POST MID-MIOCENE EVOLUTION OF THE MACQUARIE RIVER VALLEY, NEW SOUTH WALES

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INTRODUCTION

The denudational histories of valleys draining the Eastern Highlands have been the focus of numerous studies into highland evolution. Commonly, Tertiary basalts have been used to provide age controls on valley incision rates. Alluviated sections of valleys have also provided evidence for incision (e.g., Bishop & Brown 1992). Recent studies suggest a marked variability from catchment to catchment and therefore the need to gather numerous case studies in order to understand the complexity and large-scale patterns of landscape evolution of the Highlands as a whole.

The denudational history of the Macquarie River valley, flowing westerly off the Eastern Highlands in the Central-West of New South Wales, was investigated to provide further evidence for highland evolution. The study area is the bedrock-confined alluvial valley, extending from Burrendong Dam to Narromine, at the margin of the highlands and the Darling Riverine Plain (Figure 1). The catchment is formed of Palaeozoic rocks of the Lachlan Fold Belt south east of Wellington and Mesozoic sediments of the Oxley Basin to the north and north west as far as Narromine. Neogene sediments fill the alluvial valley and Riverine Plain (Martin 1991, Watkins & Meakin 1996). Mid Miocene basalt flows (11.6 – 13.9 Ma) overlying alluvial gravels are found within the study area at Mookerawa and Brocklehurst (Wellman & McDougall 1974, Dulhunty 1973).

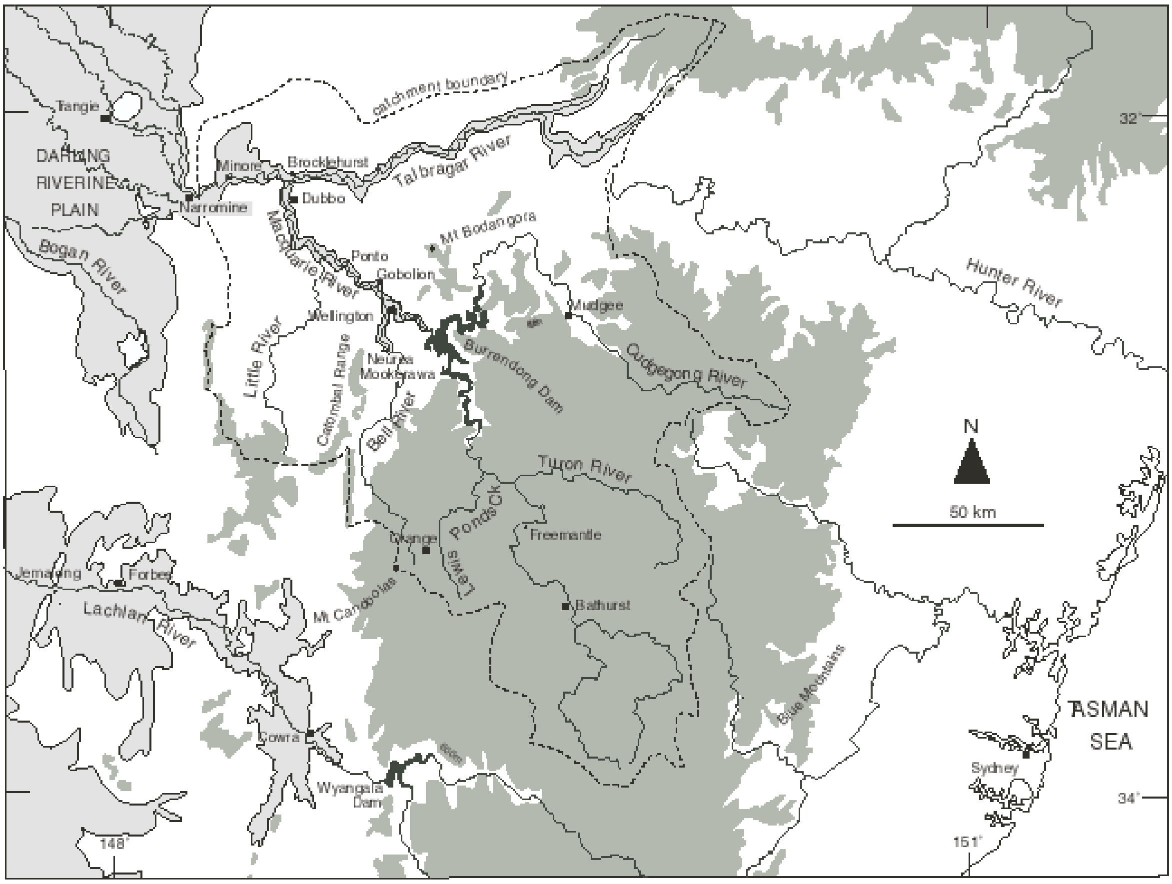

Figure 1: The Macquarie River valley showing the location of the study area, Burrendong Dam – Narromine and other localities mentioned in the text. The Highlands above 600 m are indicated by the dark shading.

METHODS

Cross-sections of the alluvial sediments were constructed at 11 sites in the study area using bore hole logs from the Department of Water Resources combined with topography surveying. Due to the limited descriptions of some logs, supplementary augering combined with samples taken from a bore at Minore and quarry exposures were used to check interpretations. An additional 4 cross-sections were added using information from exploration records held by the Department of Mineral Resources. Ages of sediments were determined from pollen associations (Martin 1991 and *pers. comm.* 1997).

A long-profile of the bedrock basement and alluvial stratigraphy was constructed over the length of the study area, extending out to the Riverine Plain using the deepest bore to bedrock or the one most representative of the stratigraphy in each cross section. The elevations of the alluvial terraces and the present river were also plotted using data obtained by extensive surveying tied to survey control benchmarks.

RESULTS

Mid-Miocene basalts

The elevated outcrops of Mid-Miocene basalts at Mookerawa and Brocklehurst provide an age control for the denudational history of the Macquarie River valley. The presence of underlying alluvial gravels indicates that the basalts were valley-filling at the time of extrusion and that the pre-basalt landscape was characterised by well developed valleys transporting sediments and approximating the current drainage. The basalt flows are around 60 m in thickness at Mookerawa and 30 m in thickness at Brocklehurst, although significant erosion of the basalt outcrop surface may have occurred since the Mid Miocene. Indeed the surface of a nearby basalt at Mookerawa is almost 50 m higher, however it is possible that this was a tributary flow rather than a flow down the Macquarie River.

Incision from the surface of the basalt at Mookerawa (536 m asl) to the current river level was at least 225 m. Incision below the current surface of the basalt at Brocklehurst (278 m asl) to the bedrock basement (underlying the post-Miocene alluvial fills in the valley, determined from bore hole depths) was greater than 70 m, and more likely around 97 m based on bores at Dubbo.

Late Miocene to Quaternary alluvial fills

The long-profile (Figure 2) reveals an extensive sediment-filled valley that becomes progressively deeper below present river level with distance downstream. Three stratigraphic units can be identified:

1. The basal Late Miocene – Early Pliocene clays and sand, informally named Eurombedah unit
2. The Pliocene gravels and sands, informally named Mickety Mulga unit
3. The surface Quaternary sandy clays and clay (downstream), informally named Bunglegumbie unit

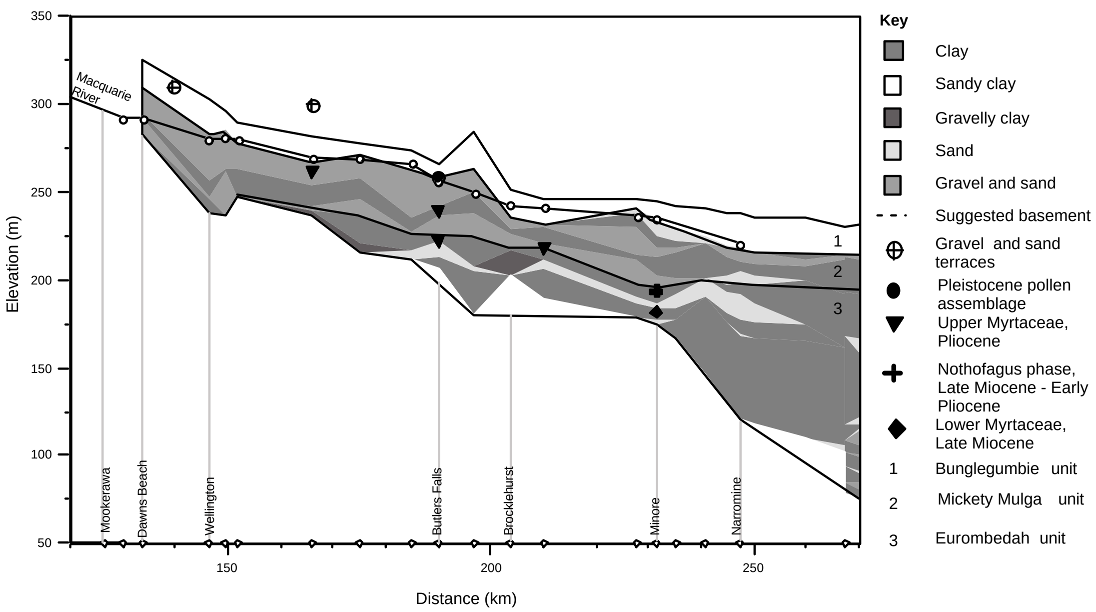

Figure 2: Long-profile of the valley between Burrendong Dam and the Darling Riverine Plain, showing the Eurombedah, Mickety Mulga and Bunglegumbie units filling the valley, elevated alluvial terraces and the pollen sampling locations / depths.

The basal Eurombedah unit forms a wedge within the valley base between Wellington and Narromine and beyond, thickening in a downstream direction. The unit is composed of layers of mottled clays and poorly sorted coarse sands indicating deposition in a low energy fluvial environment with abundant sediment supply. The headward limit of sedimentation appears to have progressively migrated upstream over time, such that this limit was located at Minore in the Late Miocene and had reached Butlers Falls by the Early Pliocene. The vegetation, reconstructed from palynology, was initially wet sclerophyll, changing to rainforest with increasing precipitation (Martin 1987).

The Mickety Mulga unit is found within the valley over the length of the study area and is dominated by large rounded polymictic gravels and angular sand comformably separated by a thinner clay layer. The age of this unit is Pliocene, probably from Early to Late (Martin 1991). The Mickety Mulga unit conformably overlies the Eurombedah unit indicating continuous sediment deposition. Infilling was by non-erosive vertical accretion of fine and coarse sheets of alluvium, through lateral migration of a fluvial system with an abundant supply of bed load material. Gravel and sand terraces, indicating the extent of infilling with this unit, are found at Nanima and Ponto. The volume and calibre of sediment suggests a catchment dominated by rapid erosion and mass wasting of slopes. The vegetation during this time was wet sclerophyll after a short period of wetter climate and rainforest around the Miocene / Pliocene boundary (Martin 1987).

The surface Bunglegumbie unit is composed mostly of massive red-brown sandy clay, with some mottled clays and fine sand layers found downstream beyond Minore. The unit shows an erosional base throughout the study area, e.g., Brocklehurst and Narromine, providing evidence of incision prior to or concurrent with deposition. In the lower part of the study area, the Macquarie River is commonly at the level of the Mickety Mulga gravels indicating on-going reworking of sediments by lateral migration. One Pleistocene pollen age was obtained from a silt and sand layer, assumed to be the base of the unit, at Butlers Falls. However it is possible that the layer is part of the Mickety Mulga unit, suggesting that the transition from gravels and sand to sandy clays was in the Pleistocene. Terraces composed of the Bunglegumbie unit are found throughout the study area and form an extensive plain at the confluence of the Macquarie River and Coolbaggie Creek near Minore. The change in sediment calibre from bed load to mixed load and cessation of gravels being introduced into the system even in the upstream reach suggests that weathering processes dominated the catchment. Martin (1987) found that in the Late Pliocene – Pleistocene the rainforest element disappeared and woodlands / grasslands became dominant with decreased precipitation.

DISCUSSION

The Mid Miocene basalts and alluvial fills provide a good record of the dendational history of the Macquarie River valley. The extent of incision below the basalts indicates a period of massive erosion of the valley beginning in or after the Mid-Miocene, which may have been associated with extrusion of the basalts. Incision appears to have been initiated at the highland margin (Narromine) and by the Early Pliocene had advanced at least as far upstream as Butlers Falls. Incision may have been concurrent with sedimentation of the Eurombedah unit downstream. The commencement of infilling with the Mickety Mulga unit in the Pliocene over the whole study area provides evidence that incision had extended upstream of Gigmalerie and possibly upstream of Mookerawa. The evidence from the basalts and timing of deposition of sediments suggests that river incision in the study area was a rapid, discrete event confined to the Mid- to Late Miocene – Early Pliocene.

Rates of incision (post-basalt – pre-alluviation) were relatively rapid, with a minimum rate of 10 m Ma^{-1} at Brocklehurst and 32 m Ma^{-1} at Mookerawa. These are similar to rates of knickpoint retreat determined elsewhere in the Highlands (Nott *et al*. 1996). A major knickpoint or knick-zone is evident in the Macquarie valley upstream of the study area between the Turon River confluence and "Freemantle" and on the major tributary streams including Lewis Ponds Creek, Summerhill Creek, Turon River, Winburndale River and Bell River. All of these rivers exhibit steep-sided gorges downstream of the knickpoints and a flat or undulating plateau above.

Models of base level change, climate change and highland uplift have been proposed as explanations for incision of valleys draining the highlands. Base level change is an unlikely explanation for incision in the Macquarie valley, firstly because such changes would be attenuated along the 2000 km river length from the coast to the site and secondly, because the time of low sea level in the Late Miocene coincides with conformable deposition of the Eurombedah unit. Climate change can be discounted using evidence from the pollen record, which suggests only a short period of increased rainfall at the end of the Miocene within an otherwise extensive period of climate stability (Martin 1987, 1991). The more plausible explanation for incision of the valley in the Mid- to Late Miocene – Early Pliocene is highland uplift. The rates of incision and its confinement to a relatively brief, constrained, single episode point to active uplift rather than isostatic rebound. Mid-Miocene basalts are also found at Gulgong, Bathurst and Orange in the Central-West of NSW and the Warrumbungles and Nandewars further afield (Dulhunty 1971, 1973, Wellman & McDougall 1974) indicating a time of widespread tectonic activity.

Conformable deposition of the Eurombedah and Mickety Mulga units in the Macquarie valley during the Late Miocene to Late Pliocene indicates a rising base level on the Riverine Plain, tectonic stability and an abundant supply of sediment from the catchment. In the Early Pliocene the river changed in sediment load from mixed or suspended load to bed load. One explanation for the sediment change is an increase in river competence in response to greater discharge. However, higher rainfall is not supported by the pollen record, which shows a stable climate during the Early – Mid-Pliocene declining in the Late Pliocene (Martin 1987, 1991). We believe that the change in units can be explained by the retreat of knickpoint(s) through the different lithologies of the catchment. The knickpoint(s) would have retreated initially through the soft Mesozoic rocks resulting in deposition of the sands and clays of the Eurombedah unit downstream of Wellington and then through the harder Palaeozoic rocks resulting in deposition of large, polymictic gravels and sands along the length of the valley. The knickpoints are still cutting through (mostly) Palaeozoic rocks in the upper catchment.

The change from deposition of the Mickety Mulga unit to erosion, reworking and deposition of the Bunglegumbie unit at the beginning of the Pleistocene may be explained by climate change or a period of later uplift. Bishop & Brown (1992) use evidence of offset terraces, inset valley fills and an offset basement to argue for on-going isostatic uplift in the Lachlan River valley (which neighbours the Macquarie valley). The terraces in the Macquarie valley however, show no evidence of deformation and instead indicate the extent of filling of the valley with sediments to a higher level in the Late Pliocene. Climate change is well reflected in the pollen record as a significant decrease in precipitation in the Quaternary (Martin 1987, 1991). The response in catchment processes would have been weathering of soils rather than mass wasting of slopes, resulting in a reduced sediment supply to the streams. We believe that the Macquarie River responded to the reduction in sediment supply by incising and reworking older sediments, leaving terraces preserved at the valley margins. The river continues to laterally migrate today reworking the older sediments and redepositing a sandy clay floodplain.

CONCLUSIONS

The denudational history of the Macquarie River valley between Burrendong Dam and Narromine, post Mid-Miocene, shows three major periods of incision and sedimentation:

1. Incision by knickpoint(s) retreat in the Mid- to Late Miocene - Early Pliocene, possibly triggered by highland uplift. Uplift may have also triggered basalt extrusion in the Mid-Miocene.
2. Infilling with sands and clays then gravels and sands in the Late Miocene – Late Pliocene as the knickpoint(s) retreated upstream through the different lithologies of the catchment. This is also the time of major sedimentation in the upper Darling Basin.
3. Incision and reworking of older sediments and deposition of sandy clays in the Quaternary in response to reduced sediment supply resulting from a drier climate.

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