

Experimental determination of cation exchange capacity of sandstones and shales in the Phalen Colliery, Cape Breton

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This study experimentally quantifies cation exchange capacities (CEC) of sandstones and shales in the Phalen Colliery, Sydney Coalfield, Cape Breton. Phalen Colliery rocks belong to the Sydney Mines Formation, Morien Group, which is Upper Carboniferous Westphalian D to Stephanian in age. Phalen formation waters are the inferred evaporative residues from Viséan Windsor Group salt precipitation, but have been modified from their original evaporative chemistry. Waters are saline, moderately undiluted, and stagnant. A trend of increasing Na with decreasing salinity, balanced by Cl, suggests cation exchange modified the water composition.

This experiment tests the exchange hypothesis by determining mineralogy and measuring cation exchange capacities of Phalen sandstones and shales. The clay portions of the samples are predominantly chlorite, mica, and kaolinite groups, with minor illite. Nine clay samples were reacted with four equilibrating solutions to invoke exchange between solution

and clay cations. The equilibrating solutions (sodium adsorption ratios 70 and 120 mmol/L, total concentration 4000 and 5400 mmol/L, pH 5.6) were modeled after Phalen formation waters. A 0.25M Ba(NO₃)₂ solution extracted exchanged cations from the clay.

Calculated exchangeable Na ranges from 0.058 to 0.786 meq/100g, with a 0.167 meq/100g mean. Exchangeable Ca ranges from 0.008 to 0.141 meq/100g, with a 0.036 meq/100g mean. The ratio of exchangeable Na to exchangeable Ca ranges from 0.702 to 10.9, with a 4.72 mean, and CEC ranges from 0.073 to 0.927 meq/100g with a 0.209 meq/100g mean. Phalen sandstones and shales contain low exchange capacity clay types. Experimental cation exchange capacity results suggest even lower cation exchange capacities than normal. The preliminary interpretation is that cation exchange would not fully account for the chemical trends observed.