

The use of foraminifera to quantify reworked grains in coastal sediments using Amino



Acid Racemization: Preliminary results

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Introduction

Coastal barrier landforms, located where either the coastline is subsiding or the uplift rate is slower than sea level rise, are often found to contain a substantial reworked component derived from older, antecedent features (Cooper 1994; Roy et al. 1994; Bateman et al. 2011; Ryan 2015). Quantification of this reworked component is seldom attempted.

Here we present preliminary results of a study utilizing amino acid racemization (AAR) analysis of individual foraminifera as a means of quantitatively assessing the contribution of reworked sedimentary materials of earlier interglacial periods.

Methods

Individual *Elphidium* sp. and *Lamellodiscorbis* sp. foraminifera were plucked from the $\leq 500 \mu\text{m}$ fraction of 3 modern beach sediment samples (Figure 1) taken along the South Australian coast. Tests were preferentially selected for robustness, color, and level of preservation; characteristics which can serve as indicators of age.

Individual tests were analyzed separately using AAR and followed the sample preparation and analysis method established by Kaufman and Manly (1998), Hearty and Kaufman (2000), and Hearty et al. (2004). All analyses were conducted at the University of Wollongong, Australia using an Agilent 1100 series RP-HPLC.

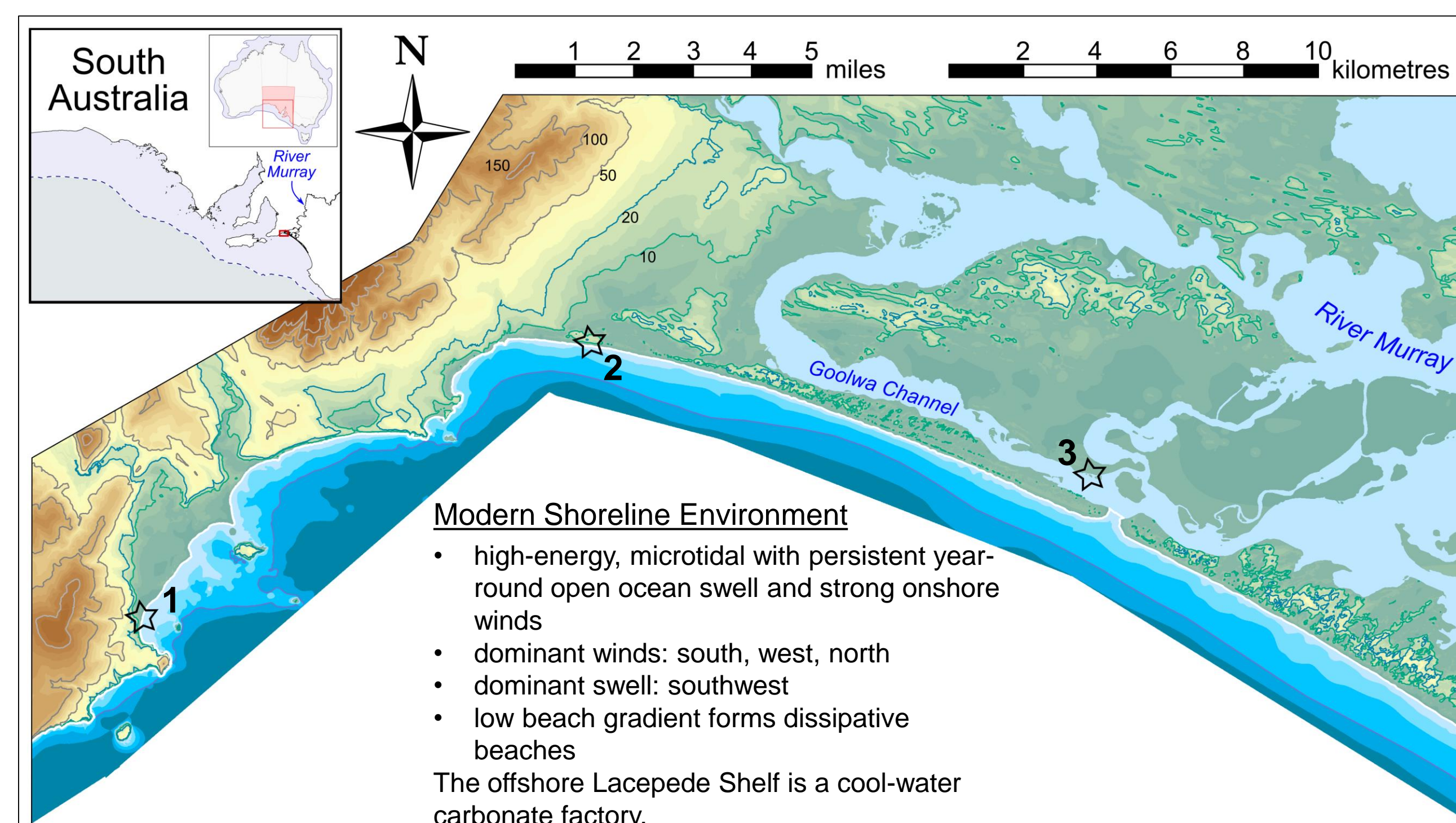


Figure 1: Location and pictures of shorelines from which sediment samples were retrieved: 1) Yilki Beach, 2) Surferr Beach, and 3) flood tidal delta sediments of the River Murray Mouth.

In addition to the Lacedpede Shelf offshore environment, which hosts remnants of interstadial barrier shoreline complexes, and nearby estuarine environments as sources of modern foraminifera, other potential sources of pre-Holocene foraminifera within proximity to each site are: Yilki Beach – an offshore platform composed of highly-indurated MIS 5 aeolianite, Surferr Beach – a beach cliff of MIS 5c aeolianite, and the Murray Mouth – immediately upstream the River Murray flows through subtidal, estuarine and aeolian sediments of late Pleistocene age and aeolian sediments of middle Pleistocene age.

Results

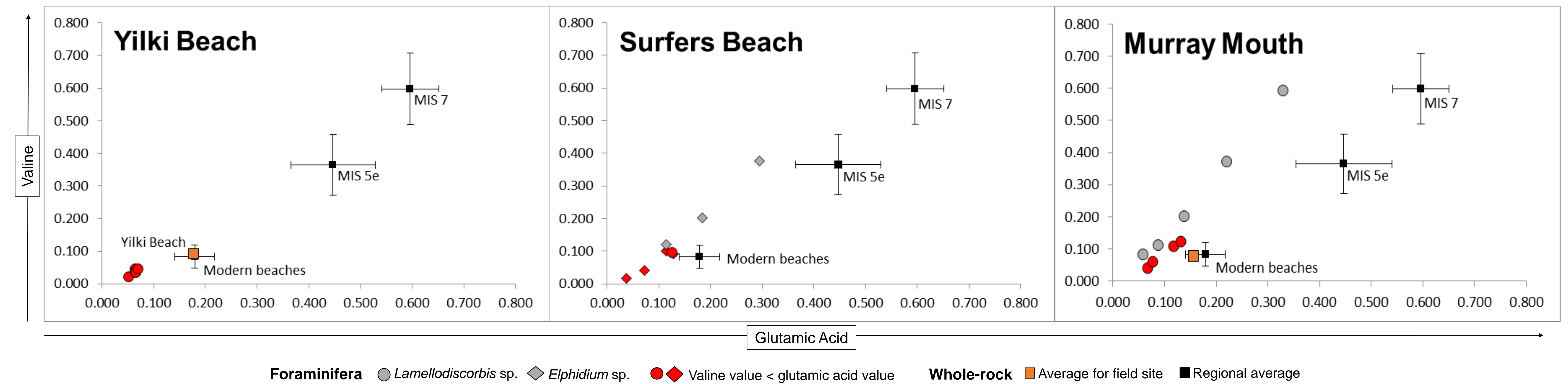


Figure 2: AAR results of individual foraminifera retrieved from modern beach sediments illustrating a mixture of Holocene and reworked foraminifera at two of three beaches analyzed. The lack of reworked foraminifera at Yilki Beach may reflect the sample selection process or be a result of the highly indurated nature of the offshore MIS 5 aeolianite limiting the contribution from the relict feature. Foraminifera results are shown in comparison to field site and regional whole-rock averages. Whole-rock analysis of Surferr Beach sediments was not undertaken due to the small ($<250 \mu\text{m}$) overall grain size. Regional whole-rock averages from Ryan (2015).

Holocene foraminifera can be differentiated from reworked foraminifera because:

- Pyrolysis experiments of *Lamellodiscorbis dimidiatus* and *Elphidium crispum* show that Holocene tests should exhibit a lesser extent of valine racemization than of glutamic acid (Lachlan 2011). AAR results of modern shell and whole-rock have supported this conclusion (Ryan 2015).
- The average racemization extent of accepted individual Holocene tests should not exceed the whole-rock result, which represents an integrated average of all biominerals in that sample.
- Older, reworked tests will plot as outliers to Holocene values.

Preliminary Conclusions

1. Analysis of modern foraminifera results shows that the extent of valine racemization is less than that of glutamic acid with very few exceptions to a D/L value of 0.200. Therefore, any accepted foraminifer result from a Holocene sedimentary unit with a valine D/L value greater than 0.200 can be regarded as reworked.
2. Individual foraminifera of Holocene-age can exhibit extents of racemization above and below the site whole-rock value but the calculated average does not exceed the whole-rock value.
3. Reworked foraminifera of late to middle Pleistocene age are distinguishable.
4. The quantity of reworked grains is variable along the length of the coastline with a relationship to sediment source.

Ongoing Research

- Pyrolysis experiments to establish racemization rates through time for inner-shelf foraminifer species *Lamellodiscorbis dimidiatus*, *Elphidium advenum*, *Elphidium crispum*, and lagoon foraminifer species *Ammonia becarri*.
- Additional single foraminifera analysis to establish representative 'modern' AAR values for *L. dimidiatus*, *E. advenum*, *E. crispum*, *Cibicides corticatus*, *Rosalina bradyi*, and *A. becarri*.
- Additional single foraminifera analysis to establish AAR values representative of MIS 5e for *L. dimidiatus*, *E. advenum*, and *E. crispum*.
- Additional analysis of foraminifera plucked 'blindly' from sediment samples to establish a representative population of contemporaneous and reworked foraminifera at individual field sites followed by quantitative analysis to determine percent contribution by antecedent landforms.
- AAR analysis of *A. becarri* tests plucked from modern lagoon shoreline sediments stained by Rose Bengal to assess the effects of the stain to AAR procedure and results.

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