Towards a Geochronology for Long-Term Landscape Evolution, Northwestern New South Wales

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This thesis is the result of my own work, unless indicated otherwise in the text.

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Abstract

The study area extends from west of the Great Divide to the Broken Hill and Tibooburra regions of far western New South Wales, encompassing several important mining districts that not only include the famous Broken Hill lodes (Pb-Zn-Ag), but also Parkes (Cu-Au), Peak Hill (Au), Cobar (Cu-Au-Zn) and White Cliffs (opal). The area is generally semi-arid to arid undulating to flat terrain covered by sparse vegetation.

During the Cretaceous, an extensive sea retreated across vast plains, with rivers draining from the south and east. After the uplift of the Great Divide associated with opening of the Tasman Sea in the Late Cretaceous, drainage swung to the west, cutting across the Darling River Lineament. The Murray-Darling Basin depression developed as a depocentre during the Paleogene. Climates also underwent dramatic change during the Cenozoic, from warm-humid to cooler, more seasonal climates, to the arid conditions prevalent today. Up until now, there has been very little temporal constraint on the development of this landscape over this time period. This study seeks to address the timing of various weathering and landscape evolution events in northwestern New South Wales.

The application of various regolith dating methods was undertaken. Palaeomagnetic dating, clay $\delta^{18}O$ dating, (U+Th)/He and U-Pb dating were all investigated. Palaeomagnetic and clay dating methods have been well established in Australian regolith studies for the last 30 years. More recently, (U+Th)/He dating has been successfully trialled both overseas and in Australia. U-Pb dating of regolith materials has not been undertaken. Each method dates different regolith forming processes and materials. Palaeomagnetic and clay dating were both successfully carried out for sites across northwestern New South Wales, providing a multi-technique approach to resolving the timing of weathering events. Although (U+Th)/He dating was unsuccessful, there is scope for further refinement of the technique, and its application to regolith dating. U-Pb dating was also unsuccessfully applied to late-stage anatase, which is a cement in many Australian silcretes.

Results from this study indicate that the landscape evolution and weathering history of northwestern New South Wales dates back at least 60 million years, probably 100 million years, and perhaps even as far back as 180 million years. The results imply that northwestern New South Wales was continuously sub-aerially exposed for the last 100 Ma, indicating that marine sedimentation in the Murray-Darling and Eromanga-

Surat Basins was separated by this exposed region. The ages also provide further evidence for episodic deep chemical weathering under certain climatic conditions across the region, and add to the data from across Australia for similar events. In particular, the palaeomagnetic ages, which cluster at ~60 ± 10 Ma and 15 ± 10 Ma, are recorded in other palaeomagnetic dating studies of Australian regolith. The clay ages are more continuous across the field area, but show older clays in the Eromanga Basin sediments at White Cliffs and Lightning Ridge, Eocene clays in the Cobar region, and Oligocene – Miocene clays in the Broken Hill region, indicating progressively younger clay formation from east to west across northwestern New South Wales, in broad agreement with previously published clay weathering ages from around Australia.

These weathering ages can be reconciled with reconstructions of Australian climates from previously published work, which show a cooling trend over the last 40 Ma, following an extended period of high mean annual temperatures in the Paleocene and Eocene. In conjunction with this cooling, total precipitation decreased, and rainfall became more seasonal. The weathering ages fall within periods of wetness (clay formation), the onset of seasonal climate (clay formation and palaeomagnetic weathering ages) and the initiation of aridity in the late Miocene (palaeomagnetic weathering ages).

This study provides initial weathering ages for northwestern New South Wales, and, a broad geochronology for the development of the landscape of the region. Building on the results of this study, there is much scope for further geochronological work in the region.

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