SEVEN WONDERS OF THE HYDROGEOLOGICAL WORLD CANNING BASIN

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The Canning Basin of Western Australia is a magnificent hydrogeological entity, representing Australia's second largest sedimentary basin (after the Great Artesian Basin) and containing a fascinating ensemble of extensive aquifers and doubtlessly large volumes of groundwater beneath the Great Sandy Desert. The underexplored, pericratonic Early Ordovician to Early Cretaceous Canning Basin occupies about 506,000 km², of which 430,000 km² are onshore. It has a maximum sediment thickness of over 15,000 metres concentrated in two NW trending depocentres. The northernmost of these is the Fitzroy Trough-Gregory Sub-basin complex, while the southernmost is the Willara Sub-basin-Kidson Sub-basin complex¹. The Canning Basin is also exceptional because of the unique cultural history and significance to remote desert dwellers and early settlers. The latter is well-represented along the Canning Stock Route where an unusual variety of aquifers supply natural wells and watering points.

Five phases of geologic evolution are recognised in the basin, from the Early Ordovician onwards. Of these, perhaps the fifth is the most significant in terms of deposition of sediments that now function as aquifers in the upper strata: marked by renewed extension and rapid subsidence, coinciding with the onset of glacial conditions in the Early Permian and incorporates a sag stage with widespread marine transgression following the glaciation. The final tectonic phase was triggered by regional dextral wrench movements in the Late Triassic - Early Jurassic when up to 3 km of uplift and erosion occurred, accompanied by extensive molasse deposition. This was followed by deposition of fluvio-deltaic and marine sediments. Thus, the most significant aquifers are the Cretaceous Callawa Fm and Anketell Sandstone, the Triassic Erskine Sandstone, and the Permian Grant Group strata, each interspersed with shale aquicludes.

The most interesting Canning aquifers include the following, although these are not necessarily the most important in terms of quantities and quality of stored waters, but merely examples of distinctive scenarios where the geology and hydrogeologic scope, extent and characteristics are a source of wonder (selected photographs and figures follow):

- Permian glaciogenic Paterson Formation palaeovalley aquifers, incised into Proterozoic bedrock at the edges of the basin;
- Permian Triwhite Sandstone, groundwaters from which emerge as springs in the Percival Lakes chain across the basin, sustaining Punmu and other isolated inhabitants and unique ecological habitats;
- Distinctive shallow aquifers including (silicified?) karstic calcrete, representing many of the Canning Stock Route wells, and rock waterholes whose connectivity with deeper aquifers and geologic structures is unknown.

Although limited data from current investigations by Geoscience Australia's Groundwater Group² indicates the widespread presence of palaeowaters, the region nonetheless is subject to relatively common cyclonic incursions associated with the northern monsoon system and is episodically inundated and a well-watered desert environment, suggesting some recharge of shallower aquifers is likely.

¹Geoscience Australia: <u>http://www.ga.gov.au/oceans/ea_OnsCanning.jsp</u>

² <u>http://www.nwc.gov.au/www/html/538-water-for-arid-zonepalaeovalley-groundwater-resources.asp?intSiteID=1</u>



Image from Geoscience Australia



The four main sub-basins of the Canning Basin: The Fitzroy/Gregory Basin (up to 15 kilometers of section); Kidson Basin has thinner section (4 to 5 kms) Broome Platform; Willara Basin. Image from Buru Energy Ltd: <u>http://www.buruenergy.com.au/files/Image/canning-geology-large.jpg</u>





Palaeovalley conceptual model for the Permian Triwhite Sandstone where the Percival Palaeoriver has incised through Mesozoic sediments to the aquifer, from which groundwater is discharging into the valley (English, 2010).



Groundwater discharging at a exploration drill-hole near Lake Waukarlycarly, Canning Basin, possibly from the Triwhite Sandstone aquifer, obscured in dunefields, creating a local oasis for camels (P. English).



Mesozoic strata typical of the Canning Basin (P. English)



Polished glaciogenic striae on the Archean-Proterozoic Pinjin Chert, Carrawine Gorge, legacy of Permian deglaciation from the Pilbara ice Cap. Glacial scouring of palaeovalleys in crystalline bedrock and deposition of Permian fluvioglacial sediments, the Paterson Formation, represent a distinctive aquifer system in the edges of the Canning Basin (P. English).



Airborne Electromagnetic (AEM) data for part of the Paterson Province at the edge of the Canning Basin. Permian Paterson Formation outcrops shown overlain in purple, and buried extents revealed as higher conductivity palaeovalleys inset into resistive crystalline bedrock, in an area where palaeovalley groundwater is sought to support mining activity (English, 2010).



Cenozoic Oakover Formation near Carawine Gorge, Oakover River, Pilbara, at the edge of the Canning Basin (P. English)



Palaeovalley network in the central Canning Basin, along part of the Canning Stock Route, revealed beneath dense dunes of the Great Sandy Desert using a modified high-resolution Digital Elevation Model. The sparse outcrops of key lithological units are shown (P. English, 2010).



Well 26. Tiwa Well, Canning Stock Route (P. English)



Canning landscape (P. English)



Typical trajectory of cyclonic incursions into the Canning Basin, episodically replenishing shallow aquifers (Bureau of Meteorology, 2009).