

Saline brines of the Sydney Basin: origin as evaporative Windsor residues?

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The Phalen and Prince collieries are mining coal from the Morien Group of the Carboniferous Sydney Basin, Cape Breton, Nova Scotia. The mines are situated beneath the sea, as much as 5 km offshore. Retreat longwall mining techniques allow the roof to collapse behind the mine operation and create an overlying fracture system that taps into the formational aquifers. Understanding the origin of mine wa-

ters is critical to the development of conceptual and physical models.

Major ions and selected isotopes were analyzed on samples from both mines. Despite dramatic salinity variation (4,400-160,000 mg/L) within and between mines, most waters are chemically similar Na-Ca-Cl brines that are depleted in K and SO₄ relative to seawater. High Br/Cl ratios favour an

origin of the brines from the residue remaining from the evaporation of salts, probably from the Windsor salt event. Dissolution of halite by groundwater, in contrast, generally produces low Br/Cl ratios, as seen in analysis from local salt springs. Regression lines through both Cl and Na versus Br intersect the seawater evaporation curve at values of 25 to 30 times seawater. This is the concentration where halite precipitates, consistent with Windsor salt mineralogy. The brines were possibly expelled from the underlying Windsor and older sediments during basin compaction and diagenesis.

The waters are greatly enriched in Ca and Sr in comparison to evaporated seawater. $^{87}\text{Sr}/^{86}\text{Sr}$ ratios range be-

tween 0.710051 and 0.711422 and increase with increasing salinity. These are much higher than Windsor (or later) seawater values. The ^{87}Sr may have originated from water-rock interaction with K-rich minerals. Abundant kaolinite pore-filling supports the interpretation that Ca was derived from the breakdown of anorthitic feldspars by acidic waters. The ^{18}O and ^2H isotopes plot near the GMWL between SMOW and local rainwater, which is unusual for evaporative brines that underwent water-rock interaction. ^{18}O and ^2H isotopes within the brine may have been lightened by extended evaporation, removal of heavy isotopes in hydrolysis reactions and/or by meteoric dilution.