THE USE OF AIRBORNE RADIOMETRIC SURVEYS IN MAPPING RIVERINE SYSTEMS – EXAMPLES FROM THE NAMOI, GWYDIR AND BARWON ALLUVIAL PLAINS, NORTHWESTERN NEW SOUTH WALES.

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INTRODUCTION

The study area comprises the northeastern part of the 'Darling Riverine Plain' (Watkins & Meakin 1996) in northwestern New South Wales, and contains the towns of Moree, Goondiwindi, Mungindi, Narrabri and Wee Waa (Figure 1).

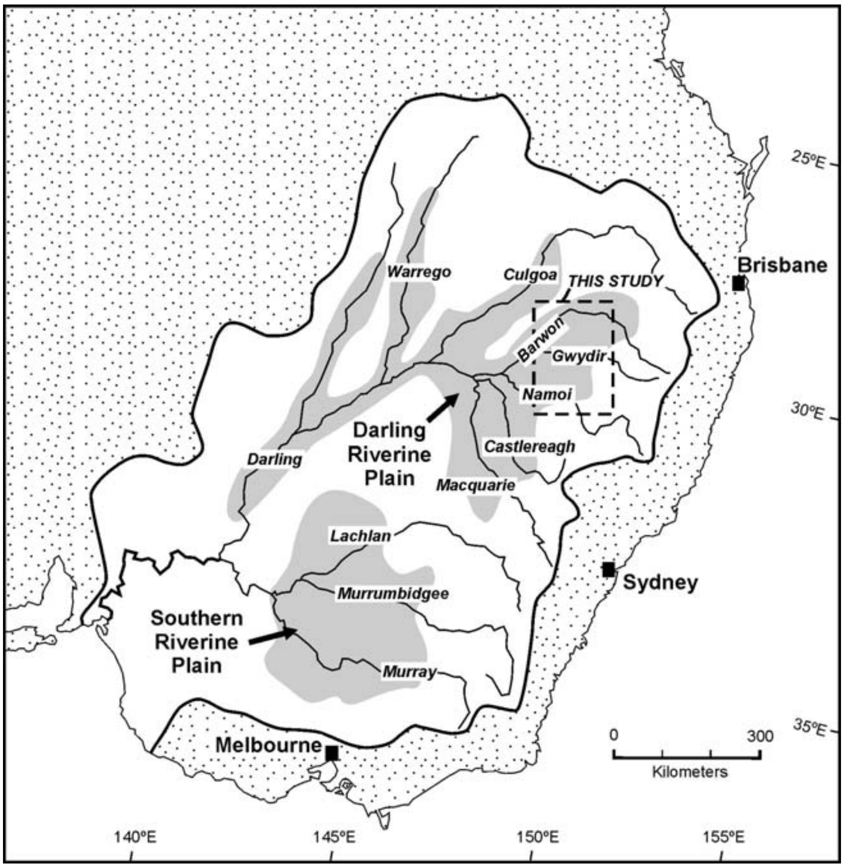

Figure 1. Riverine alluvial plains, which comprise the Murray-Darling Basin.

The Namoi, Gwydir and Barwon alluvial plains are a major cotton growing area in Australia and have a long history of irrigation. Salinity associated with cotton irrigation is a growing concern and affects crop-yield, etc. Triantafilis (2001) outlined the use of ground-based electromagnetic (EM) surveys for identifying areas of high groundwater recharge rates and associated irrigation salinity potential on the Namoi alluvial plain. He concluded that increased salinity potential corresponds to areas of 'prior stream formations'. Therefore, the identification and detailed surface mapping of these 'prior stream formations' is important for cotton production and planning.

This work was undertaken as part of the geological data integration and mapping for the Brigalow Belt South Bioregion Assessment (Barnes *et al.* 2002, Dawson *et al.* 2003). This assessment was a multi-agency (both government and community) approach to land use decisions for a large part of northwestern New South Wales. All data used in this paper are in Australian Geodetic Datum 1966, decimal degrees.

REGIONAL SETTING AND RIVERINE STRATIGRAPHY

The Namoi, Barwon and Gwydir catchments are characterised by east to west topographic, climatic and hydrologic asymmetry. Headwaters to the catchments in the east comprise the dissected New England Plateau with maximum heights of over 1500 metres above sea level. From these headwaters the land falls to the west as a series of wide valleys towards Gunnedah, Gravesend and Goondiwindi. From these towns the rivers flow westward across broad low gradient (<1%) alluvial plains and coalesce near Walgett at a height of 130 metres above sea level.

The headwaters and bedrock to the Quaternary alluvial plains comprise parts of the Cambrian to Triassic New England Orogen (Flood & Aitchison 1988), Permian to Cretaceous sedimentary basins (Surat Basin, Gunnedah Basin, Bowen Basin, Warialda Trough; Hawke & Cramsie 1984), and a number of Tertiary igneous provinces (Central Province, Nandewar Volcanic Complex, Warrumbungle Volcano; Wellman & McDougall 1974).

Watkins & Meakin (1996) were the first to use standardised stratigraphic and facies models for mapping the Quaternary alluvium for the Darling River Basin on the Nyngan and Walgett 1:250 000 geological maps. Work by Young *et al*. (2002) on the Namoi alluvial plain supported this stratigraphy and added another formation. Burton (2004) has also completed new mapping of the Quaternary on the Angledool 1:250 000 geological map. All workers used Thermoluminescence dating to constrain the ages of these formations. Briefly, the alluvial plain stratigraphy for the Barwon, Namoi and Gwydir River alluvial plains comprises the following:

- Marra Creek Formation — Late Holocene 6 ka to present. Silt and clay.
- Bugwah Formation — Early Holocene 13 ka to 6 ka. Silt, clay and sand.
- Carrabear Formation — Late Pleistocene 26 ka to 13 ka. Bedload to mixed load sands.
- Willows Formation — Pleistocene 56 ka to 39 ka. Red silty loams.
- Trangie Formation — Pleistocene 460 ka to 127 ka. Bedload sands and gravels.

METHODS

The airborne geophysical surveys used for this study include Moree, Narrabri, and Moree North as part of the Exploration NSW initiative by the then Department of Mineral Resources. The surveys had a line spacing of 400 metres at a flight height of 60 or 80 metres, and were released between June 2000 and November 2001. This study used single band potassium, uranium, thorium and total count radiometric images, as well as composite RGB images using potassium (red), thorium (green), and uranium (blue) images with a pixel size of 75 metres. Mapping was digitised on-screen against the radiometric images and other multithematic data (Landsat 7 ETM+, Digital Elevation Model, water bores, etc.) using ESRI ARCVIEW/ARCINFO software. Field checking of the mapping was also undertaken.

RESULTS

Image interpretation showed that the Bugwah and Marra Creek formations dominate the Quaternary surface mapping of the Namoi, Barwon and Gwydir alluvial plains. There is a minor occurrence of the Carrabear Formation in the Mungindi to Collarenebri area. This study showed the potassium radioelement channel is the most useful data source for differentiating the Bugwah and Marra Creek Formations and associated facies. The Bugwah Formation meander plain facies has characteristic moderate to high counts of potassium from airborne radioelement data, whereas all facies of the Marra Creek Formation have low to moderate potassium counts (Figure 2).

Concealment of the Bugwah Formation by actively accreting Marra Creek Formation backplain facies is an important process on the studied alluvial plains. The elevated potassium counts of the Bugwah Formation meander plain facies are still detectable where the Bugwah Formation meander plains are concealed by less than 20 cm of Marra Creek Formation backplain facies. However, at greater depths of concealment the elevated potassium counts of the Bugwah Formation meander plain facies are masked by the lower potassium counts of the Marra Creek Formation backplain facies.

A progressive reduction in the potassium counts of the Gwydir and Mehi River meander plains downstream from Moree can be observed (moderate → low to moderate). This reduction in potassium radiation corresponds to a reduction of meander wavelength dimensions and grainsize from silts near Moree to clays on the Bunna Bunna (8738) and Bunarba (8739) 1:100,000 map sheet areas. Marra Creek Formation floodbasin facies have lower levels of potassium, thorium and uranium counts relative to Marra Creek Formation backplain facies. This is attributed to increased soil moisture for the Marra Creek Formation floodbasin facies, which inhibits the gamma radiation propagation.

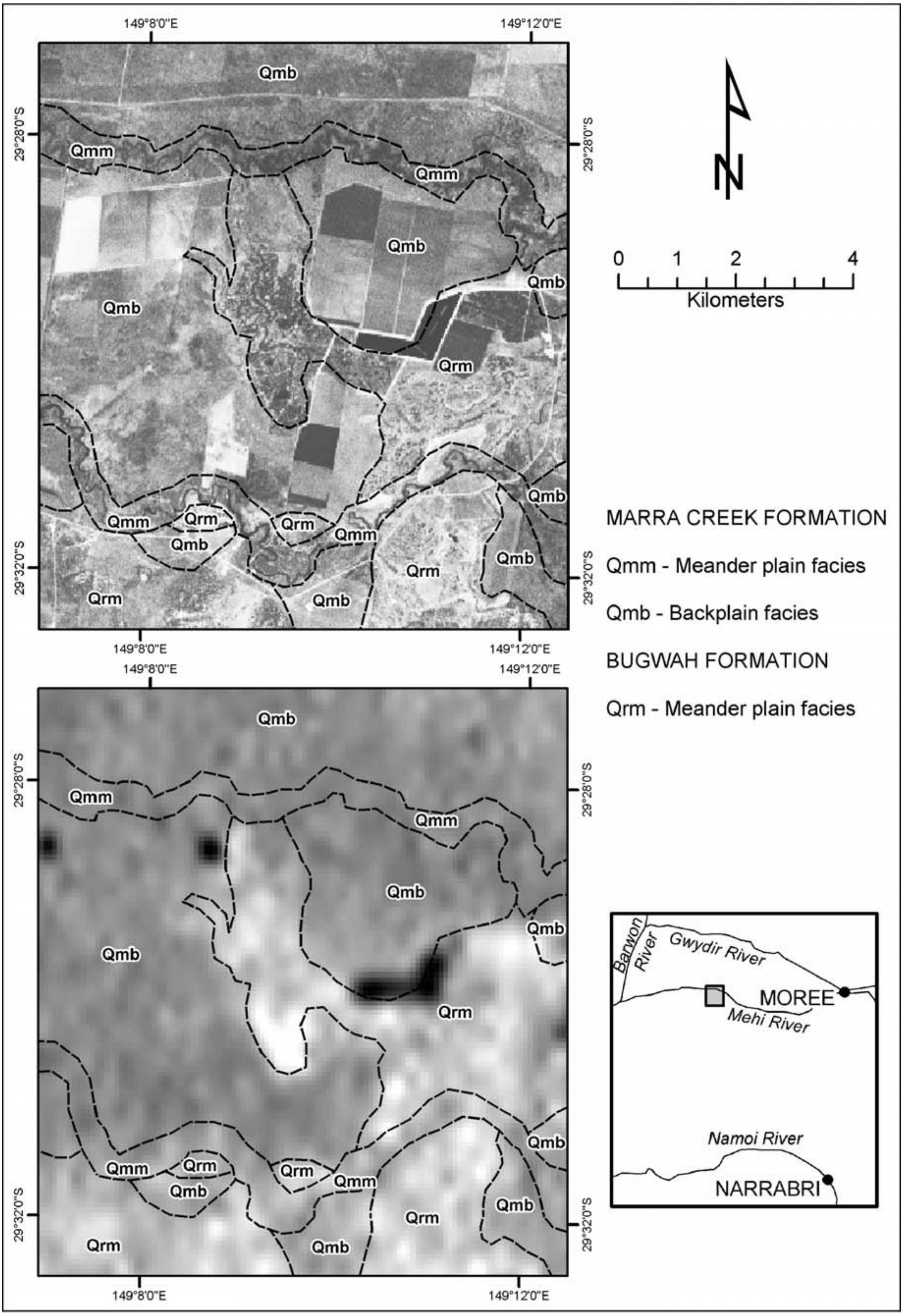

Figure 2. Surface geology overlain on a panchromatic Landsat 7 ETM+ image (top) and linear stretched potassium radioelement image (bottom) for part of the Gwydir alluvial plain.

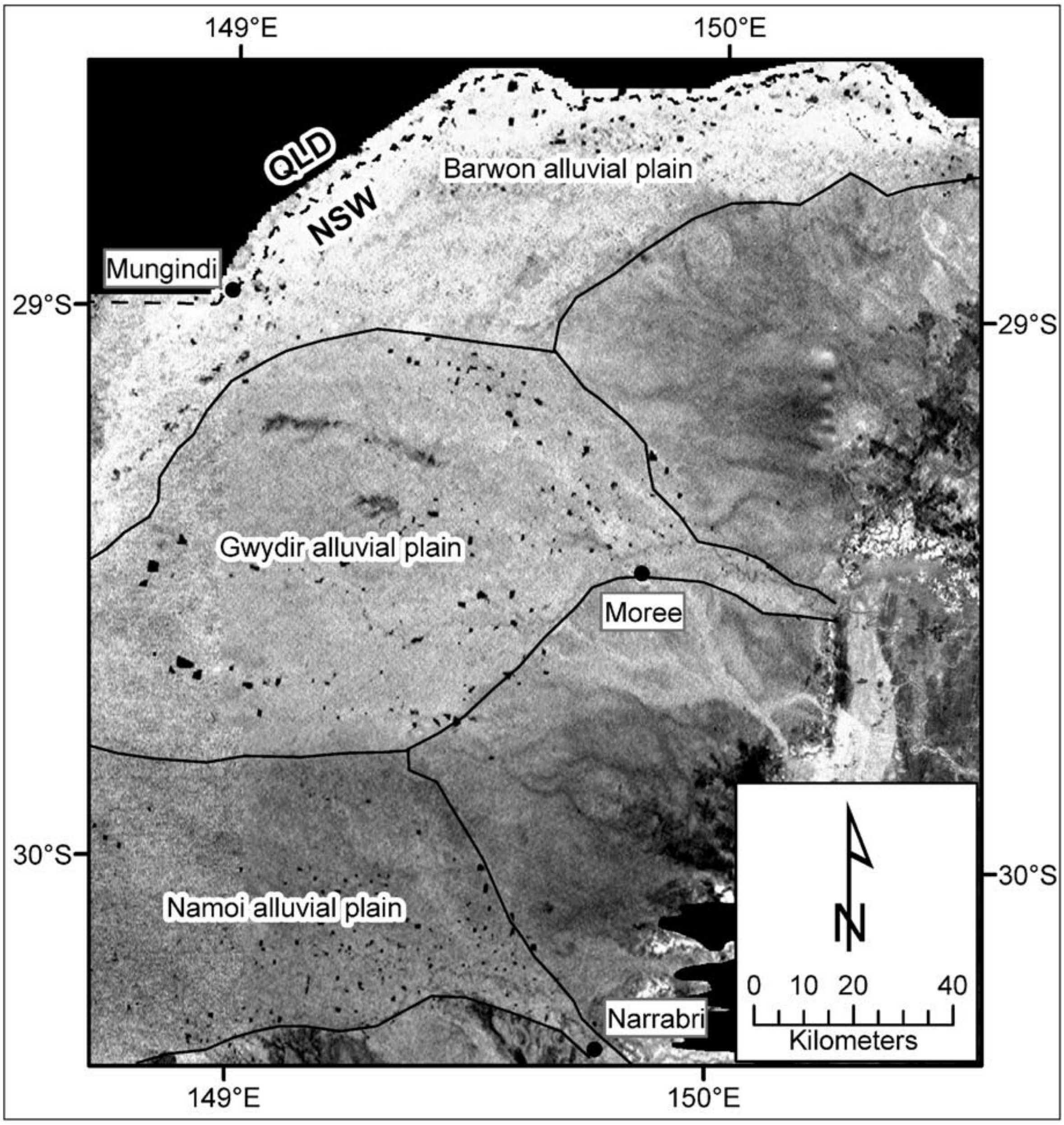

Figure 3. Stretched thorium radioelement image showing the boundaries of the Namoi, Gwydir and Barwon alluvial plains.

Background thorium counts are unique for each of the Barwon (highest), Gwydir (middle) and Namoi (lowest) alluvial plains, reflecting separate sources of detrital material for each respective catchment. The differences in thorium counts can be observed in Figure 3. The thorium radioelement channel is another useful tool in differentiating the Bugwah Formation (higher thorium counts) from the Marra Creek Formation (lower thorium counts).

Elevated uranium counts occur in the Marra Creek and Bugwah Formations for the northern part of the Barwon alluvial plain in the Mungindi and Goondiwindi areas. The source of the increased counts can be traced east by radiometrics to highly fractionated granites and volcanics in the headwaters of Dumaresq River (e.g., Mole Granite, Wandsworth Volcanics).

CONCLUSION

Airborne radiometric surveys are a dependable, relatively high-resolution data source for mapping the distribution and sedimentary provenance of surficial Quaternary riverine sedimentary sequences for the Darling Riverine Plain. Radiometrics coupled with Landsat 7 data can provide rapid delivery of high-quality riverine systems mapping at 1:100,000 and 1:250,000 scales. This mapping can be used subsequently to identify areas of risk for irrigation salinity.

The practicality of radiometrics coupled with the methods outlined here could have a direct application to the Southern Riverine Plain of the Murray, Murrumbidgee and Lachlan valleys in southern New South Wales. This area is already covered by airborne geophysical surveys flown by the New South Wales Department of Primary Industries (Murray/Riverina, Cargelligo and Oaklands surveys). Therefore, a substantial upgrade of previous surface mapping in this area could be achieved relatively quickly.

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