A NEW REGOLITH/GEOLOGY/LANDFORM FRAMEWORK FOR HYDROGEOLOGICAL INVESTIGATIONS IN THE ANGAS BREMER PLAINS AREA, SA

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Airborne electromagnetic, magnetic and radiometric surveys of the Angas-Bremer Plains area (southwest Murray Basin, adjacent to Lake Alexandrina, Figures 1, 2), were flown in mid 2002 as one of the National Action Plan for Salinity and Water Quality study areas in South Australia. This is a prime agricultural area (wine grapes, lucerne and dairy) that relies on irrigation because of low rainfall, but has groundwater problems related to salinisation of high production aquifers and rising shallow saline water tables. The surveys were specifically aimed at improving the understanding of groundwater, particularly whether there are as yet unknown areas of good quality groundwater, and whether there are areas where shallow groundwater is contained within palaeochannel gravels which may be pumped to provide an engineering solution to the problems caused by shallow saline water tables. Part of the work being done under the National Action Plan for Salinity and Water Quality (NAP) in the area includes new investigation of the landscape, regolith and geological history, incorporating interpretation of the new geophysics, and new ground investigations. These studies and new CRC LEME hydrochemistry studies aimed at determining recharge mechanisms will provide a basis for new upgraded hydrogeological modelling.

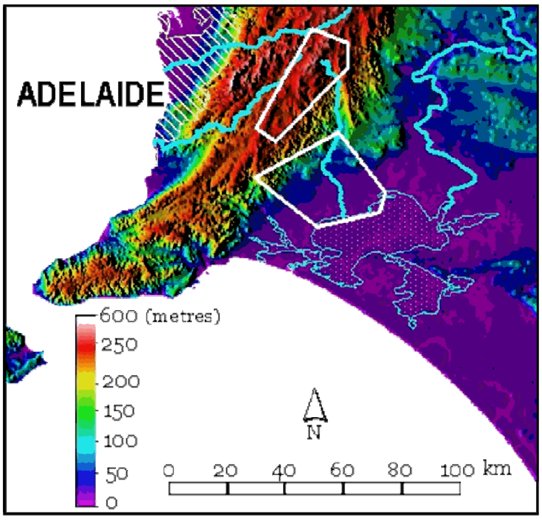

Figure 1: Nine second DEM of the region, showing location of the Angas Bremer Plains study area in the lower white box.

To better understand the regolith, geology and landscape of the area, investigations have included:

- Ground investigations of soils, sediments and basement rocks
- Detailed study of new DEMs of the area acquired during geophysical flying, including the inter-relationships between radiometric response and landform
- Study of the radiometric response of various materials
- Interpretation of the AEM data, as depth slices, elevation slices and cross-sections
- Ground geophysics (ground EM and wireline logging of boreholes)
- Project drilling at 11 sites (including construction of 6 piezometers)
- Gathering and interpretation of information from >500 water and mineral exploration drillholes

The basic geometry of the geology/regolith framework of the main area of irrigation on the Angas-Bremer alluvial plain is well known. A 20-40 m thick sequence of Quaternary muddy alluvial sediments overlies Eocene to Miocene calcarenites, sands and clays of the Murray Basin. The calcarenite has high porosity and permeability, and is a source of good quality groundwater beneath much of the alluvial plain. The overlying alluvial sediments contain generally poor quality groundwater (locally in sandy beds that form local aquifers), and form a leaky confining layer over the limestone. Prior overproduction from the limestone has resulted in drawdown of salty water from the alluvial sediments into the limestone, and lateral inflow of salty water from areas of the aquifer away from the alluvial plain. The water table in the alluvial sediments is locally very close to the surface, thus there needs to be a fine balance between irrigation (now largely with water pumped from nearby Lake Alexandrina) and recharge to the shallow water table by deep drainage from irrigation. The groundwater situation is further complicated by the use of recharge wells to divert flood water from the rivers into the deeper limestone aquifer.

The Angas and Bremer Rivers rarely flow to Lake Alexandrina, drying up as they cross the alluvial plains due to leakage of water into the aquifer systems. Recharge is thought to occur mostly in times of high flow. Both the rivers cross a zone of rising basement that has previously been interpreted to be a fault that

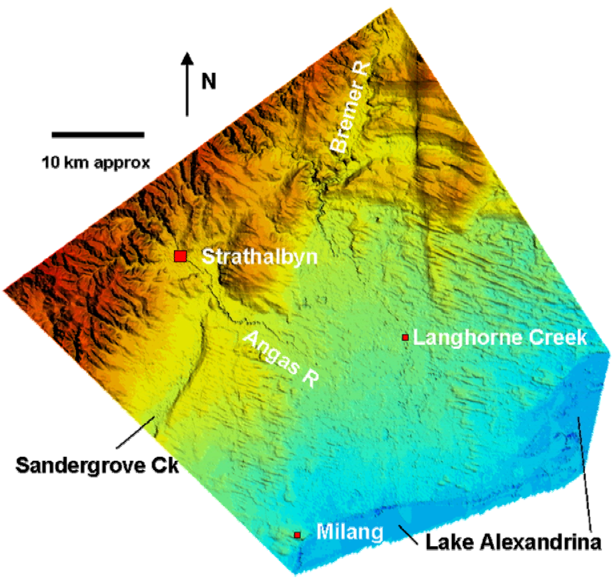

Figure 2: Radar generated DEM of the area from the new Magnetic/Radiometric survey, showing locations of towns and watercourses, with sun shading from the northeast. Blue is low elevation, red high, with logarithmic colour stretch to highlight variations at lower elevations. Maximum elevation is 334 m.

terminates the main aquifer against basement. This feature has been modelled as the main recharge conduit in the area.

The current study has shown that the only evidence for this fault is relatively rapid changes in the elevation of basement in scattered drill holes. In particular, the AEM data do not show a sharp lateral change in conductivity, which would be expected if the aquifer were faulted against basement. The proposed fault is more likely to be a zone of rising basement (a dip of 2.5 degrees is sufficient to explain the drillhole data), due either to warping or palaeo slope on the land surface prior to deposition.

The AEM data show that conductivity in the shallow aquifers is lowest in zones immediately beside the Angas and Bremer Rivers, suggesting that fresh water recharge occurs along the length of the rivers rather than primarily at the previously proposed fault (Figure 3).

There are three other previously unrecognised faults outside the main irrigation area that have clear signatures in the AEM and DEM data, and are backed up by drillhole depths to basement. These faults offset the sediments by up to ~60 m, and have a profound effect on the geometry of the aquifers (Figure 4). This geometry has been quantified by detailed study of drillhole data combined with CDI elevation slices to produce structure contours of the base of the aquifer system. The new knowledge of the geometry of the aquifers and basement, and recharge mechanisms gained from CRCLEME water geochemistry studies will allow new modelling of the groundwater system.

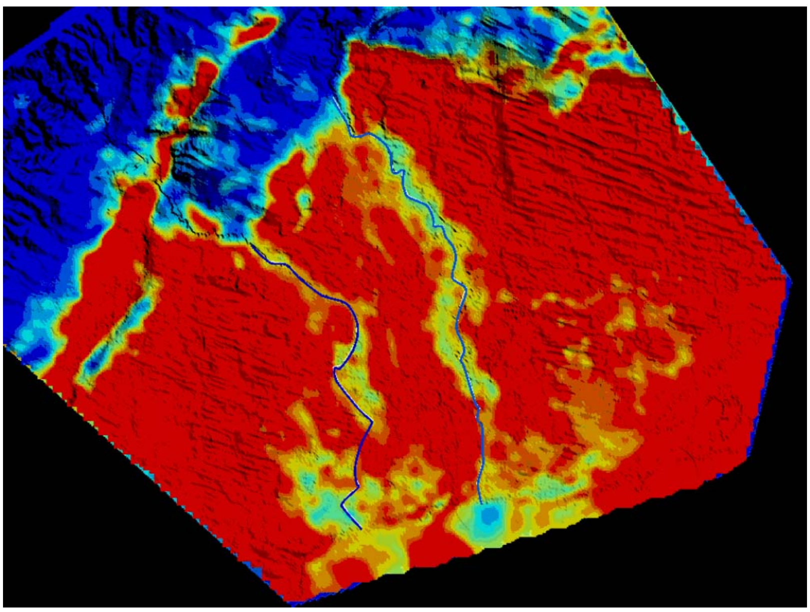

Figure 3: AEM 5-10 m depth slice over greyscale shadow topography, showing zones of lowest conductivity along Angas and Bremer Rivers, due to fresh water recharge. Rivers are highlighted in blue. AEM data linear colour stretch 0-100 ms/m (blue-red).

Unfortunately, the magnetic survey has failed to show any significant magnetic palaeochannel gravels within the alluvial deposits, so the project aim of finding gravel beds that could be pumped to lower saline shallow water tables has not been realised. The AEM data also do not appear to show shallow zones of higher hydraulic conductivity. This does not mean that such zones don't exist. Their apparent absence may be due to inability of the AEM system to adequately differentiate palaeochannels within the alluvial package due to lack of contrast in electrical conductivity or dimensions to small to be imaged by the AEM.

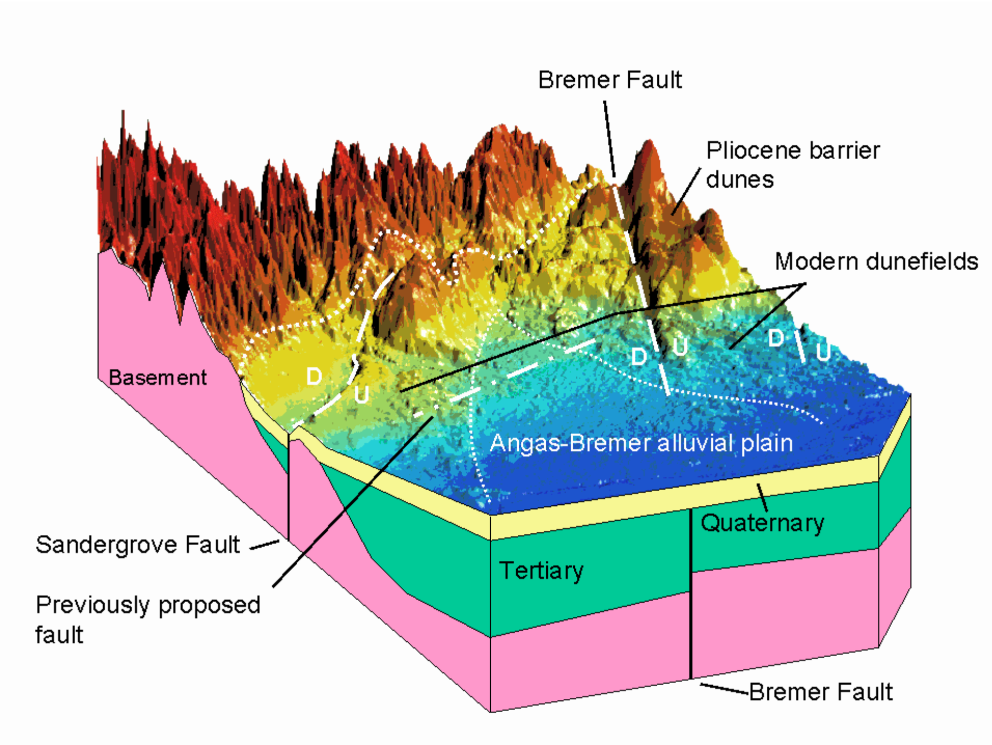

Figure 4: Oblique view of DEM with sketch geology added in block view. Several faults have offset geology and landscape, but there is no evidence for a previously proposed fault.

There are several unexpected results that have been highlighted by the study, including:

- Areas of deep weathering in basement rocks in the eastern Mt Lofty Ranges are imaged in in radiometric and shallow AEM data. These areas may act as salt stores.
- Identification of previously unknown areas of eroding Cainozoic sediment in the eastern Mt Lofty Ranges from radiometric and AEM data. These areas have different soils from the surrounding basement areas, and may act as salt stores.
- Changes in radiometric response over much of the area including the alluvial plains correspond with microrelief and soil texture. The radiometrics will provide the basis for a new generation of soil maps in this agriculturally important area.
- There are areas of internal drainage on the downthrown side of the Bremer Fault in the north of the area (Figure 4); these appear to be a result of local downwarp adjacent to the fault. These areas may concentrate surface water and be local groundwater recharge sites.
- A linear asymmetric ridge south of Strathalbyn, thought previously to be an old strand line, is a result of recent faulting, and is a basement high (Figure 4). This fault has disrupted drainage, and the basement high has formed a groundwater flow barrier.
- The known extent of the Tertiary aquifer has been increased as a result of project drilling.
- The use of AEM elevation slices rather than depth slices has allowed coherent interpretation of data in areas with considerable relief (eg dune fields, fault scarps and erosional areas), and has helped considerably in the generation of structure contours of the base of the aquifer system.

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