GSA DATA REPOSITORY 2015065

1. RADIOCARBON DATING

Thin section analysis was used to screen for diagenesis with only pristine coral samples used for AMS ^{14}C dating. The foraminifera species *Baculogypsina sphaerulata* and 6 mollusc shells (where foraminiafera were not as prevalent, Table DR1) were also selected for the sediment cores for AMS ^{14}C dating. Near-pristine samples that have undergone the least amount of surficial transport and abrasion were selected under microscope where possible in order to minimize the disparity between death and postmortem deposition. All ^{14}C radiocarbon ages from samples in this study and the Marshall and Davies (1982) cores were corrected to calibrated years BP (cal. yr. BP) with 2σ age ranges using the Marine13 data set (Reimer et al. 2013) with a marine reservoir correction of $\Delta R = 4 \pm 40$ yr (Druffel and Griffin, 2004) and the calibration program Calib 7.0.2 (Stuiver et al., 2005).

Table DR1: ^{14}C AMS radiocarbon dating results showing conventional and calibrated radiocarbon ages. Samples include foraminifera and mollusc shells from sediment cores and corals from fossil microatolls and buried patch-reefs. Different codes relate to the laboratory that conducted the dating with OZ codes from the Australian Nuclear Science and Technology Organisation (ANSTO) (Fink et al., 2004) and UBA codes from the ^{14}CHRONO Centre at Queen's University, Belfast. Locations are in GDA 1994 MGA Zone 56.

Sample Number	Sample Code	Code	X	Y	Elevation (MSL)	Sample Type	Radiocarbon Age (^{14}C BP)	^{14}C 1σ error	Median Calibrated ^{14}C age	2σ range (cal yr. BP)
1	C5	OZN404	406884	7399781	-0.946	Foraminifera	1030	80	603	474 - 753
2	C5	OZN405	406884	7399781	-0.996	Mollusc	3305	50	3138	2956 - 3322
3	C5	UBA-15989	406884	7399781	-1.166	Bivalve Veneridae	960	68	558	441 - 670
4	C5	UBA-15988	406884	7399781	-1.276	Bivalve Veneridae	3693	72	3606	3402 - 3821
5	C5	OZN406	406884	7399781	-1.216	Mollusc	1030	40	600	610 - 680
6	C5	OZN407	406884	7399781	-1.276	Foraminifera	2580	90	2245	1977 - 2532
7	C5	OZN408	406884	7399781	-1.436	Foraminifera	2140	110	1722	1428 - 1993
8	C5	OZN409	406884	7399781	-1.596	Foraminifera	3670	60	3576	3390 - 3774
9	C7	OZO089	404736	7400428	-1.166	Foraminifera	1170	45	718	624 - 866
10	C7	OZO090	404736	7400428	-1.256	Foraminifera	1180	40	725	635 - 863
11	C7	OZO091	404736	7400428	-1.336	Foraminifera	615	40	250	90 - 407
12	C7	OZO092	404736	7400428	-1.686	Foraminifera	2380	45	2005	1844 - 2160
13	C7	OZO093	404736	7400428	-1.986	Foraminifera	765	40	398	290 - 491
14	C7	OZO094	404736	7400428	-2.236	Foraminifera	1050	40	614	519 - 701
15	C7	OZO095	404736	7400428	-2.616	Foraminifera	1990	45	1547	1388 - 1697
16	C12	OZO096	406137	7399803	-0.586	Foraminifera	490	40	113	1 - 239
17	C12	OZO097	406137	7399803	-0.646	Foraminifera	500	45	124	1 - 246
18	C12	OZO098	406137	7399803	-0.916	Foraminifera	785	40	414	291 - 508
19	C12	OZO099	406137	7399803	-1.016	Foraminifera	3180	40	2971	2816 - 3143
20	C12	OZO100	406137	7399803	-1.436	Foraminifera	3500	40	3380	3230 - 3530
21	C14	OZO101	406103	7400310	-0.936	Foraminifera	580	40	201	45 - 319
22	C14	OZO102	406103	7400310	-1.276	Foraminifera	855	45	476	322 - 565
23	C14	OZO103	406103	7400310	-1.466	Foraminifera	610	660	239	54 - 416
24	C14	OZO104	406103	7400310	-1.636	Foraminifera	845	45	467	317 - 553
25	C14	OZO105	406103	7400310	-2.096	Foraminifera	3060	45	2829	2716 - 2976

Sample Number	Sample Code	Code	X	Y	Elevation (MSL)	Sample Type	Radiocarbon Age (^{14}C BP)	^{14}C 1σ error	Median Calibrated ^{14}C age	2σ range (cal yr. BP)
26	C15	OZO106	404700	7400951	-1.056	Foraminifera	775	40	407	295 - 497
27	C15	OZO107	404700	7400951	-1.226	Foraminifera	990	60	577	475 - 677
28	C15	OZO108	404700	7400951	-1.626	Foraminifera	2105	50	1681	1527 - 1838
29	C15	OZO109	404700	7400951	-1.776	Foraminifera	2850	45	2598	2409 - 2738
30	C15	OZP109	404700	7400951	-2.796	Foraminifera	2430	45	2066	1912 - 2263
31	C3	UBA-15986	406847	7399893	-2.236	Acropora	658	68	301	105 - 467
32	C3	UBA-15987	406847	7399893	-2.616	Tridacnea crocea	1031	68	602	489 - 726
33	C3	OZP106	406847	7399893	-0.586	Foraminifera	1410	35	955	817 - 1085
34	C6	OZP107	404729	7400179	-1.586	Foraminifera	3340	40	3188	3021 - 3343
35	C6	UBA-15990	404729	7400179	-0.866	Fragum fragum	662	69	305	106 - 472
36	C6	UBA-15991	404729	7400179	-1.096	Fragum fragum	1122	68	679	531 - 838
37	C18	OZP110	406154	7400089	-1.236	Foraminifera	2780	50	2516	2341 - 2688
38	C18	OZP111	406154	7400089	-1.526	Foraminifera	670	45	319	146 - 165
39	C18	OZP112	406154	7400089	-2.656	Foraminifera	2290	40	1899	1745 - 2050
40	Atoll A01	OZP785	407618	7400032	0.134	Porites?	2565	35	2230	2092 - 2345
41	Atoll A08	OZP786	406864	7402303	-0.116	Porites	3520	40	3403	3255 - 3548
42	Atoll A94	OZP787	406755	7402381	0.022	Porites	2870	40	2625	2443 - 2748
43	Atoll A2	OZP788	407639	7400031	0.014	Porites?	3895	40	3864	3693 - 4038
44	Atoll A99	OZP789	407688	7400195	-0.03	Favites	2920	40	2694	2495 - 2809
45	Patch P2	OZP790	406772	7399933	-0.626	Cyphastrea	3185	35	2978	3831 - 3142
46	Patch P4	OZP791	406778	7399879	-0.566	Favia?	3410	35	3273	3128 - 3405
47	Patch P6	OZP792	405793	7400081	-0.516	Isopora	2780	35	2517	2349 - 2676
48	Patch P7	OZP793	405757	7400256	-0.956	Leptoria	2460	40	2106	1960 - 2285
49	Patch P14	OZP794	404803	7400473	-0.546	Montipora?	5440	40	5807	5658 - 5922
50	Patch P16	OZP795	404665	7400953	-0.906	Platygyra?	2180	35	1769	1617 - 1896

Table DR2: Conventional radiocarbon ages from Marshall and Davies (1982) cores 1, 2, and 4 and their calibrated ages.

Sample Number	Sample Code	Lab Code	Lat	Long	Elevation (MSL)	Sample Type	Radiocarbon Age (^{14}C BP)	^{14}C 1σ error	Calibrated ^{14}C age	2σ range (cal yr. BP)
1	Core 1 1_28B	NSW-319	-23.5089	152.0910	-5.2	Sand	3760	146	3697	3346 - 4079
2	Core 1 1_35C	NSW-314	-23.5089	152.0910	-8.3	Sand	5280	126	5647	5380 - 5906
3	Core 4 1D	GX-6951	-23.6069	152.0959	-0.6	Coral	4155	141	4218	3827 - 4602
4	Core 4 1F	GX-6952	-23.6069	152.0959	-0.98	Coral	4010	155	4025	3605 - 4428
5	Core 4 1G	GX-6953	-23.6069	152.0959	-1.16	Coral	3910	141	3890	3522 - 4283
6	Core 4 2E	GX-6954	-23.6069	152.0959	-1.83	Coral	3700	146	3623	3251 - 3992
7	Core 4 3C	GX-6955	-23.6069	152.0959	-3.25	Coral	4020	155	4038	3613 - 4440
8	Core 4 4B	GX-6956	-23.6069	152.0959	-4.34	Coral	4265	146	4367	3982 - 4782
9	Core 4 5D	GX-6957	-23.6069	152.0959	-5.4	Coral	4455	150	4620	4208 - 5022
10	Core 4 6E	GX-6958	-23.6069	152.0959	-6.65	Coral	4885	165	5172	4803 - 5573
11	Core 4 7B	GX-6959	-23.6069	152.0959	-8.58	Coral	5535	155	5921	5595 - 6250
12	Core 4 8B	GX-6960	-23.6069	152.0959	-9.53	Coral	5560	180	5948	5570 - 6315
13	Core 4 8F	GX-6961	-23.6069	152.0959	-10.47	Coral	6415	170	6894	6492 - 7292
14	Core 4 9B	GX-6962	-23.6069	152.0959	-11.03	Coral	6460	189	6943	6506 -7348
15	Core 2 3	NSW-289	-23.5110	152.0918	-0.465	Coral	5290	126	5658	5382 - 5918
16	Core 2 4	NSW-293	-23.5110	152.0918	-0.61	Coral	5330	126	5700	5430 - 5980
17	Core 2 5	NSW-301	-23.5110	152.0918	-0.76	Coral	5380	155	5753	5431 - 6135
18	Core 2 7	NSW-290	-23.5110	152.0918	-0.975	Coral	5330	126	5700	5430 - 5980
19	Core 2 8	NSW-302	-23.5110	152.0918	-1.105	Coral	5310	126	5679	5393 - 5955
20	Core 2 10	NSW-291	-23.5110	152.0918	-1.6	Coral	5400	126	5770	5487 - 6061
21	Core 2 11	NSW-298	-23.5110	152.0918	-1.765	Coral	5310	126	5679	5393 - 5955
22	Core 2 12	NSW-294	-23.5110	152.0918	-1.95	Coral	5460	126	5831	5577 - 6135
23	Core 2 15	NSW-299	-23.5110	152.0918	-2.29	Coral	5310	126	5679	5393 - 5955
24	Core 2 20	NSW-300	-23.5110	152.0918	-2.98	Coral	5760	136	6158	5873 - 6453
25	Core 2 20	NSW-295	-23.5110	152.0918	-2.98	Coral	5780	136	9180	5888 - 6470

26	Core 2 22	NSW-296	-23.5110	152.0918	-3.345	Coral	5680	136	6076	5756 - 6357
27	Core 2 31	NSW-308	-23.5110	152.0918	-5.9	Coral	6820	136	7329	7035 - 7572
28	Core 2 36	NSW-297	-23.5110	152.0918	-8.275	Coral	7440	136	7895	7623 - 8170

2. MICRO-ATOLLS AS SEA-LEVEL INDICATORS

Scoffin *et al.* (1978) originally commented on the significance of micro-atolls as sea-level indicators and found that the fossil micro-atolls grew to mean low water spring tide levels (MLWS, -1.2 m MSL for OTR). Micro-atolls in open water environments are considered the most accurate biological indicators of paleo sea levels due to their tightly restricted growth range at MLWS (Lewis et al. 2013). They have been shown to have an elevation variation of only ± 10 cm (Smithers and Woodroffe, 2000) unlike other biological indicators (Lewis et al., 2008). Consequently, micro-atolls have been used in numerous studies when developing sea-level curves, with Lewis *et al.* (2013) using micro-atoll data (along with barnacles and oysters) to exclude potentially confounding results from less accurate biological indicators (such as beachrock and foraminifera). However, atoll elevation has been shown to vary from MLWS in environments where lagoons truncate the natural tidal range thereby artificially raising water level. In such environments, corals may grow up to MSL but commonly now higher than mean low water neap (MLWN) level. Smithers and Woodroffe (2000) found that micro-atolls in open water environments on the Cocos (Keeling) Islands would grow at elevations between MLWS and MLWN tides, hence MLWN is used as a lower vertical error range in Figure 2 of the manuscript.

The fossil microatolls sampled during this project are from unmoated open water environments on algal dominated environments with no surrounding coral cover. The images in Figures DR1 and DR2 show the typical appearance of the fossil micro-atolls on One Tree Reef and the environments where they are found; usually at the junction between the algal and rubble sections of the reef flat. It is likely that these were also open water environments when the atolls were living with no geomorphic evidence to suggest moating would have occurred on the reef flats in the past.

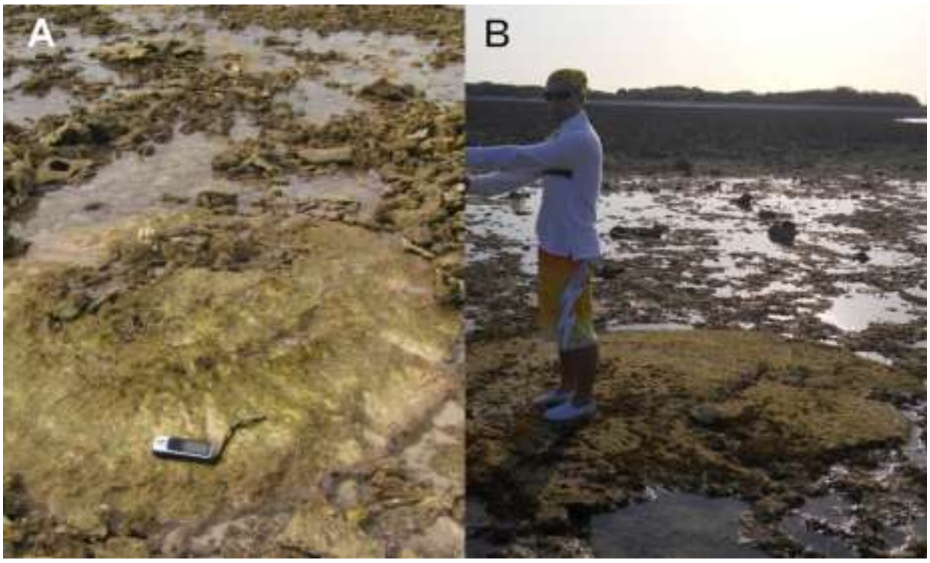

Figure DR1: a) Photo of a typical fossil micro-atoll in the northeast of One Tree Reef, located in the rubble at close to the algal rim; b) Photo of micro-atoll A2 during RTK-GNSS survey looking towards One Tree Island in a lagoonward direction. The atoll is located on the algal rim with the beginning of the rubble seen clearly behind the micro-atoll.

Figure DR2: Oblique photo taken during mid-tide conditions (exact tide not known) showing the location of microatolls on the algal rim of the southeastern reef flat near the beginning of the rubble flat. Source: D. Kaufmann

3. SEDIMENT CORES

3.1 Eastern transect

The eastern core transect contained mostly coarse sand (mean grain size (D50) ≈ 800 μm) with a gravel (> 2000 μm) unit located between -0.8 to -1.2 m MSL (Figure DR3). The gravel deposit in C5 consisted of mainly large mollusc shell and coral (mostly *Acropora sp.*) fragments. A large range of dates were also found in this deposit with ages varying from 558-3606 cal. yr. BP. The wide range of ages in the gravel layer of C5 suggests that this is a storm or cyclone deposit (Figure DR3). Deposits with similar depths (above 1.5 m), grainsize and composition to the gravel deposit in C5 are found in most cores with the exception of C15, which shows a gravel layer at a similar depth but not the large gravel grains found in the other cores.

The ages in core C5 show old dates for relatively shallow depths considering the Pleistocene base is at -13 m, with an age of 3576 cal. yr. BP at -1.6 m (Figure DR3). The ages get progressively younger towards the surface with 1722 cal. yr. BP at -1.4 and 603 cal. yr. BP at -0.9 m. In contrast C3 does is much younger with an age of 955 cal. yr. BP at -2.8 m getting progressively younger at shallower depths (Figure DR3). The younger ages and relatively fast sedimentation rates in C3 may be due to the location of the core on the sand apron. C3 is located in the southeast location of the sand apron as it slopes towards the lagoon. This location has much more dynamic sediment movement than the other transects with cores taken near the the lagoon extent of the sand apron (i.e. C14 and C15). The sedimentation in C3 represents one of the few locations showing recent (< 1000 yrs) sedimentation and progradation of the sand apron. It is also one of the few locations to have undergone measurable accretion over the last three decades (Vila-Concejo et al., 2013).

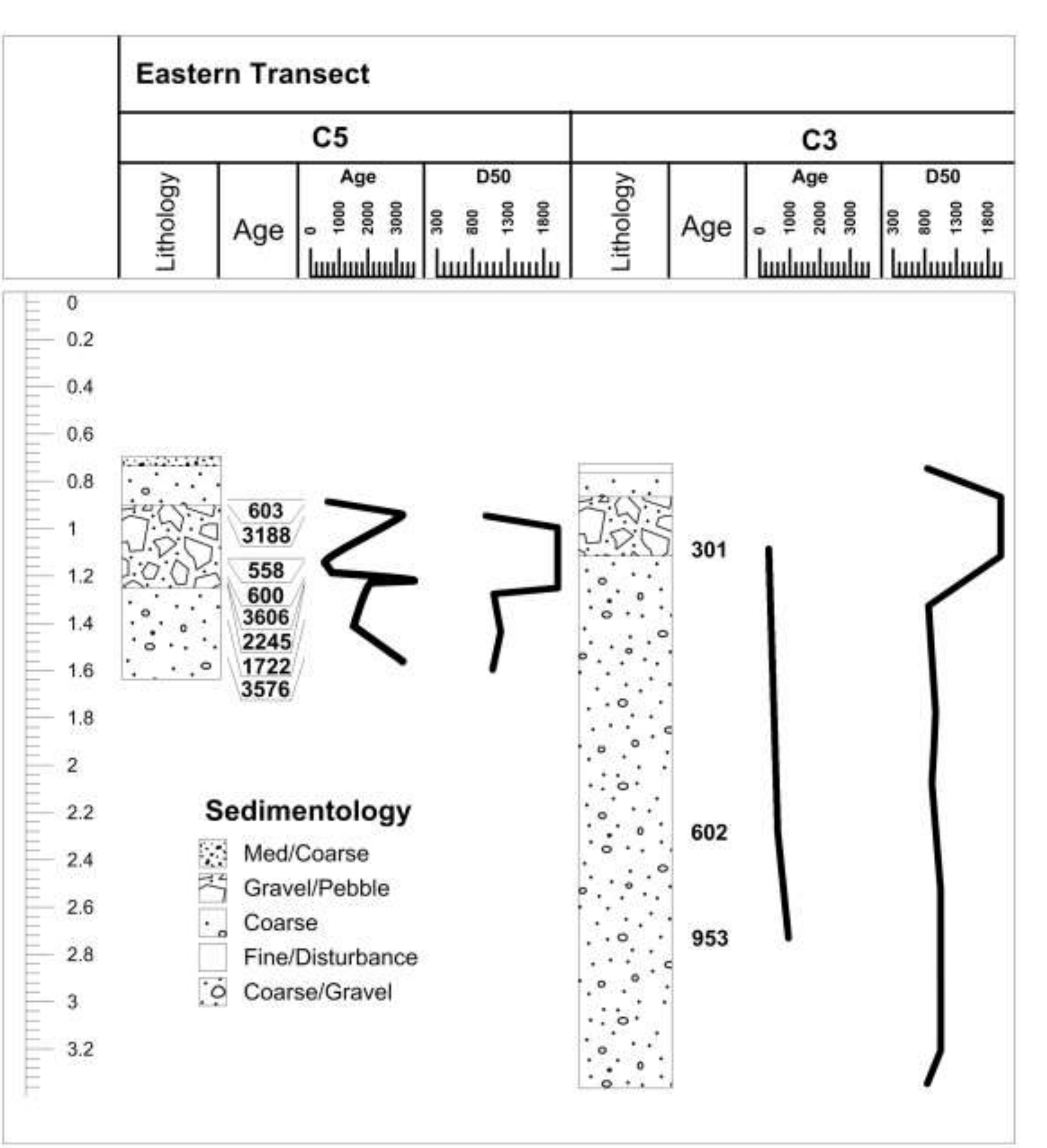

Figure DR3. Core logs of the eastern transect, with depth in MSL, mean grain size (D50), age in cal. yr. BP and sedimentology. Maximum grainsize is limited to 2000 µm (2 cm) with grainsizes exceeding this value (mainly in the coarse gravel deposits) shown as 2000 µm or greater. This was due to the poorly sorted sediment in the coarse deposits with an accurate mean grainsize difficult to determine.

3.2 Central transect

The cores in the central transect were mostly composed of to medium to coarse sand with the coarse storm deposit that was present in the eastern transect also found in this transect. Ages close to the reef flat were old at shallow depths with the oldest age in C12 near the reef flat of 3380 cal. yr. BP at -1.44 m. A relatively old age at shallow depths was also found near the lagoonward extent of the sand apron in C14 with 2829 cal. yr. BP at -2.01 m (Figure DR4). A rapid transition from an old to a younger layer occurred in C12 with ages of 2971 cal. yr. BP (-1.02 m) and 414 cal. yr. BP (-0.92 m) separated by 0.2 m. A similar trend was also observed in C14 where the ages of 2829 cal. yr. BP (-2 m) and 467 cal. yr. BP (-1.64 m) were separated by 0.4 m, both C12 and C14 have young ages above this point of rapid temporal transition (Figure DR3). Two of the three dates in C18 were discounted with one sample located in a storm deposit (2516 cal. yr. BP) and the other sample from the base of the core affected by core disturbance after extraction indicated by very fine sediment due to water seepage through the base of the core (1899 cal. yr. BP).

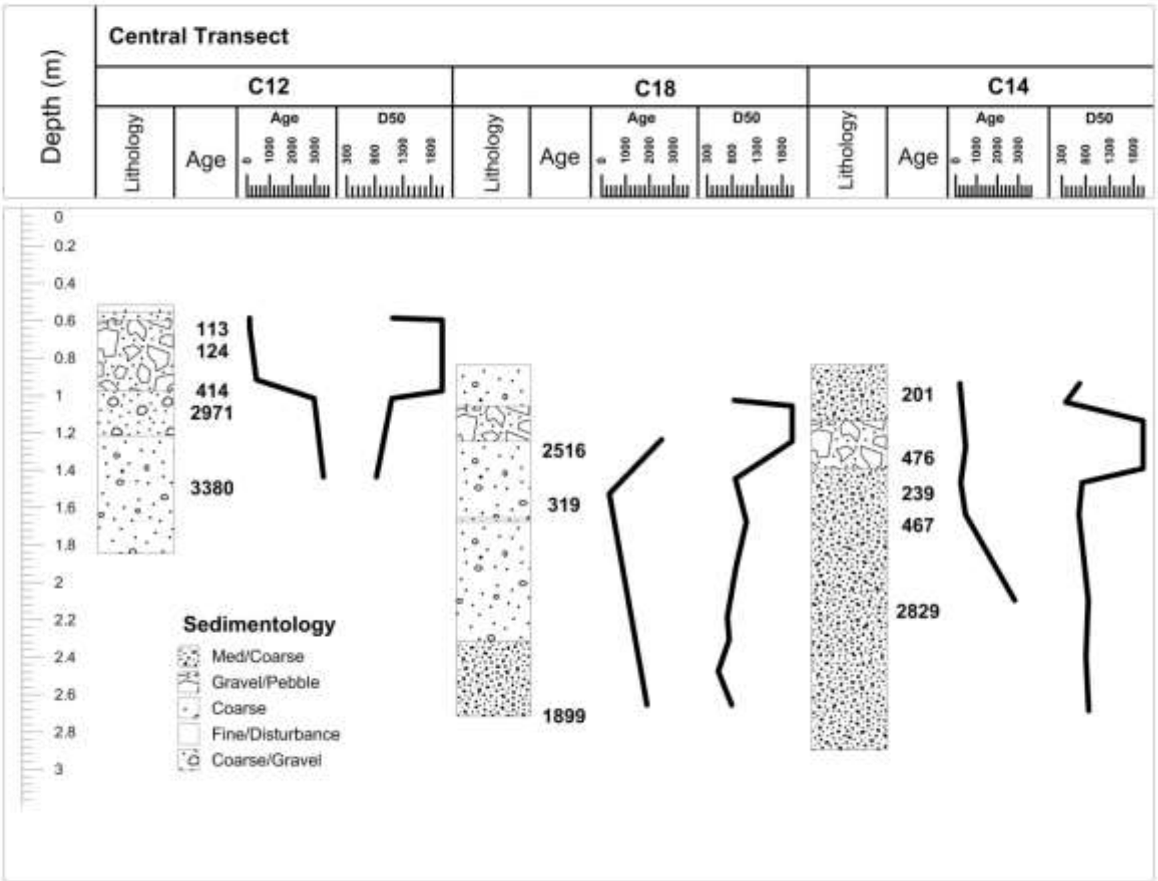

Figure DR4. Core logs of the central transect with depth in MSL, age in cal. yr. BP and D50 mean gain size.

3.3 Western Transect

The cores in the western are mainly composed of medium to coarse sand with the storm deposit most apparent in C6 near the reef flat with no gravel layer found in C15. Old ages are again observed in C6 and C15 with the oldest in C6, 3188 cal. yr. BP at -1.6 m and in C15, 2598 cal. yr. BP at -1.8 m (Figure DR5). Age reversals were apparent which were most likely due to the selection of foraminifera that underwent extensive post-mortem transport before burial. This was due to the difficultly of obtaining pristine samples in some instance in the western transect.

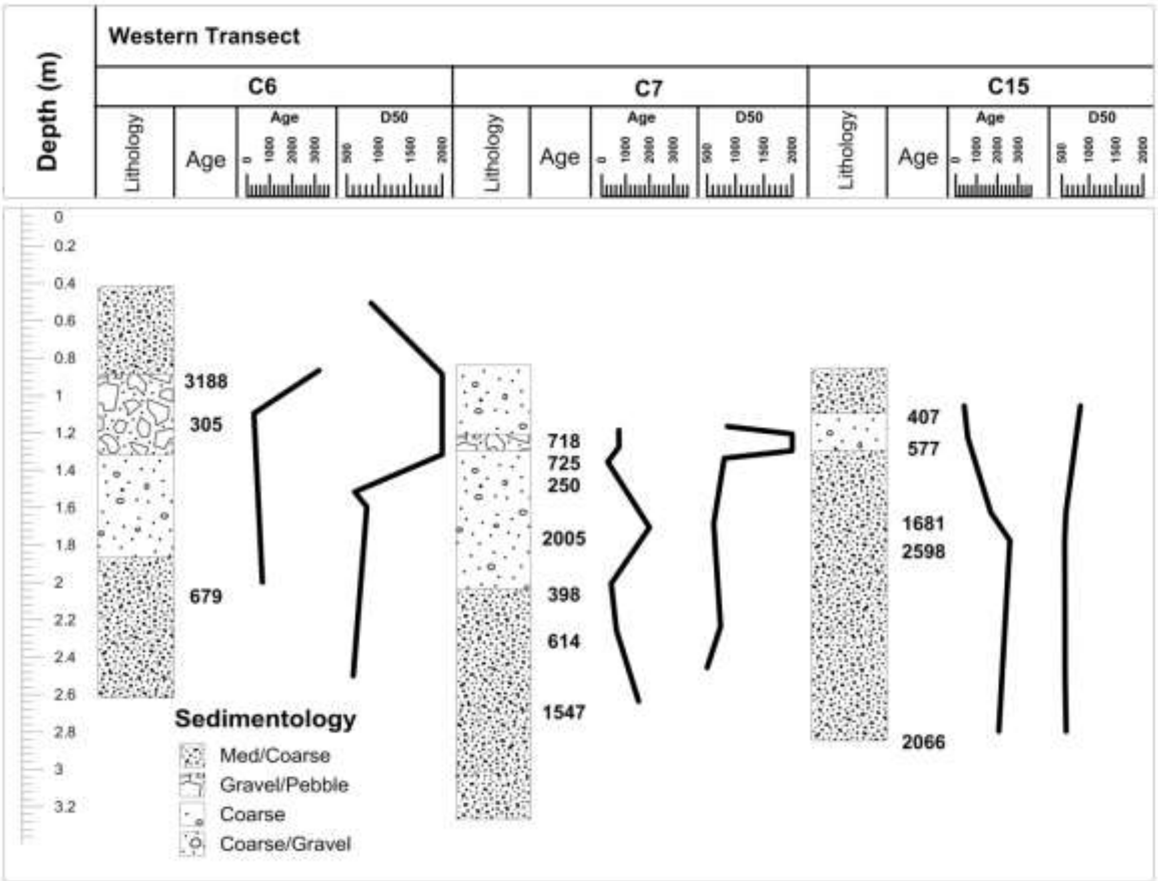

Figure DR5. Core logs of the western transect with depth in MSL, age in cal. yr. BP and D50 mean gain size.

References for Data Repository

Druffel, E. R. M., and Griffin, S., 2004, Southern Great Barrier Reef Coral Radiocarbon DataI. IGBP PAGES/World Data Center for Paleoclimatology, Data Contribution Series #2004-093, NOAA/NCDC Paleoclimatology Program: Boulder CO, USA.

Fink, D., Hotchkis, M., Hua, Q., Jacobsen, G., Smith, A. M., Zoppi, U., Child, D., Mifsud, C., van der Gaast, H., Williams, A., and Williams, M., 2004, The ANTARES AMS facility at ANSTO. : Nuclear Instruments and Methods in Physics Research B, v. 223-224, p. 109-115.

Lewis, S. E., Sloss, C. R., Murray-Wallace, C. V., Woodroffe, C. D., and Smithers, S. G., 2013, Post-glacial sea-level changes around the Australian margin: a review: Quaternary Science Reviews, v. 74, p. 115-138.

Lewis, S. E., Wüst, R. A. J., Webster, J. M., and Shields, G. A., 2008, Mid-late Holocene sea-level variability in eastern Australia: Terra Nova, v. 20, no. 1, p. 74-81.

Marshall, J. F., and Davies, P. J., 1982, Internal structure and Holocene evolution of One Tree Reef, southern Great Barrier Reef: Coral Reefs, v. 1, no. 1, p. 21-28.

Reimer, P. J., Bard, E., Bayliss, A., Beck, J. W., Blackwell, P. G., Ramsey, C. B., Buck, C. E., Cheng, H., Edwards, R. L., and Friedrich, M., 2013, IntCal13 and Marine13 radiocarbon age calibration curves 0–50,000 years cal BP: Radiocarbon, v. 55, no. 4, p. 1869-1887.

Scoffin, T. P., Stoddart, D. R., and Rosen, B. R., 1978, The Nature and Significance of Microatolls: Philosophical Transactions of the Royal Society of London. B, Biological Sciences, v. 284, no. 999, p. 99-122.

Smithers, S. G., and Woodroffe, C. D., 2000, Microatolls as sea-level indicators on a mid-ocean atoll: Marine Geology, v. 168, no. 1–4, p. 61-78.

Stuiver, M., Reimer, P. J., and Reimer, R. W., 2005, CALIB 5.0, www.calib.org.

Vila-Concejo, A., Harris, D. L., Shannon, A. M., Webster, J. M., and Power, H. E., 2013, Coral reef sediment dynamics: evidence of sand-apron evolution on a daily and decadal scale: Journal of Coastal Research, v. SI 65.