MARINE TERRACE MAPPING, FORMATION AND UPLIFT; CAPE LIPTRAP, SOUTHEASTERN AUSTRALIA

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INTRODUCTION

The Australian continental margin is usually thought of as a classic passive margin sequence (see Figure 1, Gardner, this volume). However, the southeastern portion of this passive margin has many topographic, geomorphic, and tectonic features that are highly uncharacteristic of a passive margin sequence. Marine terraces, historic seismic activity, and large scale local relief are some of the tectonic attributes found in southeastern Australia that are not usually associated with passive margins.

The terraces of southern Cape Liptrap are broad platforms that extend laterally along both sides of the Cape. Presently, a modern wave cut platform is forming along both sides of Cape Liptrap with the same general trend of the uplifted terraces. The uplifted terraces face the ocean on both sides of the cape and there is a lack of alluvial deposits covering them, which can be used to infer the terraces are marine wave cut platforms. The terraces are covered by a variably thick veneer of marine sand and cobbles overlain by a thick cover of aeolian sands. The deposits overlying the bedrock terraces are thickest in the north and nonexistent in the southern most portion of the cape. The older terraces are more weathered, covered by sediment, and dissected, making them harder to identify.

Methods

In the field, the main goal was to locate and map multiple series of laterally extensive terraces using a Trimble Por XRS global positioning system receiver (GPS). Transects were sought that contained the most obvious and continuous sequences of terraces, and were readily accessible. Seven transects that covered both the east and west sides of southern Cape Liptrap were recorded and mapped. During the surveying, the most important and characteristic features of the terraces such as; inner edges, outer edges, risers, and treads were recorded. Inner edge values are the most important, because these values are the best approximation of mean sea level. Bedrock exposures were also found and recorded in order to determine the thickness of sediment on the bedrock platforms (fig. 1). Where bedrock inner edges were not expose, due to sediment cover, the terrace slope was projected back to determine the approximate inner edge (fig. 2). The inner edge points were correlated to sea level high stands, and an uplift rate was determined for each terrace. The uplift rate for each terrace was used to compile an overall uplift pattern and regional tectonic picture.

RESULTS

In southern Cape Liptrap eight identifiable terraces were recorded and their inner edges were correlated with sea level highstands. The only age controls known in the study area are two OSL dates of 19 +-1.9ka and 21+-2.1ka for the aeolian sands covering most of the terraces (fig. 1), which gives a minimum age for the youngest terrace covered. Outside the immediate study area, an OSL date of 124 +-12 ka for the 2 m terrace near Yanakie (Flanagan, this volume) more than likely correlates to T 9, the 5.2 m terrace that can be extensively traced in the study area.

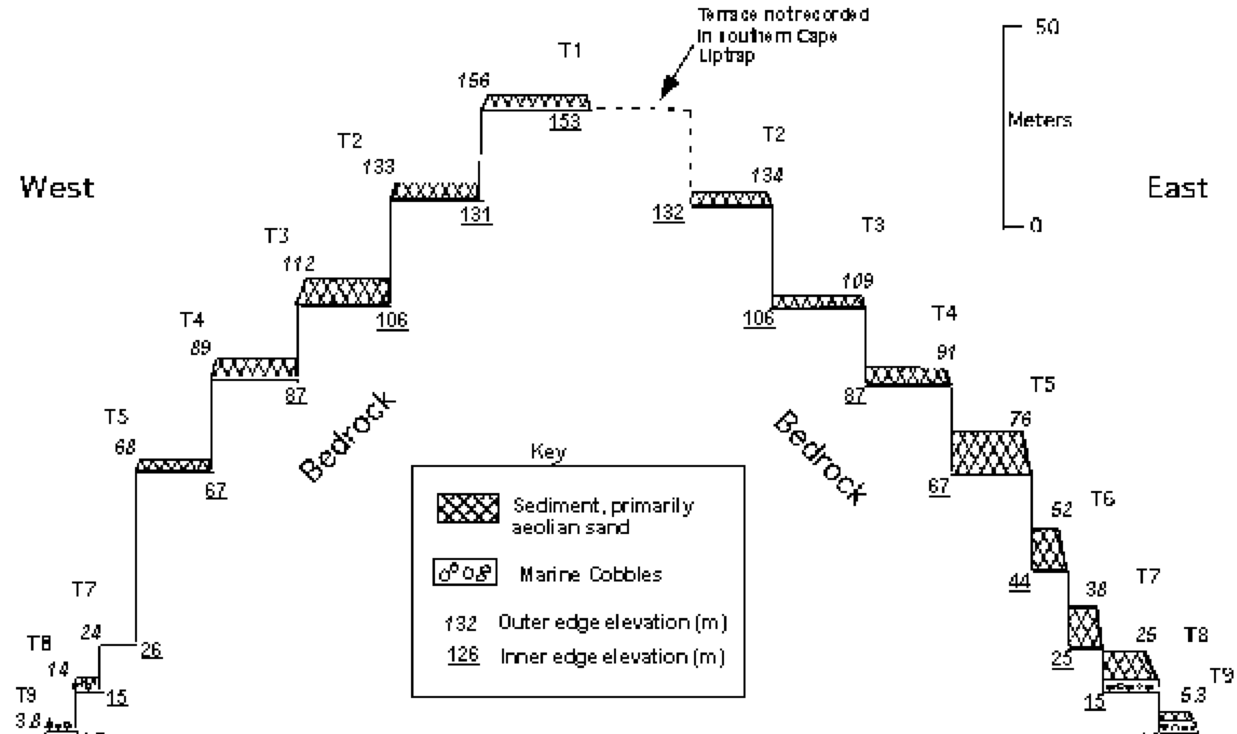

Fig. 1. Composite terrace cross section through southern Cape Liptrap

Therefore, the lowest terrace is correlated with the 125 ka highstand. Ages of higher and older terraces are derived from correlation of inner edge elevations to a sea level curve (Pezzia, this volume). Inner edge elevations and the terrace age derived from the sea level curve are then used to calculate average uplift rate. The ages of the terraces range from 125ka to the late Miocene, and uplift rates vary from .0127 to .021 m/ka along the coast (fig. 3).

Correlating Terraces to Highstands

To begin, several assumptions had to be made about the lateral extent of the terraces on both sides of the cape based on similar elevation and geomorphic features, in order to compile an accurate composite elevation for each terrace. Secondly, it was assumed that the uplift rate has not changed dramatically over time; otherwise the correlation of the upper terraces would not be possible. The 5.2 m terrace was assumed to correlate to the 125ka highstand due to the OSL date on a terrace near Yanakie, and the 80ka terrace is likely under water due to the low uplift rate calculated for this region (Muhs, 2002).

The upper terraces were difficult to correlate laterally due to bedrock weathering which created a more subdued riser, the apron of material deposited at the base of the cliff or inner edge of the lower terrace. The upper terraces were not extensively covered by wind blown sand, although deep weathering of the sandstone and shale bedrock had produced unconsolidated sand and clay. The thickness of sediment on top of the lower terraces was only calculated when bedrock outcrops were found.

Localized faulting

Two faults are mapped in the field area; however there is no exact measurement of the type, timing, or slip rate associated with the faults. The Walkerville fault offsets Devonian turbidites from relatively shallow water Limestones. This fault is exposed at Walkerville and is inferred to extend through Grinder point. The Liptrap fault cuts through Devonian turbidites, which have been extensively folded. Neither of these faults is directly exposed in the study area. However, the youngest tectonic structures in this area are kink bands at Morgans Beach that have been dated at120ka (Sandiford, in press). The mapped faults are thought to be older than 120ka, but their period of activity has not been constrained sufficiently. The amount of sediment deposited on the terraces has destroyed any visible fault trace, and therefore any faulting affect on the terraces has not been recorded in this study.

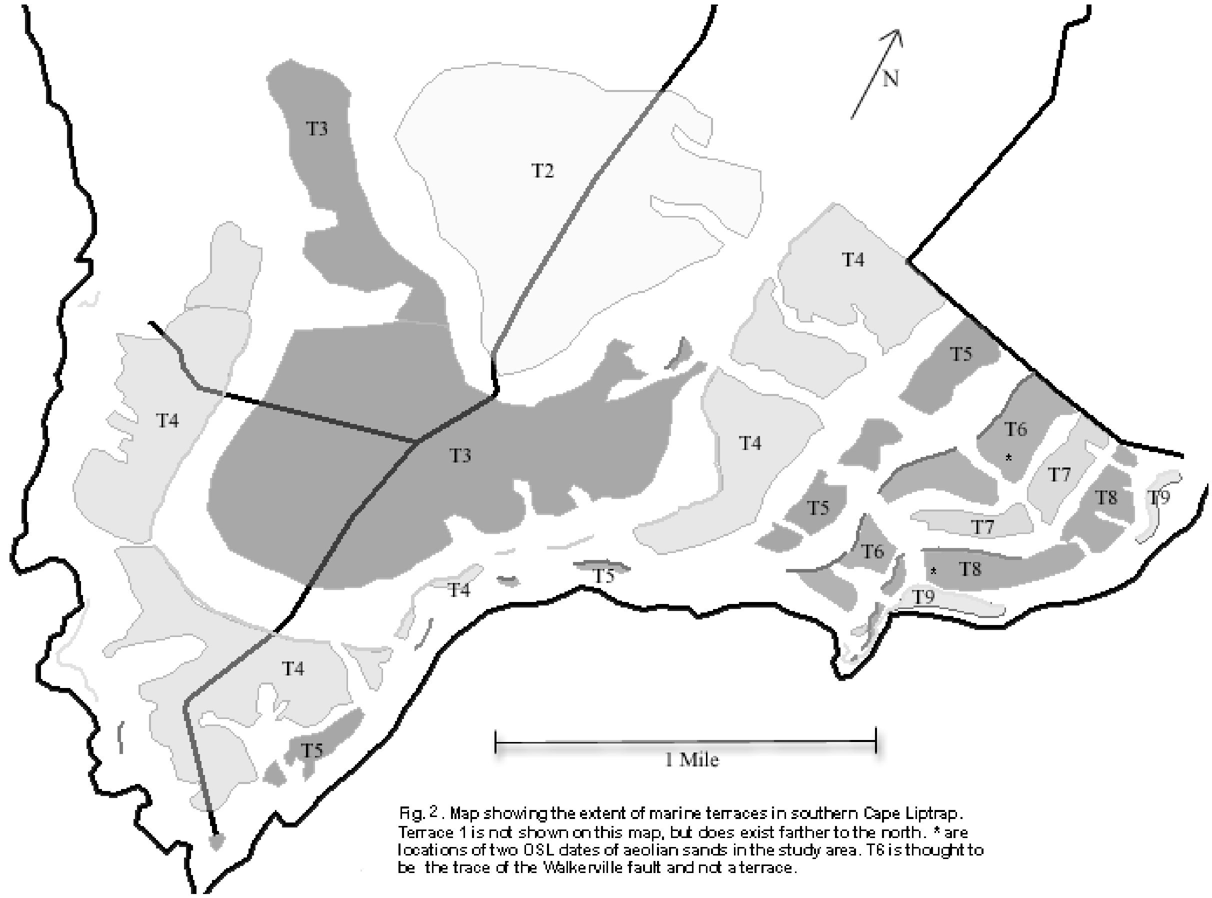

Fig. 2 . Map showing the extent of marine terraces in southern Cape Liptrap. Terrace 1 is not shown on this map, but does exist farther to the north. * are locations of two OSL dates of aeolian sands in the study area. T6 is thought to be the trace of the Walkerville fault and not a terrace.

DISCUSSION

Correlation of terraces to sea level highstands has produced uplift rates which are close to the lower bounds of rates for the region. The ages of the oldest terraces correlate to the large sea level highstands of the mid Miocene (fig. 3), while the youngest terrace formed at the 125ka highstand.

The constant uplift rate calculated in this study has remained consistent for roughly 5.5 ma. The break in the constant uplift rate correlates to the onset of the modern neotectonic regime for southeastern Australia between 5-6 ma (Sandiford, in press). Prior to the present tectonic regime, uplift rates for the oldest terraces were significantly lower, .0026 m/ka.

When the terraces from this study area are compared to terraces from northern Cape Liptrap, the northern terraces are consistently higher in elevation than those in the south (Pezzia, this volume). This suggests regional tilting to the south, which would cause terraces of the same age to be at a lower elevation in southern Cape Liptrap. There does not appear to be any major east/west tilting when a comparison of eastern and western transects are made across southern Cape Liptrap. The elevations of terraces are similar, and no major discrepancies exist between the two sides.

There is not sufficient data to argue that any tilting has taken place, and the difference in elevation from north to south could be explained in a number of ways.

In southern Cape Liptrap, a scarp has been recorded with an elevation of roughly 44m, however this terrace does not exist in the study areas to the north. This 44m scarp begins around Grinder point and can be traced to the north. The trace of this scarp could possibly be caused by uplift associated with the Walkerville fault. The assumed trace of the Walkerville fault is about the same angle as the trace of the 44m fault scarp, or terrace inner edge as it is mapped in figure 3. However, there is no direct outcrop evidence to support this hypothesis.

CONCLUSIONS

Southeastern Australia contains many tectonic features not usually associated with a passive margin sequence. Uplifted marine terraces,

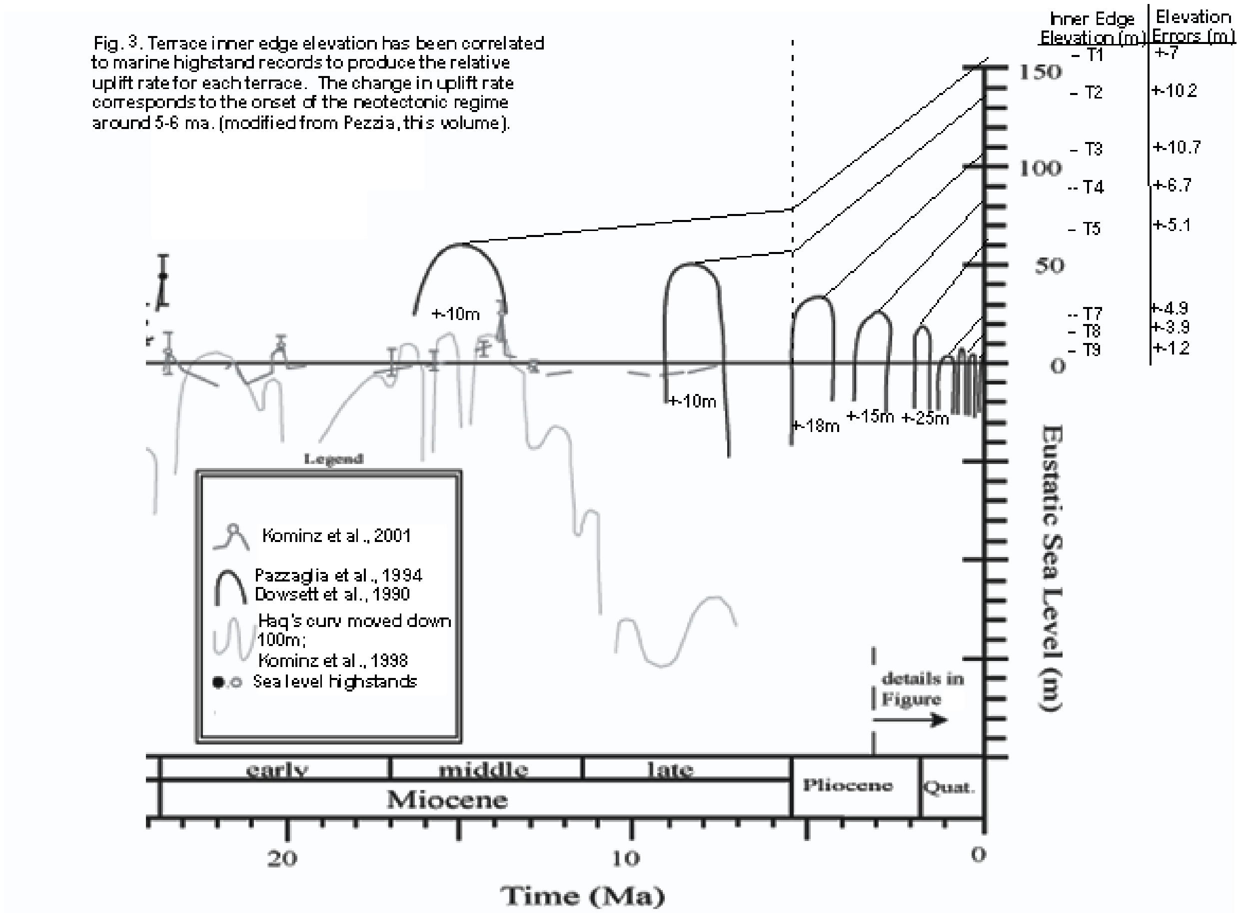

Fig. 3. Terrace inner edge elevation has been correlated to marine highstand records to produce the relative uplift rate for each terrace. The change in uplift rate corresponds to the onset of the neotectonic regime around 5-6 ma. (modified from Pezzia, this volume).

relatively young tectonic structures, and historic seismic activity are indicative of an ongoing active tectonic regime in southeastern Australia (Zhang, 1996). The marine terraces on Cape Liptrap have not been previously studied and can provide insight into the timing and rate of uplift within this region.

In this study, eight marine terraces were mapped and inner edge elevations were correlated to sea level highstands in order to determine relative uplift rates. The uplift rates err on the lower boundary, making the oldest terrace date back to the mid Miocene. Further mapping and accurate dating of marine terraces on Cape Liptrap will help identify the causes for nonuniform uplift, and the precise timing of terrace formation.

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