A hydrogeological interpretation of trace metal concentrations in lake sediment in the Holyrood granite

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A regional lake/pond sediment survey over the Avalon Peninsula in 1976, by the Newfoundland Department of Mines, showed a number of lakes with anomalous concentrations of uranium and other metals in the area of the Holyrood Pluton. These anomalies apparently have no association with the host granite rock geochemistry. The hydrogeological framework, including detailed analysis of the fracture systems as major groundwater conduits, has been studied in an attempt to determine the role of groundwaters in transporting and localizing concentrations of trace metals in lake sediment in four lakes in the area.

Groundwater discharge into the lakes was estimated to range from 20 to 35 percent of their water balances, based on characteristic differences between groundwater and surface waters. Detailed sampling, on a grid pattern, of lake sediment showed a non-uniform areal distribution of metals over these lakes. This sampling also showed that peak concentrations were not restricted to the centre or deepest point in the lake. The maximum concentration of uranium found in these lakes ranged from 69 to 309 ppm, which were higher than those recorded in the regional survey. In some cases the elongated shape of the anomalous area aligned with the orientation of one the major fracture sets in the study area. Sampling of vertical sections of sediment, through both anomalous and background areas showed a considerable variation of metals in the sediment column. However there appeared to be no direct relationship between surface sediment concentration and peak concentrations at depth. Although concentrations of most metals in the sediment are at about detrital levels anomalous concentrations of uranium in the cores appear to be associated with a sharp decline in LOI or organic content. A mechanism is proposed where mobile uranium in oxidizing groundwaters is reduced to its tetravalent state when it encounters organic rich muds as it discharges into a lake. Seepage flux values along with uranium concentrations found in deep groundwaters in the granite suggest that groundwaters are a possible mechanism of transport and metal concentration in lake sediment.

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