Sources of fluoride in groundwater in north Queensland

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Groundwater in some parts of north Queensland contains a high proportion of fluoride, which makes it unsuitable for domestic and stock water supplies. High fluoride content in otherwise potable, good-quality groundwater poses a similar problem in other parts of Australia — including portions of the arid zone in central Australia, and regions of the Great Artesian Basin. However, the sources of the fluoride in most areas remain a mystery.

Analyses of recently acquired groundwater samples in Cape York has detailed the concentration and distribution of the fluoride content. They have confirmed that high fluoride values are widespread in the Mesozoic aquifers of the Carpentaria Basin, are less extensive in the overlying Cainozoic aquifers of the Karumba Basin, and are present in some exposed pre-Mesozoic basement rocks. However, even in the Mesozoic aquifers of Cape York Peninsula, there are still too few deep water-bores to define specific haloes and sources. Groundwater in a high proportion of the water-bores contains more than 1 mg L⁻¹ fluoride (Fig. 24).

Regional geological mapping of outcrops of Permian-Carboniferous volcanic and intrusive rocks of the North Queensland Igneous Province has shown that some of these rocks, notably those of A-type chemistry, are very fluorine-rich compared with the older basement rocks. Fluorine is present in minerals such as fluorite, topaz, apatite, biotite, and some amphiboles; some of these minerals (notably topaz and fluorite) also occupy fluid or vapour cavities. Vein deposits extremely rich in fluorite are locally concentrated adjacent to some of the A-type volcanic-intrusive complexes. The comagmatic volcanic counterparts of the intrusive rocks generally contain less fluorine because it is both lost with the vapour phase during eruption and removed by circulating fluids during compaction, welding, and subaerial exposure. Even so, any fluorine present in a volcanic pile, especially that in fluorite, will be more accessible to groundwater than that in intrusives because of the much higher permeability of rocks such as tuffs and unwelded ignimbrites. We therefore consider that Permian–Carboniferous igneous rocks,

Fig. 24. Sources of fluoride in Cape York Peninsula, and groundwater flow in the Mesozoic aquifer (section A–B).

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Further constraints on sequence stratigraphic correlations in the Mount Isa, McNamara, and McArthur Groups

The Shady Bore Quartzite–Riversleigh Siltstone transition in the ‘NABRE’-hood of Riversleigh, northwest Queensland

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AGSO and Geological Survey of Queensland personnel examined relationships between igneous rocks and phases of basin development, and measured composite sequence stratigraphic sections, in the following stratigraphic units and areas during the 1996 NABRE (‘North Australian basins resource evaluation’) project field season, which lasted from late May until early September:
- Mount Isa Group at Crystal Creek, Paroo Range, and Mount Isa Valley;
- Lower McNamara Group at Gunpowder, Paradise Creek, Police Creek, Barr Hole, and Cararra Range;
- Upper McNamara Group at Lawn Hill, Riversleigh, Musselbrook, Bowthorn, and Cararra Range;
- Fickling Group along the southern flank of the Murphy Inlier;
- McArthur Group (through the Tatoola and Stretton Sandstones, Myrtle Shale, and Emmerguga Dolomite) near Cape Crawford; and
- Nathan Group near Cape Crawford.

A major objective of the field season was to constrain the chronostatigraphic surface that coincided with the onset of deformation associated with the hairpin bend (1640 Ma) on the apparent polar-wander path (APWP). On the APWP of Loutit et al. (1994: in ‘Australian mining looks north — the challenges and choices’, 1994 AusIMM Annual Conference, Darwin, 5-9 August 1994, technical program proceedings, 123–128), this inflection point coincides with magnetic overprint OP2, and probably represents a period of major change in relative plate motion. The unconformity surface was successfully located on top of the Emmerguga Dolomite at a locality 22 km northeast of Cape Crawford. Here, several metres of local relief, and carbonate conglomerate and breccia, mark the surface. Carbonate rocks of the overlying Teena Dolomite contain quartz sand, in marked contrast to the underlying recrystallised dolostones which lack terrigeneous components.

Sequence stratigraphic correlations in the highly prospective Shady Bore Quartzite–Riversleigh Siltstone transition

The NABRE project is developing a regional sequence stratigraphic and structural framework to improve mineral exploration in northern Australia. The recent field season focused attention on the sequence stratigraphy of the transition zone from the Shady Bore Quartzite to the Riversleigh Siltstone (upper McNamara Group) in the area 10 km southeast of Riversleigh homestead, northern Mount Isa. This zone hosts the Grevillea prospect (Coolgardie Gold), and is highly prospective for lead-zinc-silver deposits in black shale of the Palaeoproterozoic lower Riversleigh Siltstone. We use an example from the early results of our 1996 fieldwork to highlight the importance of precise sequence stratigraphic correlations for developing successful mineral plays.

We compare a 450-m section from southernmost Riversleigh, in the Lawn Hill 1:100 000 Sheet (GR 0271910, 783416; Fig. 26A), with a composite section of 730 m from four sites 5 km farther north (GR 0269765, 7889015; Fig. 26B). The effects of a major marine transgression from and A-type volcanic rocks in particular, are the most likely sources of fluoride in north Queensland groundwater.

Where available, gravity and magnetic information has facilitated the mapping of concealed Permian–Carboniferous intrusives and volcanic piles in Cape York Peninsula (Fig. 24). The characteristic signature of these bodies is a circular magnetic anomaly superimposed on a gravity low. Circular magnetic anomalies of this type also have been recently recognised beneath the Millungera–Savannah Downs fluoride anomaly in the southern Carpentaria Basin. Earlier drilling of this circular structure has revealed the presence of an A-type granite, typical of those found in the North Queensland Igneous Province (Fig. 25). We suggest that the association between high-fluoride groundwater, Permian–Carboniferous igneous rocks, and concealed circular magnetic anomalies is a feature common throughout north Queensland, and it should be possible to reduce fluoride risk by using this understanding in the siting of new water-bores.

Fig. 25. Sources of fluoride in groundwater in the Millungera–Savannah Downs area in the southern Carpentaria Basin (after Queensland Metals Corporation NL, unpublished reports). A key to the symbols is presented in Fig. 24.