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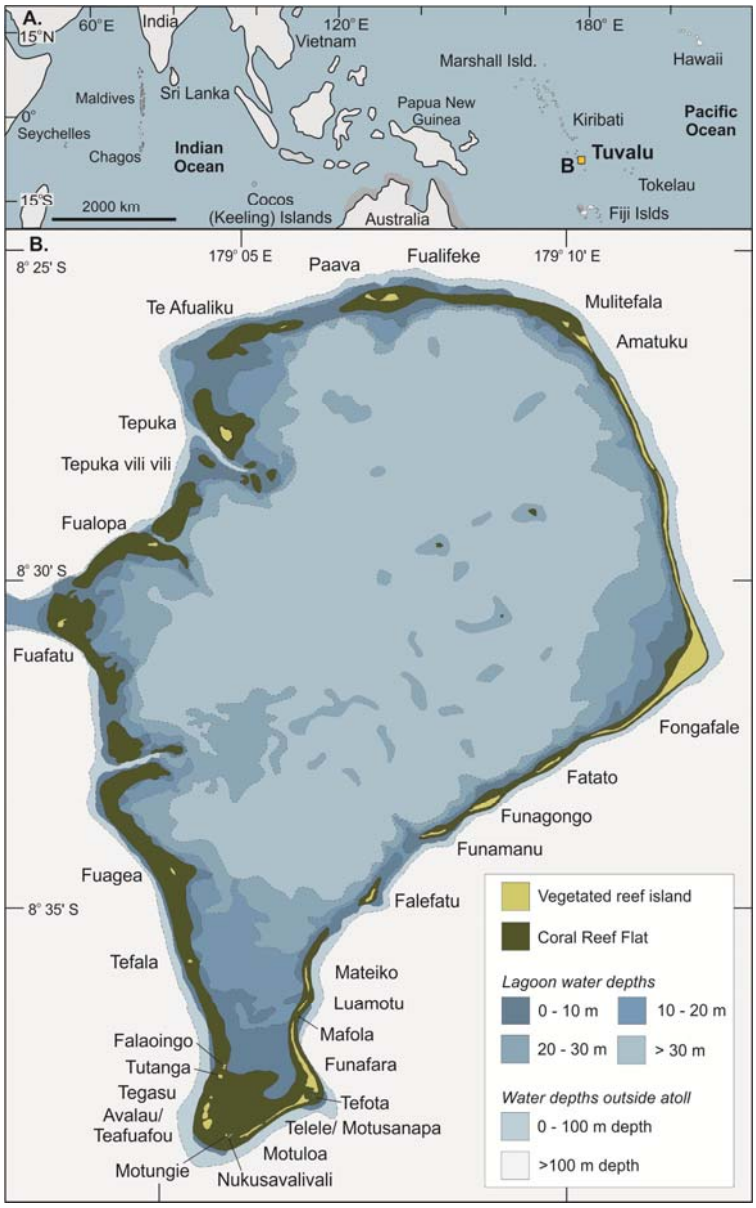
Kench et al., 2018, Storm-deposited coral blocks: A mechanism of island genesis, Tutaga island, Funafuti atoll, Tuvalu: Geology, https://doi.org/10.1130/G45045.1.

DRI Appendix 1 Field Setting

This study examines the morphology, stratigraphy and evolution of Tutaga island, located on the southwest, leeward rim of Funafuti Atoll (Figure 1). Funafuti is one of nine low-lying atolls and reef platforms of the Tuvalu archipelago, situated in the central Pacific Ocean (8^o 32.195'S, 179^o 6.776'E; DRI Fig. 1). Approximately 25 km long and 18 km wide Funafuti has an atoll reef perimeter of ~71 km, which encloses a 40-50 m deep lagoon that covers an area of ~205 km^2. In contrast, Funafuti has a small total land area of <300 ha, consisting of 33 islands distributed unevenly around the atoll, that occupies only 8 % of the surrounding reef platform. Despite variations in size and shape most islands are built of coralline sands and/or gravel derived from the adjacent reef and lagoon and are of mid- to late-Holocene age (McLean and Hosking, 1992, Fig. 1A). A number of islands however have a core of large individual *Porites* coral heads and boulders. Such islands are limited to the southwest reef rim of the atoll and include the islands of Avalau Tengasu, Tefala and Tutaga the last being the focus of this investigation (Fig. 1).

Funafuti atoll is situated in the trade wind zone, experiencing prevailing easterly winds and waves with a significant offshore wave height (H_o) of 1.3 m (maximum wave height H_{max} ~2.3 m), significant wave period (T_s) of 11 s, and peak direction (D_p) of 114° (Bosserelle et al., 2015). The western margin of the atoll, where Tutaga is located, is the leeward rim with monthly H_o values of 0.2-0.4 m (T_s ~ 8–12 s) and H_{max} of 1.0 m (T = 6 s) (Bosserelle et al., 2015). While located outside the primary zone of cyclogenesis, Funafuti is infrequently impacted by cyclone events that generate wave heights between 3 – 4+ m, with anecdotal reports of waves of 1.5-3.0 m propagating across island surfaces (Fitchett, 1981; Maragos et a., 1973). The leeward aspect of the atoll can also be impacted by cyclones that move past the western side to the atoll. A most recent example was Tropical Cyclone Pam that impacted the atoll in 2015.



DRI Figure 1. The location of the Tuvalu archipelago, South Pacific Ocean (A) and location of Tutaga on the southwest rim of Funafuti atoll (B).

References

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DRI Figure 2. Fossil coral storm blocks across the Tutaga reef flat and island surface. A) Coral B1 on outer reef flat transect, B) weathered Merulinid coral mid reef flat, C) Fossil coral with weathered growth rings showing coral not in growth position. D) Storm deposited coral boulders on the mid-island surface. E) Large storm deposited boulder. Fossil Porites coral outcropping at island surface in leeward section of island (Sample I96).

Table DRI 1. Summary of physical characteristics of coral blocks, and estimate of coral growth period, Tutaga reef flat, Funafuti atoll, Tuvalu.

Distance from reef edge (m)	Block No.	Height (m)	Width (m)	Depth (m)	[a]Block vol. (m^3)	[b]Cylinder vol. (m^3)	[C]Coral growth age (yrs)
0-20	1	2.2	2.2	2.6	12.58	9.88	**173**
	4	1.85	1.8	1.65	5.49	4.32	**123**
	5	1.48	1.62	1.1	2.64	2.12	**108**
20-40	2	1.12	1.2	1.75	2.35	1.85	**117**
	6	1.55	2.7	2.45	10.25	8.48	**180**
	16	1.28	2.1	1.95	5.24	4.30	**130**
40-60	3	1.47	2.66	1.75	6.84	5.41	**177**
	7	1.1	3.6	2.78	11.01	10.64	**240**
	14	0.46	1.0	0.95	0.44	0.39	**67**
	15	0.78	2.15	2.1	3.52	3.50	**143**
	17	0.88	2.15	2.2	4.16	3.96	**147**
	18	0.98	2.12	1.8	3.74	3.22	**141**
	19	1.04	1.55	1.52	2.45	1.99	**103**
	20	0.88	1.39	1.77	2.17	1.79	**118**
60-80	8	1.04	3.2	2.04	6.79	5.96	**213**
	31	0.75	1.15	1.54	1.33	1.09	**103**
	32	0.68	1.2	0.96	0.78	0.63	**80**
	36	0.77	0.92	1.48	1.05	0.83	**99**
	38	0.87	1.42	1.47	1.82	1.51	**98**
	39	0.82	1.28	1.08	1.13	0.91	**85**
80-100	10	1.05	1.68	1.48	2.61	2.11	**112**
	11	1.3	2.05	2.2	5.86	4.85	**147**
	12	1.2	2.45	1.5	4.41	3.51	**163**
	13	1.25	2.1	3.05	8.01	6.72	**203**
	24	1.08	1.9	1.64	3.37	2.76	**127**
	25	1.0	1.37	1.65	2.26	1.82	**110**
	26	0.6	1.05	1.0	0.63	0.53	**70**
	28	0.58	2.3	1.95	2.60	2.89	**153**
	29	0.66	1.76	0.98	1.14	0.93	**117**
	30	0.84	1.38	1.24	1.44	1.17	**92**
	33	0.86	1.1	0.98	0.93	0.73	**73**
	35	1.07	1.25	1.08	1.44	1.13	**83**
	34	0.93	1.52	1.24	1.75	1.40	**101**
	37	1.09	2.37	1.38	3.56	2.84	**158**
100-120	9	1.48	1.75	1.58	4.09	3.22	**117**
	40	0.56	1.62	3.15	2.86	2.94	**210**
120-140	23	0.54	1.1	1.56	0.93	0.82	**104**
140-160	41	0.6	1.4	1.1	0.92	0.79	**93**
	42	0.56	0.83	0.86	0.40	0.33	**57**
	21	1.05	1.53	2.0	3.21	2.61	**133**
	22	0.65	1.3	1.15	0.97	0.83	**87**

[a]Block volume calculated based on three axis dimensions. [C]Block volume based on approximation to a cylinder. [c]Coral growth age is calculated from the longest axis divided by 1.5 cm/year (the average extension rate for massive *Porites* bommies). Note the average age for the complete data set (n=41) is 126 years; for the reef flat corals (ie from 0-80 m) the average age is 131 years and for the island 80-160 m (119 years).

Table DRI 2. Radiocarbon ages from coral blocks and island materials, Tutaga Funafuti Atoll, Tuvalu

Lab code	[a]Island sample location	Sample material	Conventional age (yr B.P.)	Calibrated age range (95.4% probability) (cal. yr B.P.)	Mid point of calibrated age range (cal. yr B.P.)
Wk-41300	TUT B1	*Porites* coral block	1,550 ± 32	991-1,212	1,102
Wk-41294	TEF B1	*Porites* coral block	1,519 ± 29	966-1,166	1,066
Wk-41304	TUT B18	*Porites* coral block	1,460 ± 27	915-1,098	1,007
Wk-41301	TUT B4	*Porites* coral block	1,320 ± 30	761-937	849
Wk-41310	TUT I28	*Porites* coral Isld block	1,233 ± 26	685-871	778
Wk-41306	TUT B28	*Porites* coral block	1,216 ± 27	669-850	760
Wk-41305	TUT B21	*Porites* coral block	1,200 ± 29	658-827	743
WK-41296	TEF B35	*Porites* coral block	1,192 ± 19	661-792	727
Wk-41303	TUT B15	*Porites* coral block	1,212 ± 27	666-846	726
Wk-41302	TUT B8	*Porites* coral block	1,151 ± 27	637-765	701
Wk-41308	TUT B34	*Porites* coral block	1,130 ± 29	621-754	688
Wk-41307	TUT B32	*Porites* coral block	1,055 ± 27	544-672	608
Wk-41295	TEF B2	*Porites* coral block	1,072 ± 24	553-685	619
Wk-41313	TUT I95	*Porites* coral Isld block	1,037 ± 23	539-659	599
Wk-41312	TUT I86	*Porites* coral Isld block	984 ± 27	510-634	572
Wk-41297	TEF B40	*Porites* coral block	824 ± 29	367-518	443
Wk-41311	TUT I58	*Porites* coral Isld block	757 ± 26	304-467	386
Wk-41309	TUT I22	*Porites* coral Isld block	736 ± 22	295-449	372
Wk-41299	TUT I96	Coral gravel clast	726 ± 20	290-438	364
Wk-41298	TEF B71	*Porites* coral block	693 ± 30	265-425	345

[a] TUT = Tutaga reef flat coral blocks, TEF = adjacent Tefala reef flat coral blocks used to augment the reef flat chronology, B = coral block, I = island block or gravel sample. [b]Four age groupings are inferred suggestive of periods of storm activity: (1) 1102 to 1007 yr BP (n=3, x=1058); (2) 778 to 688 yr BP (n=7, x=732); (3) 619 to 572 yr BP (n=4, x=600) and; (4) 386 to 345 yr BP (n=4, x=367). *Note*: Radiocarbon dates obtained from the Radiocarbon Dating Laboratory, University of Waikato (Wk), New Zealand. Ages calibrated using OxCal version 4.2.4 (Bronk Ramsey, 2013) with marine data set (Reimer et al., 2013) and Delta-R of 6 ± 21 as best estimate for Tuvalu.

Notes on Coral Sampling and Sample Preparation

Samples from the coral blocks were retrieved either by drill core or geological hammer. Careful attention was paid to finding the coral growth bands and orientation of corallites in order to identify the most recent living block surface prior storm transport and polyp death. However, we cannot guarantee that that objective was achieved in all cases. Drill cores of 3.5 cm diameter and length ranging from 15 to 30cm together with 10 x 5 x 5 cm geological hammer samples (10x5x5 cm in size) were sliced to remove the surface layer of cyanobacteria and filamentous algae and inspected for any inclusions of sediment (which was removed) and obvious recrystallization of the original aragonite skeleton to calcite. Samples were forwarded to the University of Waikato Radiocarbon Dating Laboratory for radiometric (liquid scintillation spectrometry) dating.

Samples were pre-treated as marine shell samples and etched with dilute HCL to minimize the possibility contamination through isotopic exchange and all aragonite shell samples are tested for recrystallization prior to dating to ensure no chemical alteration has taken place. Further details on pre-treatment and operating procedures are available at the University of Waikato Radiocarbon Dating Laboratory at:
https://www.radiocarbondating.com/operating-procedures/radiometric-dating

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