Early Carboniferous (Visean) carbonate breccias in the Windsor Group: multiple origins and metallogenic significance

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Marine sedimentation in the Magdalen Basin is restricted to the early Carboniferous Windsor Group. The stratigraphy of the group is dominated by evaporites and siliciclastics. Carbonates are only significant at the base of the group; the Macumber Formation was deposited downslope to the reefoid mounds of the Gays River Formation. Both units are sometimes mineralized (Pb-Zn-Cu-Ba). In the Macumber, the ore is associated with carbonate breccias.

Three types of breccia are present. Synsedimentary rotational slide (slump) breccias occur in m-thick predictive rock patterns. The breccias are characterized by concave shear failure planes, monocompositional nature of the sometimes rounded clasts and a mud matrix derived from background sedimentation. Late tectonic breccias are typified by angular monocompositional clasts with a puzzle-like texture, cement matrix and were formed following lithification and chemical compaction, but prior to hydrocarbon migration, mineralization, secondary dissolution of carbonates, and syn-ore to post-ore calcite cementation. Finally, late solution collapse karstic breccias are characterized by their heterolithic nature, presence of early breccia fragments, red siliciclastic infills in dissolution voids, gravitational calcite cements and formation following burial of the host rock.

Distinction between the various breccias is critical to base metal exploration because the tectonic breccia is the only one responsible for creation of significant secondary porosity. For the Jubilee deposit, brecciation played a key role in controlling pathways for mineralizing fluids in the early Carboniferous Basin.

In the vicinity of the Jubilee deposit, regional distribution of the $\delta^{18}O$-$\delta^{13}C$-$^{87}Sr/^{86}Sr$ (relatively heavy O-C ratios and non-radiogenic Sr) suggests that the Macumber stabilized under warm burial conditions, in equilibrium with marine like waters and ^{18}O-rich evaporative fluids. These fluids have also affected the host-rocks at the deposit where breccia porosity is filled by fibrous pre-ore calcite, sphalerite-galena and anhedral syn- to post-ore calcite. The carbonate cements show similar ^{13}C-depleted carbon ratios (average -25‰), but distinct $\delta^{18}O$ fields: a cluster around -6.0‰ and an interval ranging from -5.0 to -12.0‰, respectively. The data suggest that fluids responsible for cementation of the tectonic breccia were hydrocarbons and hydrothermal fluids which mixed during mineralization.