AINSE

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PROGRESS REPORT FOR AINGRA09070P

PROJECT TITLE	**Sea levels of the Great Barrier Reef: assessing past changes using oyster bed deposits**	
INVESTIGATOR(S)		**Institution and Department**
Chief Investigator	**Dr Stephen Lewis**	Earth and Environmental Sciences, James Cook University
Other Investigators	Dr Raphael Wust; Dr John Collins	
Students		
ANSTO Investigators	Geraldine Jacobsen	
Specialist Committee	E	

SCIENTIFIC OBJECTIVES

The specific aim of the project is to better understand the nature of past sea-level change along the eastern Australian coastline over the last 7,000 years. This aim will be achieved by AMS C-14 dating of the internal structures of oyster bed horizons. Specific research questions include:

1) What is the growth age range of elevated fossil oyster beds in the Townsville region?

2) When did the living oyster zones begin to grow at their current levels?

3) What mechanisms can account for the changes in oyster beds – origin and death during the Holocene (last 10,000 years)?

PROGRESS REPORT and RESEARCH OUTCOMES

The 8 AMS radiocarbon dates from oyster and barnacle deposits from Magnetic and Orpheus Islands have returned some very interesting findings. One of our aims was to determine the onset and development of the modern large oyster mounds or structures around Magnetic Island and we obtained two age dates from one mound (Fig. 1). The basal oyster shells underneath the modern living growth mound (Fig. 1) produced a calibrated age of 760 ± 120 (calib version 5.1 beta with 2 sigma standard deviation) years BP while the middle section had an age of 375 ± 90 calibrated years BP. These dates indicate that this oyster bed had an approximately equal growth rate over time of just over 0.5 mm per year. This is the first known study to quantify growth rates of oyster beds in the Great Barrier Reef (GBR). The age of the earliest growth of the bed shows that sea level reached its present position no later than 760 years ago which is another important finding.

Most of the ages of the first AMS batch for this project were from fossil oyster and barnacle deposits elevated above current growth levels. In particular, we have focused on sections where barnacles have overgrown oysters which provide an indication of a growth hiatus and possible sea-level fall (e.g. Fig. 2). Two such similar deposits (although at different elevations) have been dated from Orpheus Island (+2.1 m above the modern oyster zone) and Magnetic Island (+1.4 m above the modern oyster zone). The Orpheus Island sample returned a large time gap between the oyster (6550 ± 130 yrs BP) and the barnacle (4370 ± 180 yrs BP) of 2180 years. Large time gaps in growth hiatuses are not uncommon on the GBR (see Higley, 2000; Lewis et al., 2008). The Magnetic Island site had a much shorter time gap between the oyster (3820 ± 140 yrs BP) and the barnacle (3790 ± 120) of only 30 years. While it could be argued that the hiatus in the Orpheus Island site may represent physical erosion (e.g. storms etc), the short time gap between the oyster and barnacle deposits at the Magnetic Island site suggest that growth was essentially continuous when the barnacles began to overgrow the oyster deposits. Because these species of barnacles grow in the zone above the oysters in the current environment, this finding is consistent with a sudden sea-level fall at ~3800 years BP. Interestingly, the sea-level envelope of Lewis et al. (2008) shows that this coincides with a period when sea-level began to fall (Fig. 3). Over the last 6 months we have taken additional measurements of the current oyster and barnacle zones and thus have a much better understanding of the growth ranges of these intertidal organisms. Our recent research has shown that *Saccostrea cuccullata* and S. *echinata* have similar growth ranges and both occur on continental islands of the GBR. This finding contradicts previous studies which suggested that S. *cuccullata* has a much more restricted growth range (e.g. Lewis et al. 2008; Higley, 2000) and that S. *echinata* only grows on the coastline and not on continental islands (e.g. Endean et al. 1956).

Because of these significant findings from the initial AMS radiocarbon dates, we seek to take advantage of the eight provisional dates provided in the AINSE award. Since this project commenced, we have learned of a large modern oyster deposit located on Hinchinbrook Island. This deposit is ~80 cm thick and is the largest we know of in the GBR. A new Marine Park permit has been obtained to collect two samples from this bed for AMS radiocarbon dating. These dates would provide further information on oyster bed growth rates on the GBR as well as provide data on when sea level fell to its present position. Since this deposit is ~30 cm thicker than the modern deposit sampled from Magnetic Island, we anticipate that this bed may be even older. We would like to date another modern oyster deposit from the lee side of Magnetic Island so we then have three independent assessments of the nature of modern oyster bed growth (i.e. another four dates from modern oyster deposits). We can then be confident on our ages when sea level fell to its present position. We have also sampled a relict oyster deposit from Picnic Bay, Magnetic Island which is only 20 cm higher than the top of the modern oyster zone. This deposit is unique in comparison to the other sampled relict oysterbeds as it is preserved facing the sea. Fossil oysterbed deposits are typically only preserved in caves where they are relatively protected from chemical weathering, 'onion-skinning' of granites and physical erosion. An AMS radiocarbon age from this elevated fossil bed will provide a valuable link between the modern beds and when sea level was slightly higher. We would like the remaining three AMS dates to continue our work on the growth hiatuses where we will select another 3 samples from our extensive collection from Magnetic Island fossil oyster beds to examine past sea-level changes. The result of the research will benefit coastal management activities, as the data can be used as a proxy for future sea-level changes. A more refined sea-level curve for the GBR over the Holocene will assist in the interpretation of past geomorphological changes along the Queensland coastline, provide a better understanding on the development and evolution of coral reefs of the GBR and place future sea-level change in better context.

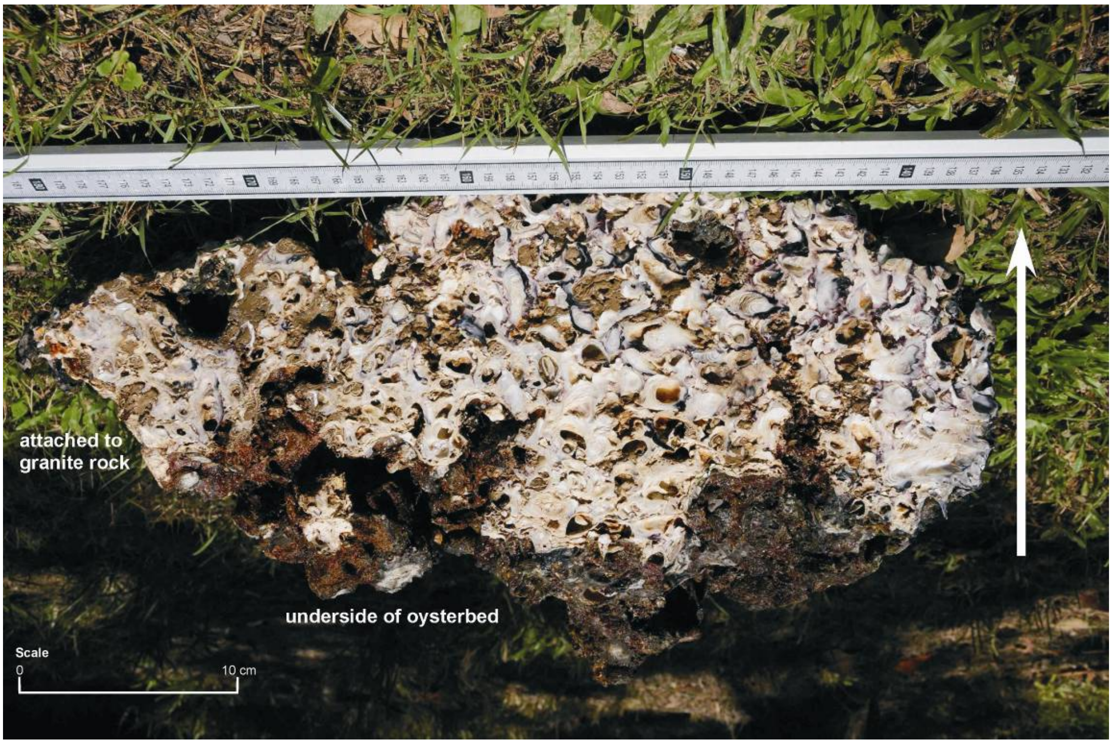

Figure 1. Modern oyster bed from Arthur Bay, Magnetic Island.

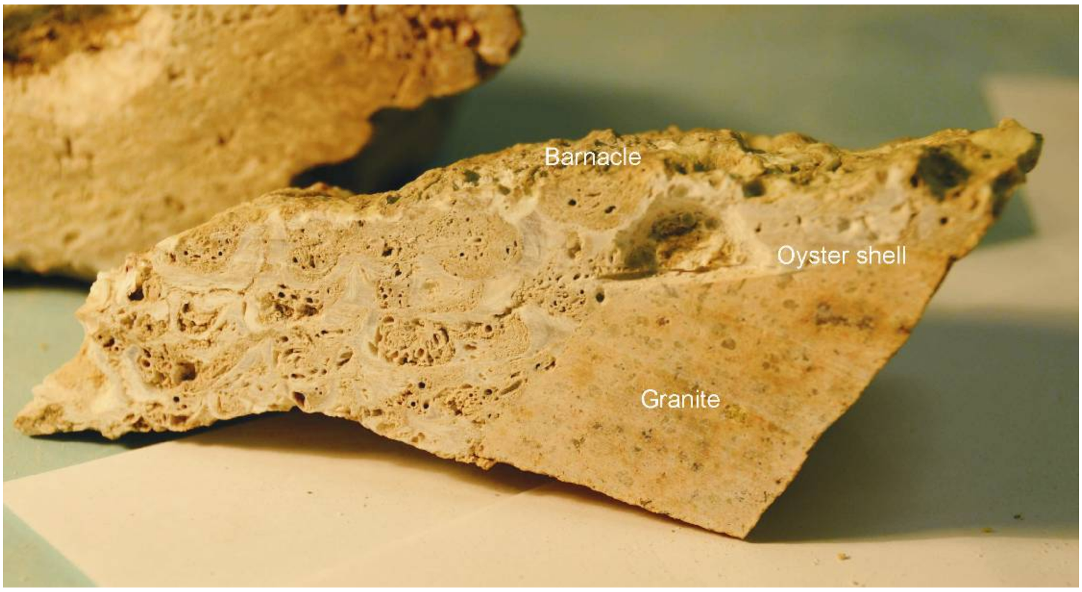

Figure 2. An elevated section with fossil oysters attached to granite boulders. Fossil barnacles have then overgrown the oysters which suggest a sea-level fall. Example from Orpheus Island.

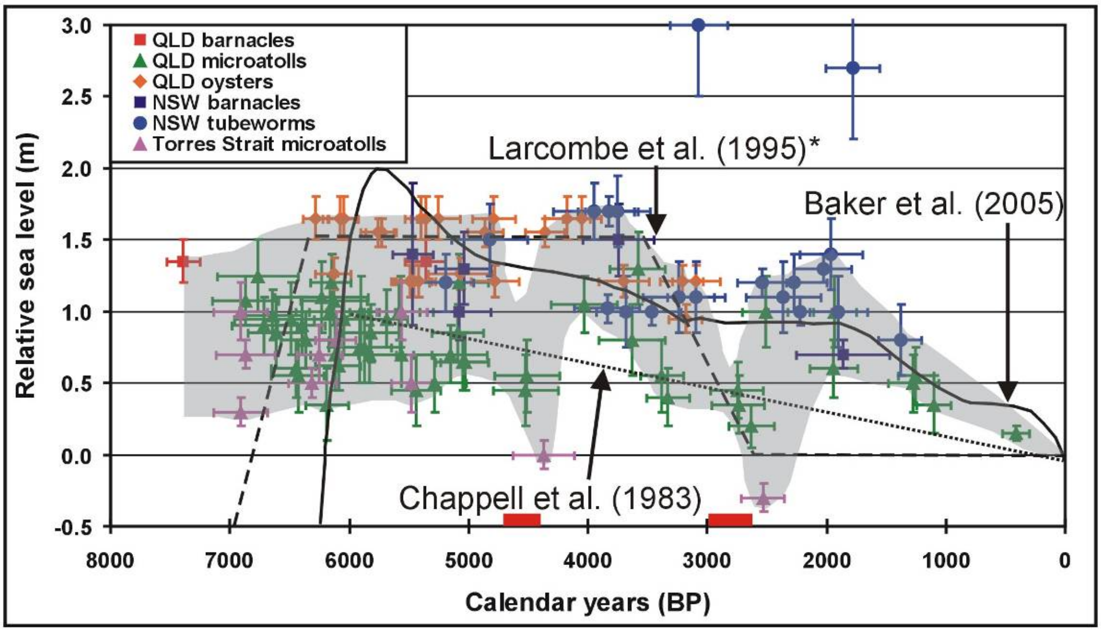

Figure 3. The sea-level envelope from Lewis et al. (2008) shows that sea-level began to fall ~3800 years BP which is consistent with the dates obtained from the barnacles overgrowing the oysters at a site from Magnetic Island.

DATA

Lab code	Sample ID	Material	Location	Method	Uncorrected age	±	Calibrated age	± (2 σ)	Sea level (m)	±
OZL588	1	Oyster	Arthur Bay, Magnetic Island	AMS 14-C	**745**	45	**375**	90	0.00	0.05
OZL589	2	Oyster	Arthur Bay, Magnetic Island	AMS 14-C	**1200**	60	**760**	120	0.00	0.05
OZL590	MAGAB-09/06	Barnacle	Arthur Bay, Magnetic Island	AMS 14-C	**3850**	40	**3790**	120	1.40	0.20
OZL591	MAGAB-09/06	Oyster	Arthur Bay, Magnetic Island	AMS 14-C	**3870**	45	**3820**	140	1.40	0.20
OZL592	OI Site 2	Oyster	Orpheus Island	AMS 14-C	**6140**	50	**6550**	130	2.10	0.50
OZL593	OI Site 2	Barnacle	Orpheus Island	AMS 14-C	**4280**	60	**4370**	180	2.10	0.50
OZL594	OI Site 3	Oyster	Orpheus Island	AMS 14-C	**4850**	45	**5130**	150	1.90	0.20
OZL595	MAGAB-09/04	Oyster	Arthur Bay, Magnetic Island	AMS 14-C	**4020**	60	**4030**	180	1.20	0.20

Signature of Investigator preparing the report for After signing this report please fax this page with your signature for our files	Proj: AINGRA09070P Date:

PUBLICATIONS / REPORTS arising as a result of your work.

AINSE Postgraduate award AINSTU1104

Lewis, S.E. Wüst, R.A.J. Webster, J.M. Shields, G.A. 2008. Mid-late Holocene sea-level variability in eastern Australia. *Terra Nova* 20: 74-81. (s,c)

PhD STUDENTS

N/A