PROGRESS REPORT FOR AINGRA06092P

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<th>PROJECT TITLE</th>
<th>Radiocarbon dating to determine the sedimentary depositional history of a confined, sand-bed stream</th>
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<tr>
<td>INVESTIGATOR(S)</td>
<td>Institution and Department</td>
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<tr>
<td>Chief Investigator</td>
<td>Dr Annabelle Keene</td>
</tr>
<tr>
<td>Other Investigators</td>
<td>Dr Richard Bush, Southern Cross University</td>
</tr>
<tr>
<td>Students</td>
<td>Mr Michael Cheetham, Southern Cross University</td>
</tr>
<tr>
<td>ANSTO Investigators</td>
<td>Dr Geraldine Jacobsen</td>
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</tbody>
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**SCIENTIFIC OBJECTIVES**

Confined streams in valley fill landscapes often exhibit landform features that are evidenced from past catastrophic events. These erosional activities develop well-connected and continuous drainage networks and provide a valuable record of climatic extremes and local stability in fluvial sedimentary systems.

This project aims to determine the floodplain sedimentology and chronology for a greater understanding of this landscape's formation and development. The extent of change will assist in assessing and managing the sustainability of riverine plains. By dating the sedimentary deposition of the alluvial floodplain, the project will be instrumental in addressing this component of a larger ARC Linkage-Project.

**PROGRESS REPORT and RESEARCH OUTCOMES**

Widden Brook, a continuous and confined, sand-bed stream in a sandstone valley catchment of the Sydney Basin with its headwaters in Wollemi National Park, was selected as the study area for this project. Floodplain and in-channel bench formation on Widden Brook was determined at two sites (Oaklands and Windmill Creek) by sedimentology, stratigraphy, chronology (AMS and OSL dating), air photograph interpretation, grain size analysis and tree characteristics. At each of the sites, a combination of trenches, drill holes, pits and auger holes were excavated and dug in the vertically accreted floodplain and in-channel bench sediments. Field work was undertaken in June and September 2006, whereby sediment samples were collected from different morphologic and stratigraphic units in the alluvial depositional sequences of floodplains and terraces. Suitable dateable organic material was sampled for a total of 13 charcoal samples from these sediments as provided by this Award. Sample preparation for charcoal was undertaken at ANSTO in August 2006 and March 2007 and submitted for radiocarbon dating by AMS. Analysis was undertaken on the STAR particle accelerator in December 2006 and May 2007. Final results were received from ANSTO in March, July and August 2007. It is important to recognise that radiocarbon dates do not represent the time of deposition, and may have been reworked after death and before being deposited. Hence, multiple dates from the same stratigraphic unit were determined because of the likelihood of fluvial reworking. Optical dating of fine to medium sands by OSL provided independent corroboration of the ages of sedimentary units. In general, the reported dates were consistent with expected age sequences with older sediments occurring at the base of sediment profiles and increasingly younger sediments towards the surface. These dates complete the Holocene floodplain chronology and promote the understanding of pre-European stream morphology for the sites established in the Widden Brook study area of the Hunter River catchment.

Preliminary interpretations of the resulting dates and floodplain sedimentology prove informative for our understanding of floodplain forming processes for a confined, sandstone valley of the Sydney Basin. Results indicate that the channel condition of Widden Brook through the Holocene has been a continuous, sand-bed stream with lateral benches, floodplain pockets and terrace features. The development of alluvial depositional sequences during this time was evident with progressive increases in soil profile development from stream bank to levee to
floodplain to terrace, from poorly differentiated alluvium to highly organised soil profile. Deposition of a range of sediments during stream flow events has lead to the formation of distinctive soils in varied stages of development.

With a straight to low sinuosity, active sand-bed stream, the floodplain has been reworked since European settlement to reflect substantial channel shifting and widening. Significantly, alluvial terraces confine the channel-floodplain unit on both the left bank and right bank sides, and older remnant surfaces persist throughout the catchment. Post-European channel change has been primarily due to:

- clearing of riparian vegetation;
- introduction of riparian weeds;
- stock grazing;
- fire;
- altered catchment hydrology;
- sequence of catastrophic floods in 1913, 1955, 1971; and
- high flood variability – Flash Flood Magnitude Index > 0.6.

Interestingly, rapid channel contraction is now occurring. The channel has contracted significantly since the large flood of February 1955 by floodplain and bench accretion into the flood-wide channel. Less frequent inundation and flood disturbance has allowed vegetation colonisation and mud deposition, which converted the bars into tabular benches. Bank stability has increased by the development of a vegetative boundary layer (lower flow velocity) and by increased resistance due to roots, root mats, and hence increased tensile strength. Bench formation is a major process of the observed channel contraction which is accelerated by vegetation growth. This has contributed to rapid channel recovery by promoting oblique accretion and stabilising in-channel features. This is supported by outcomes determined in a previous AINSE Award (AINGRA05087).

Hence, the floodplain forming processes were shown to be oblique accretion of banks, in-channel bench formation and lateral accretion of point bars. The result suggests that selected areas of bars, benches and floodplain on rivers could be managed to allow the establishment of riparian vegetation. This assists channel recovery from historical channel widening and can provide viable seed for maintenance of the ecological functioning of the riparian zone.

**DATA**

Data collected includes terrace, floodplain and in-channel bench and bar sedimentology, stratigraphy, chronology by dating (AMS and OSL), air photograph interpretation, historical channel survey plans, grain size analysis and tree characteristics. The data collected were used to construct Holocene floodplain development and characterise the pre-European stream morphology. Two cross-sectional profiles are presented here in summary.

The Windmill Creek site demonstrates that the whole floodplain has been reworked by flood events. Charcoal fragments from the channel deposits underlying the floodplain revealed ages that occurred within the last 200 yBP (OZJ218), as shown in Figure 1. The low, hummocky floodplain at Windmill Creek represents an early stage of development, with vertically accreted overbank deposits (fine sand and muddy fine sand) and sand splays (medium sand) overlying channel deposits (coarse sand and pebble gravel). The uppermost depositional layers were prominent and as young as recent floods, representing a stratic stage of soil profile formation (see McKenzie et al. 2004), which were dated as modern (OZJ218). However, charcoal fragments from the channel deposits within the contemporary channel at both Windmill Creek (Figure 1) and Oaklands (Figure 2) sites were dated from the late Holocene (OZJ216 and OZJ214, respectively). This suggests that the channel was continuous through the Holocene and that post-European fluvial reworking did not incise the channel bed to this depth.

Older charcoal fragments from swamp deposits (very fine sandy and silty clay) of terrace features were determined with ages from 1080±60 yBP at Windmill Creek (OZJ213, Figure 1) and up to 10050±260 yBP at Oaklands (OZJ393, Figure 2). A cumulic stage was present in this alluvial sequence on the low terraces dated from modern to late Holocene times (OZJ213, OZJ217, OZJ215), which experienced a lack of sedimentary features and significant translocation of materials. A low-contrast solum stage was also identified on low, infrequently flooded terraces dating from the mid to early Holocene (OZJ396, OZJ393). These soil profiles have clearly developed A horizons with gradational changes to B horizons described by slight colour and textural contrasts. The swamp deposits indicate a period of different catchment hydrology, a low energy depositional environment during the Holocene prior to European settlement that is not evident in current channel morphology.
Figure 1. Windmill Creek site featuring a low level (1.0-1.5 m high) floodplain in an early stage of development with a hummocky floodplain surface flanked by terrace features on the left and right banks of Widden Brook. Charcoal fragments from channel deposits were dated as 2475±50 yBP (OZJ216) underlying the contemporary channel bed.

Figure 2. Oaklands upstream site featuring a well-developed natural levee and high floodplain (1.5-2.5 m high) flanked by terrace features on the left and right banks of Widden Brook. Charcoal fragments from swamp deposits were dated up to 10050±260yBP (OZJ393) underlying the terrace surfaces.

References

The data presented in this report was received in March, July and August 2007, as such no publications have arisen from this work to date. A number of publications are expected when interpretation of these dates has been completed. There are currently two papers in preparation for journal publication.
Mr Michael Cheetham, Southern Cross University

Anticipated date of submission: September 2008

Proposed thesis title: Floodplain terrace geomorphic processes and chronology on the east coast of NSW: implications for Holocene river development.