Occurrence of acidic and arsenic-rich groundwater in suburban Perth, Western Australia

Ron Watkins[1], John Angeloni[1], Bobak Willis-Jones[1] and Steve Appleyard[2]

[1] EIGG, Department of Applied Geology, Curtin University of Technology
[2] Waters and Rivers Commission of Western Australia

The Swan Coastal Plain, on which the City of Perth (pop. 1.32 million) is situated, is formed of aeolian sands of Pleistocene-Recent age. The mainly unconsolidated sediments build a series of dune lines paralleling the coastline. The near-surface water-table sees expression in numerous shallow freshwater lakes and marshes in the interdunal depressions. The sands are highly permeable, and >70% of the city's total water supply is derived from this local aquifer. The uppermost zone of the groundwater is exploited by innumerable shallow bores for residential gardens and parklands.

Localised incidences of highly acidic groundwater have been reported in the past in the Perth region. However, the true extent of the environmental threat posed by the occurrence of inland acid-sulphate soils has only recently been realized. The ultimate sources of the groundwater acidity are lenses of pyritic, organic-rich sediment (peat and peaty-sand) interbedded with the sands. These result from the previous occupation of inter-dune hollows by wetlands and, possibly, estuarine and coastal brackish water embayments. The shallow depth of the peat deposits results in a change from saturated to unsaturated condition with lowering of the water-table. Resulting rapid oxidation of the pyrite, together with subsequent metal hydrolysis, has given rise locally to highly acidic groundwater in the uppermost part of the aquifer.

The present manifestation of groundwater acidification and metal contamination in two neighbouring areas in the northern suburbs of Perth well illustrates the combined influences of human activity (urban development) and climatic variation. In one area, the acidic and contaminated groundwater became manifest as a result of destruction of lawns and garden vegetables through irrigation from domestic bores. The uppermost zone of groundwater had pH as low as 2.1 and was especially contaminated with arsenic (900 μg/L) and selenium (19 μg/L), although soluble aluminium (up to 135 mg/L) was probably most damaging to plants. The excavation of peat deposits during the construction of two small, shallow recreational lakes was likely a factor in the acidification. However, it is most probable that a sequence of low-rainfall winters and resulting increased use of domestic bores resulted in a lowering of the water-table effecting oxidation of a shallow body of peat.

In the neighbouring area, urban development is manifestly influential in the development of acidic groundwater. Here, an area of marsh has been reclaimed for the construction of housing. Both the surface stockpiling of excavated peat and the temporary dewatering of the site to enable the building of foundations have exposed substantial quantities of pyrite to atmospheric oxidation.

Recently instated countermeasures have included the monthly liming of the lakes to raise pH and the better management and removal of peat stockpiles. The current groundwater contamination affects a limited area of <20 km^2 and is restricted to the upper 1-3 metres of the aquifer. However, it is of importance in highlighting a potentially more extensive environmental problem relating to inland acid-sulphate soils, since similar peat deposits are widespread throughout the Swan Coastal Plain. The very low acid-buffering capacity of the sands and the paucity of mineral components offering absorption of metals, results in a significant threat that the generation of acidic and contaminated water at the top of the aquifer could lead to more profound contamination of the groundwater resources below Perth and of environmentally sensitive wetlands.