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Determining the history of mortality in Great Barrier Reef coral communities since European settlement using the TIMS U-series dating method

T. Clark (1), G. Roff (2), J-x. Zhao (3), J. Pandolfi (1,2), and T. Done (4)

(1) School of Earth Sciences, University of Queensland, Brisbane, Australia (t.clark1@uq.edu.au / +61 7 3365 8530), (2) ARC Centre of Excellence in Coral Reef Studies, Centre for Marine Studies, University of Queensland, Brisbane, Australia, (3) Radiogenic Isotope Laboratory, Centre for Microscopy and Microanalysis, University of Queensland, Brisbane, Australia, (4) Australian Institute of Marine Science, Townsville, Australia

While the Great Barrier Reef (GBR) is considered to be one of the least degraded coral reefs in the world, monitoring of inshore reefs since the early 1980s has demonstrated periodic declines in hard coral cover as a result of floods and heatwaves, followed by periods of recovery. However little is known about the timing or cause for declines prior to the commencement of monitoring. In the absence of longer ecological baselines, it is difficult to assess changes in coral communities exposed to increasing anthropogenic disturbance and climate change.

Accurate estimates of past historical mortality events of inshore reef coral communities over broad spatial and temporal scales can be achieved through the application of thermal ionisation mass spectrometry (TIMS) uranium-series (U-series) dating of dead coral skeletons. Whilst previous studies have demonstrated that highly precise ^{230}Th ages can be achieved for young corals from pristine open-marine environments, it is challenging to precisely date corals from coastal regions with high terrestrial input. Corals from such sites usually contain high levels of non-radiogenic initial ^{230}Th (as reflected by high ^{232}Th of 2-3 ppb), and thus a precise estimate of the non-radiogenic initial ^{230}Th component in the total measured ^{230}Th is essential for precise ^{230}Th age determination. Here we attempt to improve the accuracy of TIMS ^{230}Th dates for young corals from the near-shore GBR by determining local, site-specific non-radiogenic ^{230}Th/^{232}Th ratios through (1) measurement of local seawater ^{230}Th/^{232}Th values; and (2) comparison of uncorrected ^{230}Th ages with known absolute ages or known age differences (based on band-counting or tracer-tuning chronologies). This approach allows us to achieve $\pm$ 1 yr precision in samples less than 100 years.

Preliminary results from U-series dating of surface dead corals collected from the near shore Great Barrier Reef, demonstrates that TIMS U-series provides a high precision method to determine periods of mortality in coral communities. We present evidence of historical mortality events resulting in the loss of acroporid corals across two inshore regions of the Great Barrier Reef. This mortality is significant in that it occurred prior to the mass bleaching episodes in 1998 and 2002 AD and prior to the advent of long-term monitoring. U-series dating of partial mortality events in massive poritid corals indicated that mortality also occurred at a similar time period as in the Acropora death assemblage. The results of this study will be valuable in understanding past coral community dynamics in response to climate change and anthropogenic disturbances as well as the current status of inshore reefs.