Amino acid racemization geochronology – contributions to the understanding of Quaternary sea-level changes, neotectonics and coastal evolution

by

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Abstract

This thesis presents an overview of a 20 year body of research focusing on aspects of the Quaternary coastal evolution of the southern Australian passive continental margin. This work is based on a representative selection of 20 papers chosen from over 90 peer-reviewed articles. One of the principal research foci centres on the application of amino acid racemization (AAR) reactions to the dating of Quaternary coastal sedimentary successions. Based on the degree of racemization of amino acids preserved within the biominerals of fossil molluscs and other marine invertebrates, geochronological frameworks have delineated rates of long-term coastal evolution, relative sea-level changes and neotectonism. The AAR method has been applied to a wide selection of fossil molluscs from sedimentary successions ranging from late Pliocene to latest Holocene age. Holocene coastal successions have been dated using the fast racemizing amino acid, aspartic acid to assign numeric ages to fossils that would otherwise have been problematic to date using the radiocarbon method. The research has provided a novel approach to derive geochronological frameworks to subdivide Quaternary time and is innovative in creating new opportunities to delineate the age of sedimentary successions that could not previously be dated. It has fostered several new avenues of investigative research such as evaluating the taphonomic integrity of sedimentary deposits (time-averaging and spatial fidelity), confidently undertaking stratigraphical correlation and relative age assessments over wide geographical areas, assigning ages to biostratigraphically significant fossils (e.g. *Anadara trapezia, Marginopora vertebralis*), "whole-rock" dating of aeolianites and quantifying rates of coastal evolution and neotectonism. The work has confirmed that southern Australia preserves one of the world's best preserved and most geographically extensive temperate carbonate shoreline successions of last interglacial age (128 to 118 ka). At this time relative sea level was at least 2 m above present sea level as shown from peritidal facies on Eyre Peninsula, South Australia. The research has also revealed, based on studies of the last interglacial shoreline that Australia, although a highly stable continent, continues to experience subtle neotectonic movements. These findings have modified the general perception concerning the tectonic stability of the Australian continent, and have reinvigorated an interest in the neotectonic histories of passive continental margins. Differential shoreline elevations of last interglacial deposits relate directly to their pre-Quaternary geotectonic setting and highlight the contrasting stabilities of these geotectonic domains over longer temporal scales. An enhanced understanding of the nature of the stratigraphical record preserved within marginal marine settings, the preservation potential of coastal successions in the longer Quaternary geological record and the spatial and temporal distribution of biostratigraphically significant taxa for the Quaternary represent further outcomes of this body of research. With the exception of the Coorong Coastal Plain in southern South Australia, much of the marginal marine stratigraphical record is dominated by sedimentary successions deposited during the sea level highstands of Marine Isotope Stages 1, 5e and 7, with intertidal facies of late Pleistocene interstadial successions preserved within submarine contexts (e.g. the South Australian Gulfs region and the Lacepede Shelf). The taphonomic integrity of sedimentary deposits has also been investigated based on the degree of racemization within fossils. The research has shown that fossils of broadly similar preservation state may be significantly different in age as attested to by the AAR dating of glacial age lowstand deposits from the outer continental shelf of New South Wales, which has identified strata relating to the last three glacial maxima (Marine Isotope Stages 2, 6 and 8) and has helped to constrain estimates of palaeosea level in a far-field site for these time intervals.