Origin of groundwater salinity in a fractured bedrock aquifer of the Canadian Shield in Eeyou Istchee James Bay: Case study of Éléonore Mine

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The origin of groundwater salinity in a fractured bedrock aquifer of the Canadian Shield is investigated at the Newmont Éléonore site, an active underground gold mine located in *Eeyou Istchee* (James Bay area, Northern Quebec). Groundwater samples were collected at 11 sites within the mine galleries, at depths ranging from 80 m to 830 m. Chemical and isotopic analyses included major, minor, and trace inorganic constituents, stable isotopes of water ($\delta^{2}H$, $\delta^{18}O$), $\delta^{37}Cl$, $\delta^{81}Br$ and $^{87}Sr/\ ^{86}Sr$. Shallow groundwaters (depth < 100 m) are fresh and present Ca-SO_4, and Ca-HCO_3 water types. The deep groundwaters, (770 m - 830 m) are saline and present a Ca-Na-Cl water type. Groundwater samples of the intermediate zone, (from 200 m to 500 m) present intermediate salinity with various groundwater types (Na-Cl, Na-HCO_3, Na-HCO_3-Cl). A groundwater salinity gradient is observed according to depth, with salinities of 0,05 g/l to 0,33 g/l at shallow and intermediate depths (from 80 m to 500 m) and to salinities of 1,91 g/l to 3,33 g/l at 770 m and 830 m. Groundwaters found in the intermediate depth zone present compositions that suggest the mixing of fresh and saline groundwaters. The increasing concentrations of Cl^{-}, Na^{+}, K^{+}, Ca^{2+}, and Mg^{2+} with depth could be derived from (1) intensive water-rock interactions with minerals, (2) hydrothermal fluids (Na-Cl type) preserved in rocks after crystallization, and (3) the migration of deep brines. Since the study site is located at the limit of the marine transgression of the former Tyrrell Sea (last deglaciation), a possible mixture with infiltrated sea waters may also be considered. The groundwater inorganic constituents will be interpreted together with the isotopic data ($\delta^{2}H$, $\delta^{18}O$, $\delta^{37}Cl$, $\delta^{81}Br$, $^{87}Sr/\ ^{86}Sr$) to elucidate the origin and processes that generated salinity in this fractured bedrock aquifer.