Compartmentalization of formation waters in the Prince Colliery, Cape Breton, Nova Scotia

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The Prince Colliery is located offshore from Point Aconi, Cape Breton, Nova Scotia. The Colliery is presently extracting coal from the Hub seam of the Morien Group, part of the Carboniferous Sydney Basin. A large channel sandstone body lies above the Hub seam and a calculated salinity profile from resistivity and porosity logs for the sandstone shows a high-salinity water (~65 000 mg/L) separated from a low-salinity water (~10 000 mg/L) below.

Water samples were taken from roof boreholes directly above the coal and from waters flowing from mined-out areas (gob water). Two formation waters (low and high salinity) and a mixed (gob) water are distinguished. The low-salinity formation waters show total dissolved solids less than 35 000 mg/L and a gradual increase in salinity and Ca/Na ratios down dip. The high-salinity formation waters are characterized by total dissolved solids greater than 35 000 mg/L and a higher Ca/Na ratio. Gob samples are a mix of waters from the entire sandstone (as opposed to formation waters which are directly above the coal) but exhibit much higher salinities than formation waters from the same area. Gob samples increase in total dissolved solids down dip and the Ca/Na ratios are similar to those of the high-salinity formation water. Both gob waters and high-salinity waters contain high Br/Cl ratios that distinguish them from local seawater sources.

Petrological analysis divided the channel sandstone into 3 units: (1) an upper 10 m thick sandstone (porosity 13.9-16.9%; permeability 4.44-60.5 md.); (2) an intermediate mudstone (24 cm); and (3) a lower 2.5 m sandstone, with a lower permeability (0.96 md.) upper portion and a higher (2.11 - 4.15 md.) permeability lower portion.

We suggest the compartmentalization of the sandstone by an area of low permeability which separates the two distinct waters. The gob waters are thought to comprise a mix between high-salinity waters from the thicker upper sandstone and the lower salinity waters from the thin lower sandstone. Therefore, the majority of water entering the mine is derived from local basin brines and not from modern seawater.