

# Fluid composition and thermal regime during Zn-Pb mineralization in the Lower Windsor Group, Nova Scotia, Canada<sup>1</sup>

G. Chi<sup>2</sup>, D. J. Kontak and A. E. Williams-Jones<sup>3</sup>

The Zn-Pb-Ba-Cu-Ag-F deposits hosted by Lower Windsor Group (early Carboniferous) carbonates in Nova Scotia are located along the southern margin of the Maritimes basin. Various geochemical studies indicate that the deposits were formed by fluids expelled from the basin, but it remains unclear whether the ore-forming fluids for different deposits were derived from a common source region in the central part of the basin, as proposed previously, or from separate source regions. It is also unknown how the ore fluids were conveyed from the source regions to the sites of mineralization and whether or not the mineralizing systems of different deposits were hydrologically related. This paper addresses these problems through a compilation of regional fluid composition and temperature data and thermal comparisons between the ore-forming fluids and their host rocks. The compositions and temperatures of the fluids were evaluated from fluid inclusion data, whereas host-rock temperatures were estimated from vitrinite reflectance measurements.

The ore-forming fluids are characterized by: (1) variable, but generally high salinities (mainly between 15 and 30 wt% NaCl equiv), (2) variable, but generally detectable amounts of bivalent cations (mainly Ca<sup>2+</sup>), (3) significant concentrations of hydrocarbon species, and (4) high temperatures (mainly between 150° and 250°C). NaCl/(NaCl+CaCl<sub>2</sub>) wt ratios in fluid inclusions show a broad district-scale variation: mainly <0.6 for the Jubilee deposit and several showings on Cape Breton Island, and mainly >0.4 for the Gays River and Walton deposits in mainland Nova Scotia. CH<sub>4</sub>/higher hydrocarbon ratios of the gas components are greater for the Gays River deposit (3.8-9.7) than the Jubilee deposit (0.7-1.3). Fluid inclusion homogenization temperatures do not show a negative correlation with the distance between the deposits and the central part of the Maritimes basin, as might be expected if the fluids for different deposits were derived from the same source region.

The background temperatures prior to mineralization were estimated from mean vitrinite reflectance (R<sub>o</sub>) in host rocks which were relatively far from the deposit, and were probably least affected by the mineralizing events, and from homogenization temperatures of fluid inclusions in preore minerals. These temperatures are in the range of 70° to 155°C, which are significantly lower than those of the ore-forming fluids. The paleogeothermal gradients estimated from the background temperatures and burial depths are ca. 65°C/km. Vitrinite reflectance values in host rocks adjacent to the deposits indicate that these rocks were heated by the mineralizing fluids to variable degrees, but thermal equilibrium between the fluids and rocks was not attained in most cases. This thermal relationship suggests focused and short-lived, rather than pervasive and long-lived fluid flow.

The regional variation of fluid composition and thermal patterns supports a model in which the ore-forming fluids of individual deposits were derived from separate sources; fluid flow was focused along confined conduits and individual mineralizing systems were unconnected hydrologically. Under paleogeothermal gradients of ca. 65°C/km, fluids with temperatures of ca. 250°C could have been generated in sub-basins proximal to the deposits. Sudden release of overpressured fluids from the basal part of the proximal sub-basins, characterized by high flow rate and short duration, is proposed as the mechanism of ore-forming fluid flow.

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<sup>2</sup>Geological Survey of Canada, Quebec Geoscience Centre, P. O. Box 7500, Sainte-Foy, Quebec, Canada G1V 4C7

<sup>3</sup>Department of Earth and Planetary Sciences, McGill University, Montreal, Quebec, Canada H3A 2A7