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Hydrostratigraphy and Groundwater Flow of the Deep Aquifers of the northern Canning Basin, Western Australia

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The Canning Basin is a deep, intra-cratonic sedimentary basin in the semi-arid north of Western Australia. It is situated in a remote and poorly to moderately explored region with potential sources of both conventional and unconventional hydrocarbons. Also parts of the basin are currently being considered for large-scale agricultural developments. Since the 1950s the majority of the geoscientific studies have focussed on petroleum resources, mostly in the northern sub-basins. Regional studies conducted since 1980 describe the geological evolution, regional geology, groundwater resource potential of shallow aquifers, depositional sequences, and tectonic framework of the basin with only cursory basin-wide hydrogeological investigations of the deep aquifers. These investigations do not address the need for dependable numerical modelling of the groundwater flow system that could reliably predict aquifer responses to changes in groundwater demand, and sustainable yields and to guide development. The need for a quantitative description of the groundwater system has become critical with increasing interest in the resources of the basin since 2003.

This study represents a comprehensive regional investigation into the hydrogeology of the Lower Permian and deeper sedimentary units of the northern Canning Basin. Geophysical techniques, including mapping seismic horizons tied to petroleum wells with wireline geophysical logs, were used to delineate hydrostratigraphic units. Hydraulic parameters were estimated through analyses of several sources of hydrogeological properties including core analyses, gamma ray and neutron porosity logs. A novel method of calculating hydraulic heads by converting pressure readings from petroleum exploration drill stem tests into fresh-water equivalent heads was used to determine hydraulic gradients and groundwater flow directions. The hydrostratigraphic and piezometric head information were integrated to form a first conceptual hydrogeological model of the basin and used to underpin the construction of a large-scale numerical groundwater flow model for the northern basin.

Four deep, generally confined aquifers were designated. The hydrostratigraphic units show significant lateral variations with some confining layers being locally absent, thus providing hydraulic connectivity between aquifers. The partially connected, relatively shallow Grant and Poole Aquifers were identified to be the most significant aquifers in the basin due to their combined areal extent, relatively shallow depths, and interaction with shallow groundwater and surface water. The combined aquifers store 1.2 x 1013 m3 of water with a total discharge of 630 000 m3/day. Groundwater flow in the deep aquifers occurs generally towards the north western coast, but is locally influenced by areas of direct recharge and by vertical fluxes between aquifers. The numerical model was used to explore local and basin-wide responses to changes in climatic/hydrological drivers such as recharge and large-scale abstraction for agricultural purposes.