

## SEVEN WONDERS OF THE HYDROGEOLOGICAL WORLD

### MIOCENE WINE GLASS AQUIFERS OF THE ELLENDALE DIAMOND FIELD THE KIMBERLEY REGION OF WESTERN AUSTRALIA

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***Why is this story a wonder?** The way that the “wine glass aquifer” host rocks formed – volcanic pipes erupting through a large sedimentary aquifer.*

***What is unique about these aquifers?** Hydrogeologists frequently use the term “leaky bathtub aquifer”. The Miocene wine glass aquifers are the perfect example of a leaky bathtub with rapid wet season recharge gradually draining into the surrounding Grant aquifer through a cracked eggshell (fractured quartzite rim). Dewatering of the Ellendale 4 pipe for diamond mining has resulted in a reversal of the hydraulic gradient with large inflows into the pit.*

#### WINE GLASS AQUIFERS

During the Miocene epoch over 150 volcanic pipes erupted in the West Kimberley Province; about fifty of these intruded Permian and older sediments, collectively forming the Ellendale Diamond Field.

The volcanic pipes are generally carrot-shaped at depth, but near the surface they frequently erupt outwards with the uppermost section forming a “wine glass” shaped structure. During the eruptive events which occurred 18 to 20 years ago, the sediments were super-heated and then, as they cooled, the sandstone adjoining the pipes recrystallised to form a hard quartzite rim, which commonly form an aquiclude. The surrounding sandstone of the Grant Group is moderately to highly permeable, with hydraulic conductivities ranging from 12 to 20 m/d.

Many of the pipes consist of magmatic lamproite cores with tuffaceous lamproite margins. The diamonds are mainly found within the tuff, which can be vuggy, and where calcified, moderately permeable. Streams and high rainfall runoff during the wet season recharge the tuffaceous lamproite forming low salinity aquifers. In many pipes, the lamproite has been fractured and calcretised near the surface and calcified at depth. Calcium rich groundwater originating from the nearby Devonian limestone rocks can infiltrate the tuff forming calcrete near the surface. The weathering of magmatic minerals such as diopside (calcium-magnesium pyroxene), which forms in the fine-grained groundmass under rapid cooling conditions (i.e. along chilled margins), may have contributed to calcification.

Mining of the diamond-bearing pipes has required dewatering of the wine glass aquifers. The superficial aquifer water levels were initially tens of metres above the water levels in

the underlying Grant aquifer. Tuffaceous ore, magmatic lamproite waste and part of the quartzite rim have been removed by mining and water levels in the pipes have been lowered by pumping from in-pit sumps and bores. This has resulted in a reversal of the hydraulic gradient and large inflows of groundwater from the Grant aquifer back into the pit, requiring some innovative dewatering strategies.

### GEOLOGICAL CROSS SECTION NORTHERN CANNING BASIN/KIMBERLEY CRATON SHOWING MIOCENE WINE GLASS AQUIFERS

