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Influence of geology, regolith and soil on fluid flow pathways in an upland catchment in central NSW, Australia

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The diversity of salt expression in central NSW has defied classification because salt expression, mobilisation and transport is highly variable and is typically site specific. Hydrological models are extensively used to simulate possible outcomes for a range of land use changes to mitigate the mobilisation and transport of salt into the streams or across the land surface. The ability of these models to mimic reality can be variable thereby reducing the confidence in the models outputs and uptake of strategic management changes by the community.

This study focuses on a 250 ha semi-arid sub-catchment of Little River catchment in central west NSW in the Murray-Darling Basin, Australia. We propose that an understanding the structure of the landforms and configuration of rock, regolith and soil materials at the study site influences fluid flow pathways in the landscape and can be related to observed variations in the chemical composition and salinity of surface and aquifer water.

Preliminary geological mapping of the site identified the dominant rock type as a pink and grey dacite and in localised mid-slope areas, a coarsely crystalline biotite-phyric granodiorite. Samples were taken at regular intervals from natural exposures in eroded stream banks and in excavations made during the installation of neutron moisture meter tubes. In order to establish mineral weathering pathways, samples were taken from the relatively unweathered core to the outer weathered 'onion skins' of corestones on both substrates, and then up through the regolith profile, including the soil zone, to the land surface. X-ray diffraction (XRD) analysis and X-ray fluorescence (XRF) was conducted on the rock and soil/saprock samples. Electromagnetic induction (EMI) profile data were compiled from previous work with colleagues in this area.

Preliminary interpretation of the mapping and the geophysics is that there is a three-layer framework for groundwater modelling: fractured granitic rock with an irregular upper surface, finer-grained (volcanic) rock that has either mantled the older granite or has been intruded into, and a weathering profile developed in relation to the land surface. More careful interpretation of the intervals that shallow and deep piezometers and shallow and deep bores are sampling indicates that variability in water chemistry between holes can, in part, be explained because they are sampling different materials in the sub-surface geology/regolith geology.

Quartz is a relatively resistant phase throughout the profiles. For both substrates there is a decrease in the feldspar in increasingly weathered regolith materials, with a corresponding increase in kaolinite clay. There is increased homogenisation of the profile, and some horizonation due to pedogenic processes (e.g. bioturbation, illuviation of fines down profile) nearer the land surface. This results in a concentration of more resistant phases (quartz and remnant primary feldspar as sands) at the land surface over the granitic substrate, however kaolinite persists in the profile over the finer substrate. The presence of measurable ferruginous oxides and sesquioxides relates to localised percolation of oxidising fluids through the profiles. Understanding the configuration and composition of rocks and regolith materials in the Baldry catchment facilitates interpretation of observed patterns in hydrological analyses.