late Paleoproterozoic Urquhart Shale (US) which has undergone various stages of deformation. The US and GF contain multiple generations of fine-grained pyrites, and the source(s) of reduced sulphur remains unclear. In this study we present $\delta^{34}S$ values for pyrite associated with GF obtained by in situ analysis using SIMS. The small spot size (< 5 µm) ensured spatially resolved isotopic data were produced for all generations of pyrite. The paragenetically constrained $\delta^{34}S_{pyrite}$ values provide valuable information about the processes responsible for sulphide generation in and around GF.

Three generations of pyrite were identified at GF: fine-grained subhedral-spheroidal pre-ore pyrite (py-1); coarse-grained anhedral pyrite associated with stage 1 sphalerite (py-2); coarse-grained euhedral pyrite associated with stage 2 galena and sphalerite (py-3). Coarse-grained euhedral pyrite was also identified in unmineralised US (py-euh).

Whereas pre-ore pyrite (py-1) preserves negative $\delta^{34}S$ values (-6.1 to +3.1 ‰; n = 152), the ore stage pyrites (py-2 and py-3) preserve higher $\delta^{34}S$ values (+6.0 to +18.0 ‰; n = 97). The highest $\delta^{34}S$ values are preserved in py-euh (+15.7 to +34.1 ‰; n = 40).

The negative $\delta^{34}S$ values (py-1) provide evidence for bacterial sulphate reduction (BSR) of seawater sulphate under relatively open system conditions. In contrast, the ore-stage pyrites (py-2 and py-3) may have formed during more closed system BSR, but it is not possible to rule out other pathways of sulphate reduction (e.g. thermochemical sulphate reduction). The most positive $\delta^{34}S$ values occur in py-euh, which may provide evidence for sulphate limitation in a closed system. The overall distribution of $\delta^{34}S_{pyrite}$ values from this study is similar to other late Paleoproterozoic sediment-hosted base metal sulphide deposits providing evidence that common processes were ultimately responsible for sulphate reduction.