

GROUNDWATER COMPOSITION IN THE CANNINGTON REGION, AUSTRALIA: CONTROLLING PROCESSES AND APPLICATIONS TO MINERAL EXPLORATION

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INTRODUCTION

The Cannington Ag-Pb-Zn deposit is located ~170 km southeast of Mount Isa in Queensland (Figure 1). The Proterozoic basement is unconformably overlain by 8-70 m of variably weathered Cretaceous sedimentary rocks of the Great Australian Basin (GAB). This cover includes a basal sandstone, a sequence of and siltstones, and, locally, a fossiliferous limestone unit (Figure 2).

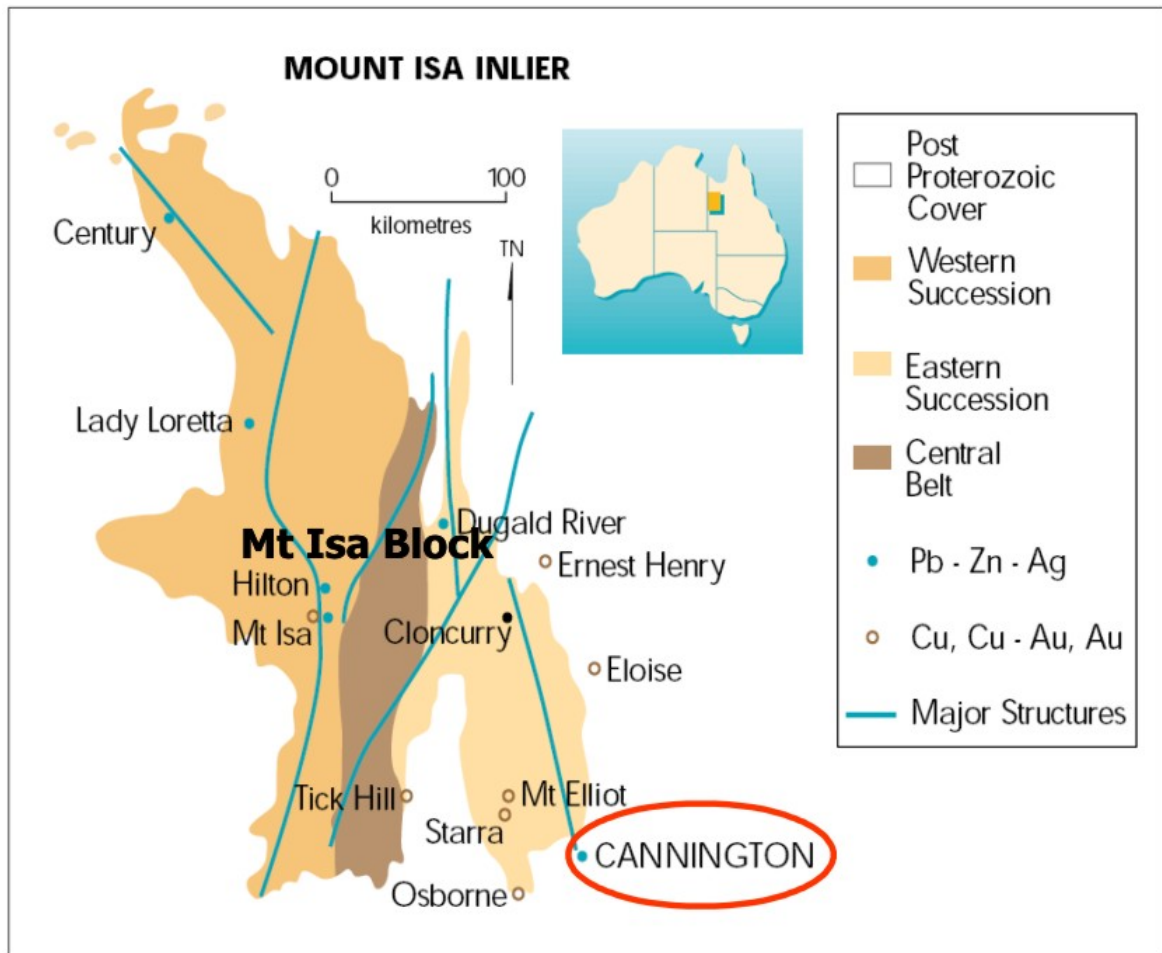


Figure 1. Location of the Cannington mine in relation to Mt Isa inlier geology and other mineral deposits.

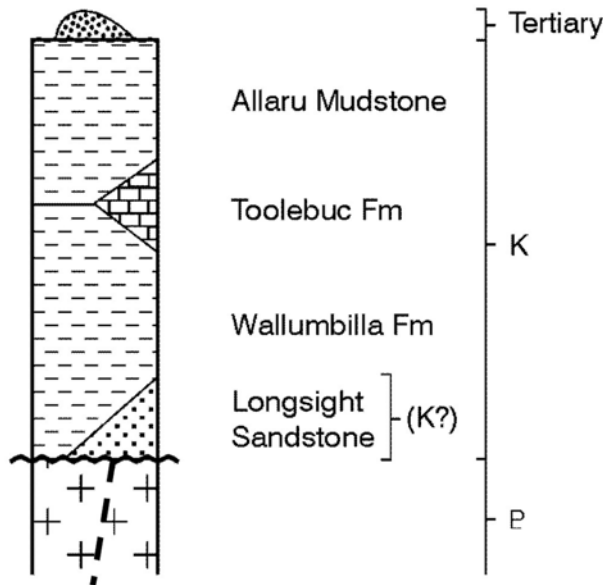


Figure 2. Stratigraphic column showing the fractured Proterozoic crystalline basement (P) overlain by Cretaceous (K) and Tertiary cover units.

METHODS

Groundwater samples were collected from 24 bores over a ~50 x 100 km area, plus one from a seep in the underground mine (Figure 3). Alkalinity, pH, electrical conductivity, temperature, dissolved oxygen and Eh were determined in the field. The samples were prepared and analysed for major dissolved anions and cations, trace elements and stable isotopes of O, H, C and S, using Ion Chromatography (IC), Inductively Coupled Plasma-Emission Spectrometry (ICP-ES), Inductively Coupled Plasma-Mass Spectrometry (ICP-MS) and various Mass Spectrometric methods (isotopes).

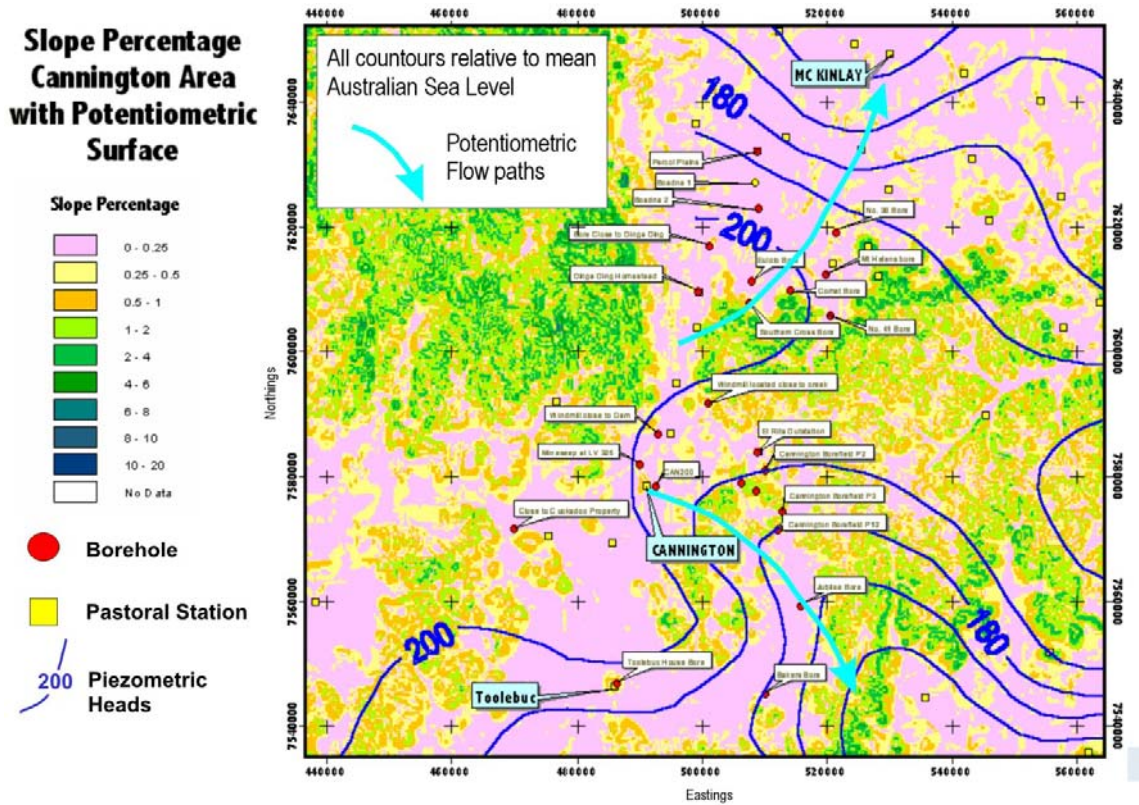


Figure 3. Location of groundwater samples in relation to slope percentage (background) and piezometric heads (contours, in m).

RESULTS & DISCUSSION

The groundwaters are fresh to brackish (total dissolved solids = 670 to 2120 mg/L), circum-neutral to alkaline (pH = 6.6 to 8.4) and warm ($T = 27$ to 48 °C). Two end-member sub-groups are recognised representing groundwaters (1) from the fractured Proterozoic bedrock (FPB) and (2) from porous and fractured Mesozoic (Cretaceous) aquifers of the GAB. The FPB groundwaters tend to be brackish, cool and Na-Cl dominated, whereas the GAB groundwaters typically are fresher, warmer and Na-HCO₃⁻ dominated (Figure 4). A third sub-group of intermediate composition represents mixing between these two end-member waters (Figure 4).

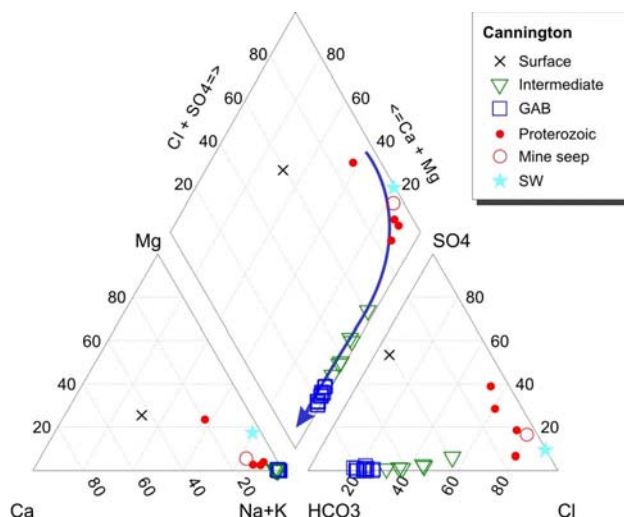


Figure 4. Piper plot showing the distinct character of groundwaters from the Proterozoic aquifer compared to those from the GAB, as well as the mixing relationship that occurs along the groundwater flow path (SW: seawater).

Evaporation and evapotranspiration have occurred to a relatively limited extent, as shown by $\delta^{18}\text{O}$, δD and Cl systematics. A number of trace element distributions as well as the stable isotopes suggest interaction between groundwater and minerals in the Proterozoic basement and the GAB aquifer(s). Elevated F⁻ concentrations delineate the western margin of the Eromanga basin and appear to be controlled by the solubility of fluorite, a common gangue mineral at Cannington. The dissolved concentrations of ore element (e.g., Pb, Zn) are low due to the stability of solid phases under the prevailing Eh-pH conditions and adsorption onto Fe-oxyhydroxides. Other elements indicate interaction with felsic rocks either in the fractured aquifer or in the basal Longsight sandstone (B, Mo, W). Bacterial sulfate reduction is inferred to have taken place for those samples with very low SO₄²⁻ concentrations and elevated S-isotope values. The low S-isotope values and elevated SO₄²⁻/Cl⁻ ratios of some samples indicate that they may have interacted with the sulfide mineralisation itself and are potential hydrogeochemical tracers for exploration through cover here.

CONCLUSIONS

The hydrogeochemical investigation of groundwaters from the Cannington mine area indicates that the following processes have taken place: mixing; evaporation and evapotranspiration; water-rock interaction (fluorite dissolution, dissolution of minerals from granites/pegmatites, sulfide oxidation); bacterial sulfate reduction; and, adsorption of trace metals onto Fe-oxyhydroxide surfaces.

The implications for mineral exploration in the area (and possibly extended to similar settings elsewhere) are that:

1. Elevated trace metal concentrations in groundwater are not likely to occur;
2. The fluoride anomaly indicates gangue mineral fluorite in Proterozoic bedrock or basal sediments sourced from it; and,
3. Low $\delta^{34}\text{S}$ concomitant with high SO₄²⁻/Cl⁻ ratios are the best indicators of mineralisation.