

# $\delta^{13}\text{C}$ - $\delta^{18}\text{O}$ - $^{87}\text{Sr}/^{86}\text{Sr}$ covariations in ore-stage calcites at and around the Gays River Zn-Pb deposit (Nova Scotia, Canada) - evidence for fluid mixing<sup>1</sup>

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The  $\delta^{13}\text{C}$ - $\delta^{18}\text{O}$ - $^{87}\text{Sr}/^{86}\text{Sr}$  variations around carbonate-hosted deposits can in theory help characterize ore-stage gangue minerals and discriminate between single fluid or two-fluid mixing models during mineralization. This paper reports on the combined use of  $\delta^{13}\text{C}$ - $\delta^{18}\text{O}$ - $^{87}\text{Sr}/^{86}\text{Sr}$  data in dolostone within the Gays River deposit and up to 30 km around it. The deposit, at the southern margin of the Maritimes basin, is hosted in carbonate banks of the Gays River Formation, a unit of the Viséan Lower Windsor Group in Nova Scotia. A previous  $\delta^{13}\text{C}$ - $\delta^{18}\text{O}$  study restricted to the Gays River deposit (and independent from an  $^{87}\text{Sr}/^{86}\text{Sr}$  investigation) had previously led to the conclusion that a single brine was responsible for mineralization.

The present isotopic investigation was governed by the paragenetic succession which includes presulfide dolomite, synsulfide calcites - both uniform and zoned under cathodoluminescence, and postsulfide calcite uniform under cathodoluminescence. Results for presulfide dolomite (avg  $\delta^{13}\text{C}=+3\text{‰}$ ,  $\delta^{18}\text{O}_{\text{V-PDB}}=-6\text{‰}$ , and  $^{87}\text{Sr}/^{86}\text{Sr}=0.7080$ ) plot near the normal marine isotopic ratios, whereas postsulfide calcite shows slightly more radiogenic  $^{87}\text{Sr}/^{86}\text{Sr}$  ratios (avg=0.7090). At the deposit, isotopic results for calcite associated with the high-grade sulfide zone cluster around a  $\delta^{18}\text{O}_{\text{V-PDB}}$  of -17.0 per mil and an  $^{87}\text{Sr}/^{86}\text{Sr}$  of 0.7120, and clearly characterize the mineralizing system. Regional C, O, and Sr isotope data are similar to those at the deposit and indicate therefore a regional flushing of the Gays River Formation by fluids of the mineralizing system.

The overall isotopic variation through time from pre- to syn- then postsulfide conditions in the  $\delta^{18}\text{O}$ - $^{87}\text{Sr}/^{86}\text{Sr}$ ,  $\delta^{13}\text{C}$ - $\delta^{18}\text{O}$  and  $\delta^{13}\text{C}$ - $^{87}\text{Sr}/^{86}\text{Sr}$  diagrams is interpreted to be similar for pre- and postsulfide conditions, marked by a warm, slightly radiogenic parent brine. This chemical system was disturbed by a much more radiogenic and high-temperature fluid during mineralization. Although most of the mineralizing trend can be explained either by a single-brine model or a mixing brine model, the mixing model allows for a much simpler evolution if the suite of conditions - on a regional basis - is considered through time.

"Show me your  $\delta^{18}\text{O}$ - $^{87}\text{Sr}/^{86}\text{Sr}$  profile, and I will tell you what you drink!" (adapted old Spanish proverb).

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