Groundwater Resource Assessment in Outback Australia – Going from the Local to the Regional Scale using Airborne Hydrogeophysical Methods

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Australia's sustained economic growth and development over the past decade has been accompanied by an increased demand for water, particularly groundwater. This demand was exacerbated by widespread drought, particularly across the southern part of Australia which was only broken last year. Drivers for that demand include new industries, new mines, the need to secure urban and regional water supply, environmental protection and a requirement to secure and develop the Australia's agricultural base. As an example, in Western Australia alone, total water demand in WA is anticipated to increase at a rate of 4% per year, from 2500 gigalitres per year in 2009 to 3820GL per year by 2020, with growth in demand from the minerals and energy sectors likely to reach 422 GL/year by 2015. Given that WA's surface water resources are limited, demand is being met in large part by accessing its groundwater resources, detail about which, for many parts of the State, we know relatively little. These knowledge gaps are mirrored in other states including South Australia, the Northern Territory, and Queensland.

Airborne geophysical methods have a demonstrated role to play in groundwater resource assessment by assisting in both groundwater and aquifer characterisation most notably in, but not limited to, data-poor areas. We are now witnessing a marked increase in their deployment to help assess our resources, particularly in outback regions of Asutralia, where the paucity of information on groundwater is most marked. Both government and industry are driving the innovative application of airborne geophysics, with particular emphasis on airborne electromagnetics (AEM), with the two working at different scales. When undertaking water resource investigations for particular mines, the mining industry and affiliated consultants, commonly employ local-, but not necessarily fine-scale, studies using AEM data as part of their tool box. This knowledge can complement, and inform broader, regional-scale groundwater assessments which are commonly the remit of State government agencies. With reference to an example from the Murchison region of Western Australia, an approach that could use AEM to aid the scaling-up from a local to watershed-scale hydrogeological framework for groundwater assessment is examined.

The Murchison region has been identified as one of West Australia's strategic groundwater investigation areas, in part to meet the demand from a burgeoning iron-ore mining sector, but also to maintain water supplies to pastoralists and local townships. In part, this demand is likely to be met by tapping groundwater in an extensive suite of palaeovalley aquifers that cross the region. Despite their recognised importance, the hydrogeology of these systems is poorly understood, save for local investigations, as is their regional extent and the quality of the groundwater they contain. Local scale studies, linked to water resource investigations around the Jack Hills iron-ore mine, have used low resolution surveys undertaken by helicopter TDEM (REPTEM and X-TEM) systems to define the extent of the thickest part of the palaeovalley systems located in close proximity to the mine (Figure 1). These studies have also been complemented by ground gravity surveys to demark the deepest sections of the palaeovalleys as an aid to constraining local groundwater models. These small scale AEM surveys have helped demonstrate the potential of AEM to elucidate the regional scale resource, given the use of appropriate technologies.

The WA Department of Water (DoW) has recognised this potential and is progressing the design of a watershed-scale AEM survey. However, the challenge has been to maximise the potential information content acquired by the AEM data, within a limited budget, without compromising the ability to guide appropriate follow-up ground investigations that will define aquifer character, groundwater quality and aquifer yield. Recent investigations by Geoscience Australia have demonstrated the value of the MrVBV algorithm in helping define the contemporary trunk valleys, within which the palaeovalleys are located, of the Murchison region. We have employed the results in helping the DoW define an optimal approach to AEM data acquisition across the whole catchment, an approach which maximises the resolution of data acquired within these valleys, at the expense of coverage over adjacent areas of subcropping or outcropping granite-greenstone lithologies which have very limited water resource potential (Figure 2). For the same budget, which could provide approximately 8200 line kms of AEM data, this approach provides for a data set with ~4km line spacing, as opposed to ~ 8kms spacing if the whole catchment was treated uniformly.

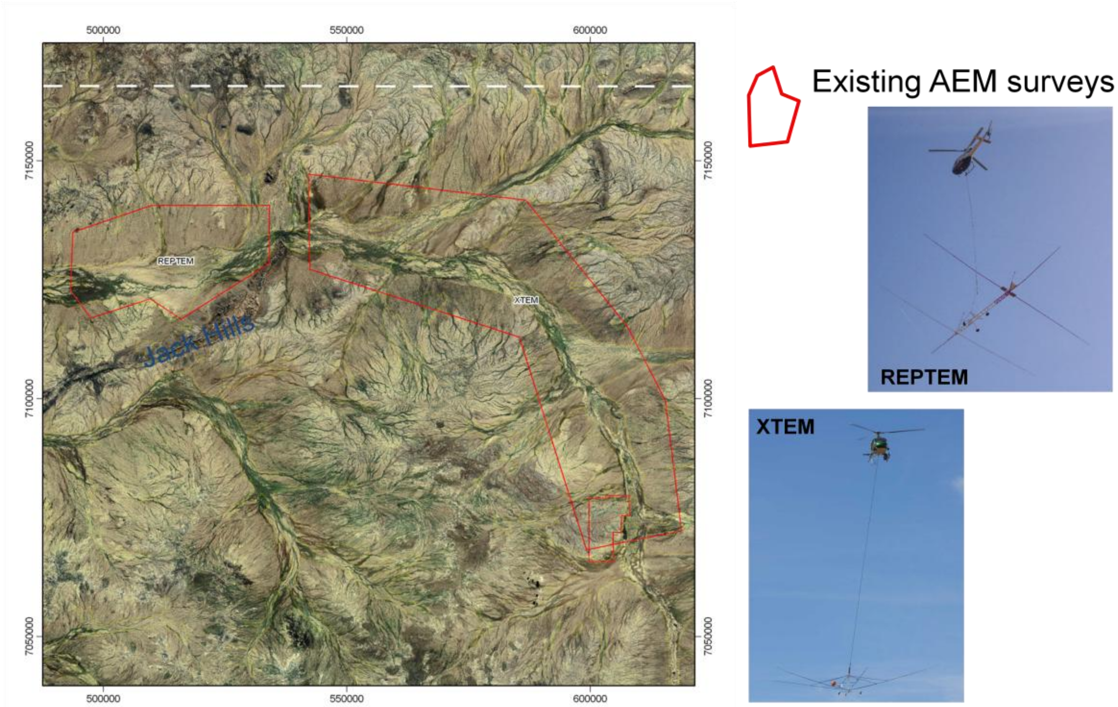

Figure 1: Local scale AEM surveys undertaken around the Jack Hills mine in the northern part of the Murchison Province

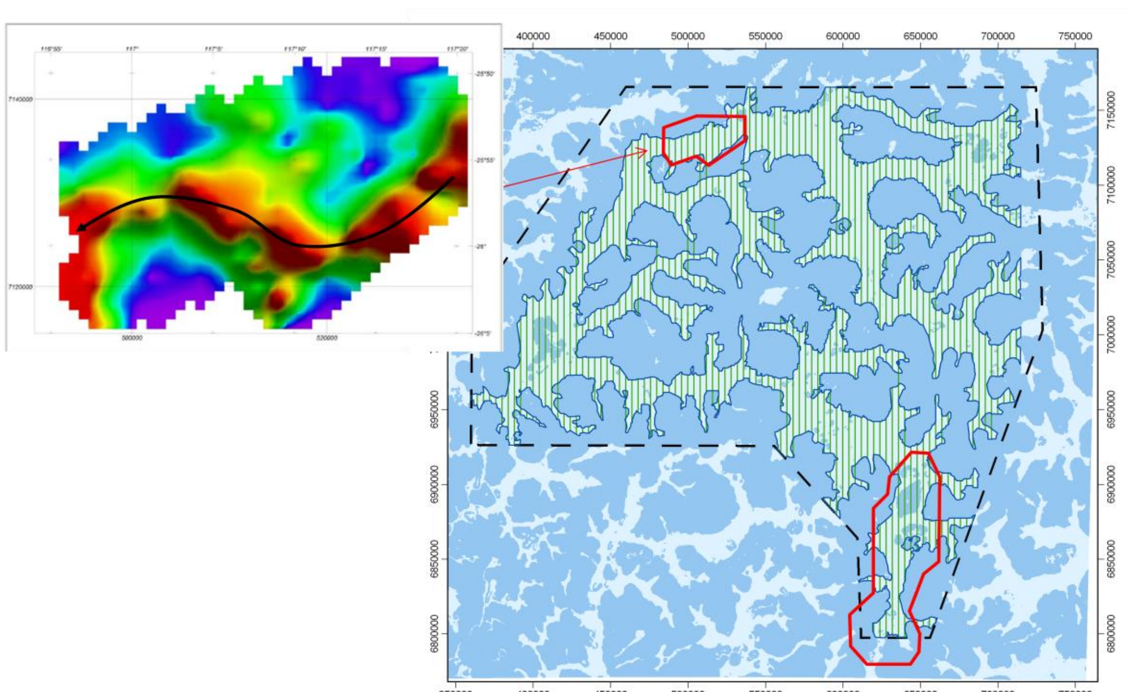

Figure 2: Interval conductivity image form a local scale REPTEM survey (top left), with proposed watershed-scale AEM survey flight line diagram targeting low-flat areas (defined by a multiresolution index of valley bottom flatness – Gallant and Dowling 2003) in the landscape, areas which host the palaeovalley sedimentary systems. This targeted survey approach maximises survey resolution for a given budget, over the region's main groundwater systems, and in this case would generate data with ~ 4km line spacing for ~8200 line kms, as distinct from a resolution of 8km if the whole catchment was covered. Other local surveys acquired for mineral exploration purposes (see red polygon in bottom left) could supplement any newly acquired data.