

A study of fluid inclusions in sulfide and non-sulfide mineral phases from a carbonate-hosted Zn-Pb deposit, Gays River, Nova Scotia¹

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This paper reports on a detailed fluid inclusion study of syn-ore (sphalerite, calcite) and post-ore (calcite, fluorite, quartz, barite) mineral phases at the Gays River Zn-Pb deposit (2.4 Mt 8.6% Zn, 6.3% Pb), Nova Scotia, Canada. The deposit is hosted by dolomitized Viséan carbonate rocks, in the basal part of the Windsor Group, that formed during a marine transgression on terrestrial clastics of the Tournaisian Horton Group. Mineralization is dominantly of replacement style, with lesser porosity infilling, and mainly occurs in the fore-reef of a carbonate bank, the shallow water equivalent of the laterally extensive, laminated algal and bituminous Macumber Formation. Paragenetically, constant volume dolomitization of the host rock is followed by euhedral, manganiferous dolomite cement, then sphalerite and galena. Syn- to post-ore calcite with trace amounts of barite, fluorite and quartz, occlude the remaining porosity.

Fluid inclusions types include: (1) aqueous, L-rich \pm solids, including halite, (2) methane, (3) H₂O-CO₂, (4) monophasic L- and V types, and (5) liquid petroleum \pm aqueous phase. Type 1 inclusions are most abundant, types 2 and 3 are rare, and type 5 are post ore. Type 4 inclusions are mostly related to post-entrapment changes (e.g. necking). Thermometric data indicate that the mineralizing fluids were high-salinity, NaCl-CaCl₂-H₂O brines with 20 to 28 wt.% eq. NaCl. Hydrohalite-ice melting relationships indicate considerable variation in the NaCl/(NaCl+CaCl₂) ratio of the fluids (0.2 to 1). Lower salinity fluid inclusions (0-16 wt.% eq. NaCl) are restricted to post-ore calcite and barite. Combined SEM-EDS analysis of decrepitate mounds identify Na, Ca and Mg as the major solute components. Homogenization temperatures (T_h) for all mineral phases range from 70° to 250°C, but ranges of \leq 10-20°C occur within isolated groups of inclusions. Homogenization data on liquid petroleum inclusions and associated aqueous inclusions in fluorite are 120° to 150°C, whereas three petroleum inclusions in syn- or post-ore calcite have T_h values of 53°, 53° and 167°C.

Bulk crush gas chromatography indicates inclusion fluids contain up to 1.4 mole % combined CO₂ and CH₄, with the most abundant condensable gases in sphalerite and galena. Since the high pressures (\leq 2000 bars) required to retain this gas as dissolved species in the fluid are incompatible with the local stratigraphy, it is inferred that the gas was either picked up along the fluid path and transported as an immiscible phase or was produced locally in the carbonate bank by thermal degradation of organic material.

The data are interpreted to indicate that a high-temperature (\leq 250°C), saline (ca. 25 wt.% NaCl) metalliferous fluid migrated into the carbonate bank where it reacted with reduced sulfur generated by thermochemical sulfate reduction and mixed with an equally saline but lower temperature fluid. The variability of the NaCl/(NaCl+CaCl₂) ratio of the fluids suggest contamination by dissolution of the host dolostone; this dissolution may also have provided some of the CO₂ component of the gas. The pressure of the mineralizing environment is constrained at ca. 400 bars by the presence of liquid petroleum, aqueous and methane inclusions and their respective isochoric projections.

The high homogenization temperatures for the mineralizing fluids may reflect the regional setting of the deposit. That is, it is located on the margins of a large stable craton in an area that was structurally active during the Carboniferous and within which widespread thermal disturbances are known. The high temperatures also suggest affinities with the Irish carbonate-hosted base-metal deposits.

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