



Australian Government

Department of the Environment, Water, Heritage and the Arts

## Marine and Tropical Sciences Research Facility (MTSRF) January 2008 Milestone Report

### Project 1.1.4 – Dating and Mapping Historical Changes in GBR Coral Communities

**Project Leader:** Dr Jian-xin Zhao, University of Queensland.

#### Summary

Since last report in June 2007, we have made the following progress: (1) recruited Ph.D student Miss Tara Clark who started her Ph.D project in August; (2) honour's student Miss Kylie McGrath finished her honour's project on ecological reconstruction of death assemblages; (3) Ph.D students Jez Roff and Tara Clark are progressing well in their joint effort to date and analyse short cores and surface death assemblages collected from back-reef settings on Hannah/Pelorus reefs; (4) extra dating of death assemblages from Swain reefs are being carried out in conjunction of the study on in situ dead coral reef fraemwork at the same site carried by Dr Stacy Jupiter of the ANU. Our combined high-precision U-series dating and community structure analysis have resulted in significant discovery regarding the timing and nature of historical collapse of Acroporid corals on Pelorus Reef.

#### For reference: Milestone extracted from Project Schedule

Project 1.1.4 - 28 January 2008

- Results on dating for coral rubbles from Swain Reefs and other sites that are currently in CMM collection [UQ]
- Report on sample collection in central GBR [UQ]

## Project Results

### *Description of the results achieved for this milestone*

Following last milestone report in June 2007, major achievements made over the past 6 months include:

- (1) recruitment of Ph.D student Miss Tara Clark into the team;
- (2) Completion of an honour's project by Miss Kylie McGrath (with hand-on help from Mr Jez Roff) on ecological reconstruction of the surface death assemblages from central GBR.
- (3) Initial dating and systematic analysis of short cores (by Mr Roff) collected from central GBR in May 2007, which show significant and systematic changes in community structure at millennial to centennial timescales.
- (4) Systematic high-precision U-Th dating of surface death assemblages from Pelorus reef by Miss Clark and Mr Roff, which was carried out while they were both receiving training in the labour-intensive, unconventional U-Th dating laboratory.
- (5) More surface death assemblages from both central and southern (Swains reefs) GBR are being chemically processed, awaiting allocation of TIMS time for dating.

- (6) A manuscript on dating cyclone-transported coral assemblages on Heron/Wistari reefs in southern GBR has received positive reviews with only minor revisions recommended. This paper will be in press shortly.
- (7) An abstract reporting the timing and nature of historical collapse of *Acroporid* corals on Pelorus Reef was submitted to the Coral Reef Symposium to be held in July 2008 in Florida (see the abstract below):

Since European settlement of the Queensland coastline in the mid-18<sup>th</sup> century, extensive changes in land usage within in the Great Barrier Reef (GBR) catchment region have occurred, resulting from increases in grazing, agriculture and land clearance. Evidence is accumulating that inshore reefs of the GBR are undergoing persistent phase shifts, with losses of previously dominant *acroporid* communities and local removal of coral species. Despite this, considerable difficulty exists in determining the extent and magnitude of the decline, primarily due to a lack of historical data on coral communities. To address this issue, we conducted palaeoecological reconstructions of coral communities through surveys of modern coral communities in conjunction with extensive collections of *in-situ* surface coral rubble (death assemblages) at Pelorus Reef (central GBR). Comparisons of sites with low modern coral cover (<5%) revealed a remarkable disparity between the composition and diversity of modern coral communities and death assemblages, with substrate dominated by extensive *in-situ* dead *Acroporid* rubble. High-precision U-series dating of *Acroporid* fragments by thermal ionization mass spectrometry (up to  $\pm 1$  year precision) revealed that the majority of *Acroporid* mortality occurred much earlier than previously assumed, following the onset of European Settlement (~1860 AD) and prior to 1950 AD (see Table 1). In contrast, one site with a high cover of modern dominant coral genera (*Pavona* & *Goniopora* spp.) with *in-situ* death assemblages showed remarkable similarity in community composition and diversity, implying temporal stability of community structure. Representative dating of corals from the death assemblage using the high precision U-series method supports this, with mortality bracketed to within the last two decades after 1980 AD) (see Table 1). Our results suggest a long-term decline on previously dominant *Acroporid* corals on the inshore reefs studied began long before the advent of monitoring in the late 1980's. By contrast, entire cycles of post-1980s *Acropora* decline and recovery have been documented widely across the Great Barrier Reef (Sweatman et al. 2005) including inshore reefs (Done et al. 2007)

#### References:

[Done T., E. Turak, M. Wakeford, L. DeVantier, A. McDonald, and D. Fisk. 2007. Decadal changes in turbid-water coral communities at Pandora Reef: loss of resilience or too soon to tell? *Coral Reefs* [doi: 10.1007/s00338-007-0265-3].]

H. Sweatman, S. Burgess, A. Cheal, G. Coleman, S. Delean, M. Emslie, I. Miller, K. Osborne, A. McDonald, A. Thompson. 2005. Long-Term Monitoring of the Great Barrier Reef Status Report Number 7. Australian Institute of Marine Science online reference series. <http://www.aims.gov.au/pages/research/reef-monitoring/lrm/mon-statrep7/statrep7.html>

Table 1: U-Th data and ages for selected coral death assemblages from Pelorus reef

Sample Name	U (ppm)	<sup>232</sup> Th (ppb)	( <sup>230</sup> Th/ <sup>232</sup> Th)	uncorrected <sup>230</sup> Th Age (AD)	±2σ	corrected <sup>230</sup> Th Age (AD)	±2σ
PA3A1	3.104	0.47	13.15	1944.8	1.0	<b>1947.9</b>	<b>1.2</b>
PA4A1	3.104	2.14	3.69	1927.2	1.1	<b>1941.3</b>	<b>3.0</b>
PB1A1	4.011	1.97	1.07	1990.6	0.4	<b>2000.7</b>	<b>2.0</b>
PB4A1	3.328	1.68	1.49	1983.7	1.3	<b>1993.9</b>	<b>2.4</b>
PB4B2	3.296	0.64	4.80	1978.0	0.6	<b>1981.9</b>	<b>1.0</b>
PB7A1	3.475	0.79	3.18	1984.3	0.6	<b>1989.0</b>	<b>1.1</b>
PB7B2	3.383	0.98	2.04	1988.5	0.4	<b>1994.4</b>	<b>1.2</b>
PC2A1	2.987	1.26	6.29	1924.4	1.3	<b>1933.0</b>	<b>2.2</b>
PC2B1	2.907	0.95	8.22	1923.1	2.7	<b>1929.8</b>	<b>3.0</b>
PC4B2	2.998	1.81	4.49	1922.3	1.0	<b>1934.6</b>	<b>2.7</b>
PC5A1	3.104	2.89	3.16	1915.0	1.7	<b>1934.0</b>	<b>4.2</b>

Note: PA, PB and PC represent three different traverses. The average Th/U ratio of 4.8±1.0 for over 40 dust and sediment samples from the Burderkin River catchment area is used for non-radiogenic <sup>230</sup>Th correction. The corrected ages are more reliable.

**Explanation of Activity changes**

- (1) Our target of completing the dating of death assemblages from Swains reefs will be delayed by a few weeks mainly due to high demand and bottleneck effect of the availability of the TIMS time. We give Pelorus reef a higher priority over Swains reefs mainly because our fieldwork and sampling strategy for the Pelorus reef were better planned and thus more definitive results can be (and have been) obtained. With the Swains reefs, we are in close contact with Dr Stacy Jupiter of the ANU who has collected the *in situ* dead reef framework from the same site. This collaboration will improve our sampling strategy for dating to avoid a scattergun approach. This is also part of the reasons for delays.
- (2) Our target of completing all planned fieldwork in central GBR was deliberately delayed to April 2008 mainly because we have more than sufficient samples collected last year for lab work. At the moment, there is still a lot of lab work to complete.
- (3) In response to the June 2007 report, it is worth noting that a coral reef expert Mr Qu (Gagan & McCulloch's Ph.D student at ANU) had submitted his Ph.D thesis and started to work at UQ from the end of last year. We expect he will play an active role in overseeing the lab work for this project as the current lab manager (Dr Feng) will be probably too busy in looking after a large number of lab users.

**Problems and opportunities**

**Problems**

We do not have much problem, except that we found out that it is much more difficult than expected to date coral fragments from short cores mainly due to strong alteration and pervasive contamination by mud. We are exploring a new method to pre-clean the non-carbonate component, a crucial step to improve age precision and accuracy.

Of course the second issue is that demand for the old TIMS at UQ has exceeded its capacity, which may cause delays in our planned lab work. A new ARC LIEF proposal is to be submitted this year for a new instrument to ease the workload of the TIMS.

## **Opportunities**

Miss Clark and Mr Roff are collaborating with Dr Stacy Jupiter of the ANU for a better understanding of the timing and causes of coral mortality and reef degradation in the southern GBR.

A historical collection of photos are available from GBRMPA which document changes in reef-flat benthic communities and provide visual evidence for the observed loss of hard coral cover from around the 1890's. Miss Clark is making effort to collaborate with GBRMPA for a comparative study of the death assemblage chronology she will have with historic photographic records.

Through Dr Kefu Yu, a UQ Early Career Research grant has been obtained to continue our effort in the dating and reconstruction of past cyclones using transported coral blocks and lagoon sediment cores. We plan to expand this study to include lagoonal reef systems in the vicinity of Pelorus/Hannah reefs (e.g. Trunk/Bramble reefs). Data derived from such study will provide a baseline knowledge of cyclone history for the interpretation of millennial/centennial coral community changes in the short cores in Mr Roff's Ph.D project, and for separating human impact on from natural variability in coral community structure change. We have also applied for a MTSRF Ph.D scholarship (through a mature-aged candidate MR ALBERTO RODRÍGUEZ RAMÍREZ (who is holding a relatively senior position in Columbia). If his MTSRF scholarship application is successful, this cyclone research will significantly boost the scope of MTSRF Project 1.1.4, especially in the interpretation of community change leading up to European settlement. In addition, we expect that this project on cyclone history reconstruction will attract enormous interest from end-users such as GBRMPA, EPA, DEW, AMPTO, QDPI, Queensland Canegrowers, and insurance companies.

## ***Communications, major activities or events***

### ***During milestone reporting period***

- Continuing email communications among team members.
- Dr Pandolfi, Dr Done, Mr Roff and Miss Clark attended the ACRS conference held in Perth in Sept 2007.
- Mr Jez Roff submitted an abstract to the Coral Reef Symposium to be held in July 2008 in Florida.
- Miss Clark and Mr Roff were in touch with a number of existing and potential collaborators such as Dr Stacey Jupiter.

### ***During next milestone reporting period***

- Complete lab work for dating the next batch of selected coral samples in the next few weeks.
- Fieldwork in central GBR to be held in April to May.
- Drafting a paper reporting the results from Pelorus. Perhaps another paper on Swains Reefs if the new data comply with our old story.