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Integrating experimental petrophysical studies with field studies to produce semi-quantitative 3D products from airborne electromagnetic (AEM) data

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In Australia's low relief depositional landscapes, groundwater and salinity dynamics are influenced strongly by the physical properties of regolith materials, the connectivity of aquifers (and aquicludes) and hydraulic gradients, in addition to climate (and palaeo-climate) considerations and anthropogenic influences. In Australia, a multi-disciplinary systems approach has been developed to map and assess salinity hazards and assist with the quantification of groundwater resources in a range of complex buried regolith landscapes. However, until recently these studies have been limited to qualitative interpretations due in part to a lack of reliable data on the movement of salts and pore fluids at a range of scales in representative regolith materials.

This study shows the results of an approach that integrates experimental petrophysical studies and laboratory analysis of pore fluids and regolith textures, with studies of landscape evolution to produce semi-quantitative 3D products from airborne electromagnetic (AEM) data. The study area is in the Bland Basin, New South Wales.

A study of landscape evolution in the area shows that the regolith sequence comprises up to 75 m of alluvial and colluvial sediments overlying variably thick weathered bedrock (up to 100m thick). Textural analysis and permeability experiments were carried out on drilled cores and cuttings. The majority of sediments were found to have very low permeabilities on account of the primary mud content and clays formed during weathering. Pump tests confirm very poor hydraulic connectivity over relatively short distances.

This textural and permeability data have been used to produce pseudo-coloured depth interval and 3D images, modified from standard AEM inversion models. These images provide a semi-quantitative 3D picture of regolith architecture and groundwater and salinity distribution, and provide a framework for more detailed process studies as well as more rigorous assessments of salinity hazard and risk.

This approach has been used to demonstrate that groundwater flows in the study area are sluggish, and the low permeable materials act as a natural store for the saline pore fluids. Given the current climatic conditions, salinity hazard in the study area is thought to be low despite the presence of relatively shallow saline groundwaters.