

# Supporting Information for Precision measurement of $\delta^{234}\text{U}$ in annually banded tropical corals

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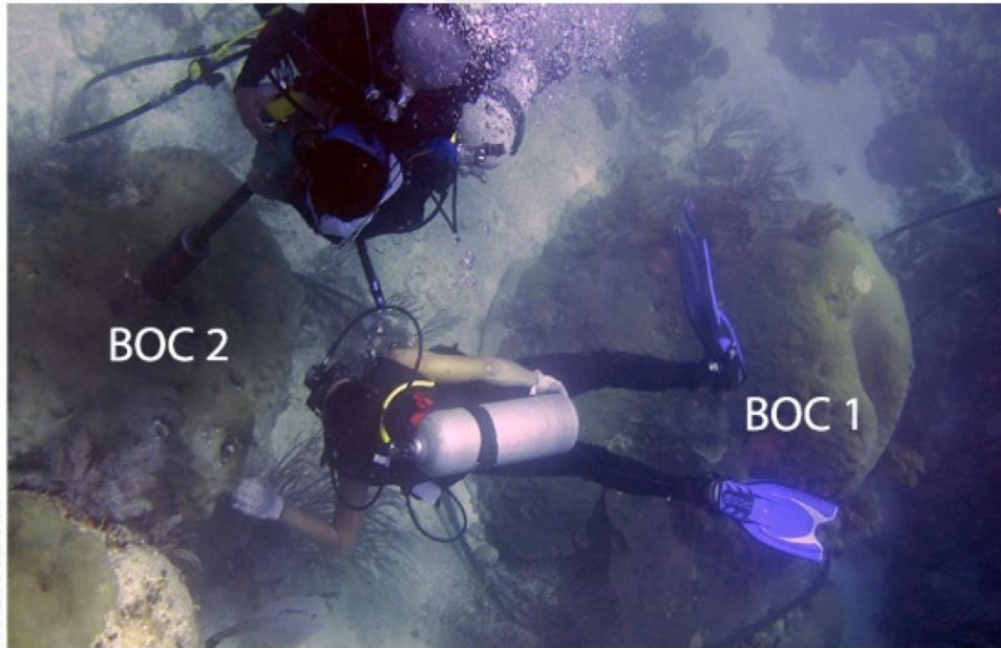
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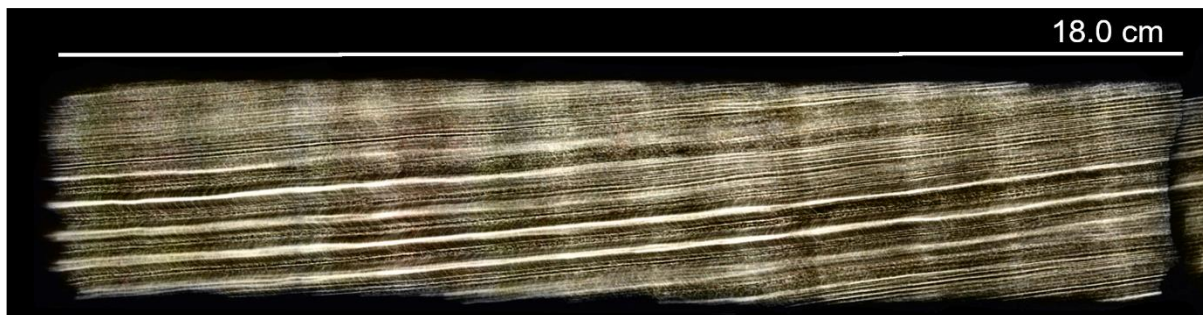
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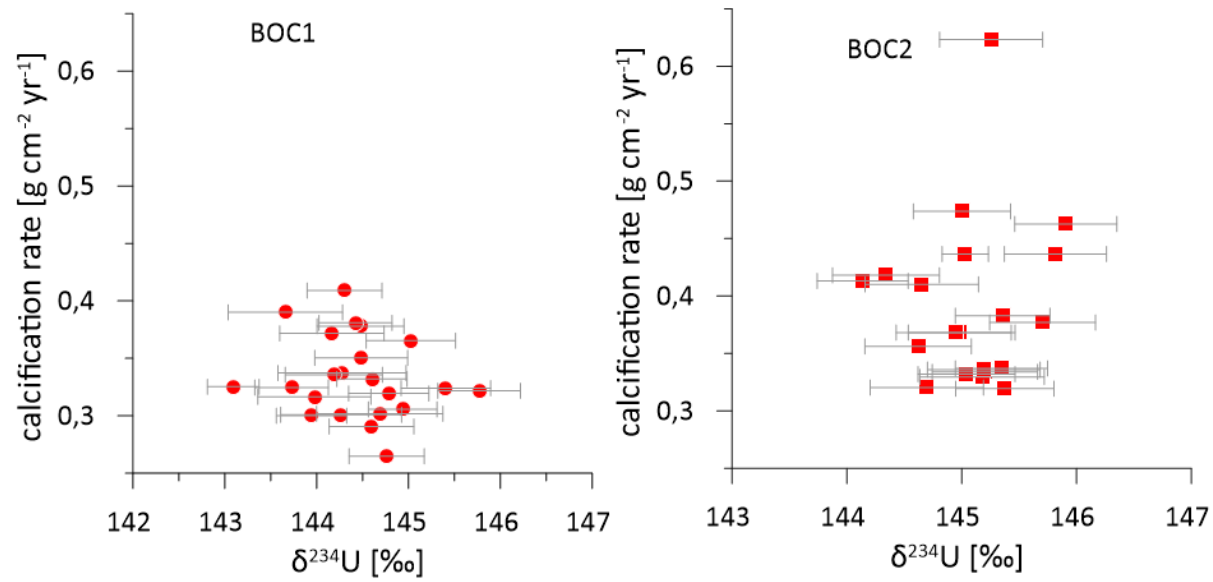
Tables S1 to S4



Supplementary Figure S1: La Bocana Reef, Mexico, the underwater image showing proximity of the two sampled coral colonies BOC1 and BOC2



Supplementary Figure S2: Photo with the overlain x-ray image of the Venezuelan ROQ\_V coral core. Semi-annual samples were cut along the density bands, and seasonal samples were archived by halving these density bands.



Supplementary Figure S3: no correlation between the calcification rates (Rico-Esenaro et al., 2022) and  $\delta^{234}\text{U}$  values is visible.

**Supplementary Table S1: Cuban Species  $\delta^{234}\text{U}$  measurements together with concentrations of  $^{238}\text{U}$  and  $^{234}\text{U}$  of annually integrated samples.  $\delta^{234}\text{U}$  values are given normalised after (Cheng et al., 2013). Measurement uncertainties are  $2\sigma$  analytical errors**

sample ID	sample lable	Year	$\delta^{234}\text{U}$ (‰)	Error $\delta^{234}\text{U}$ (‰)	$^{234}\text{U}$ (pg/g)	Error $^{234}\text{U}$ (pg/g)	$^{238}\text{U}$ ( $\mu\text{g/g}$ )	Error $^{238}\text{U}$ ( $\mu\text{g/g}$ )
12477	RL_Siderastrea siderea	2015	146.01	0.59	147.20	0.31	2.37466	0.00016
12478	RL_Mycetophyllia lamarckiana	2015	145.65	0.44	139.05	0.25	2.24837	0.00010
12480	RL_Agaricia agaricites	2015	145.44	0.64	170.26	0.48	2.73821	0.00035
12481	RL_Meandrina meandites	2015	146.20	0.54	194.88	0.57	3.11970	0.00016
12482	RL_Acropora cervicornis	2015	145.62	0.50	174.16	0.53	2.79614	0.00016
12484	RL_Colpophyllia natans	2015	145.65	0.53	114.33	0.13	1.84539	0.00011
12485	RL_Diploria labyrinthiformis	2015	145.21	0.62	142.79	0.17	2.30343	0.00017
12486	RL_Colpophyllia natans 2	2015	145.11	0.52	116.07	0.14	1.87722	0.00011
12487	RL_Montastraea cavernosa	2015	145.23	0.51	157.84	0.21	2.55018	0.00015
12490	RL_Orbicella faveolata	2015	145.47	0.58	160.94	0.44	2.58431	0.00017
12479	RL_Acropora palmata	2015	145.48	0.47	164.04	0.67	2.61844	0.00018

**Supplementary Table S2: Volume test  $\delta^{234}\text{U}$  measurements together with concentrations of  $^{238}\text{U}$  and  $^{234}\text{U}$  of annually integrated samples.  $\delta^{234}\text{U}$  values are given normalised after (Cheng et al., 2013). Measurement uncertainties are  $2\sigma$  analytical errors**

sample ID	sample lable	$\delta^{234}\text{U}$ (‰)	Error $\delta^{234}\text{U}$ (‰)	$^{234}\text{U}$ (pg/g)	Error $^{234}\text{U}$ (pg/g)	$^{238}\text{U}$ ( $\mu\text{g/g}$ )	Error $^{238}\text{U}$ ( $\mu\text{g/g}$ )
12312	Mururoa 20mg	144.69	0.62	139.58	0.14	2.24378	0.00006
12313	Mururoa 40mg	146.32	1.16	140.36	0.61	2.22908	0.00013
12314	Mururoa 60mg	145.11	0.36	135.24	0.18	2.16803	0.00006
12315	Mururoa 70mg	145.83	0.33	137.25	0.20	2.20175	0.00006
12316	Mururoa 80mg	146.51	0.98	135.85	0.90	2.15256	0.00019
12318	Mururoa 100mg	143.92	0.38	135.85	0.44	2.17141	0.00011
12319	Mururoa 120mg	145.99	0.34	137.41	0.48	2.18193	0.00016
12320	Mururoa 150mg	146.53	0.42	136.10	0.23	2.16909	0.00007

Supplementary Table S3: ROQV  $\delta^{234}\text{U}$  measurements together with concentrations of  $^{238}\text{U}$  and  $^{234}\text{U}$  of annually integrated samples.  $\delta^{234}\text{U}$  values are given normalised after (Cheng et al., 2013). Measurement uncertainties are  $2\sigma$  analytical errors

sample ID	sample lable	Year	$\delta^{234}\text{U}$ (‰)	Error $\delta^{234}\text{U}$ (‰)	$^{234}\text{U}$ (pg/g)	Error $^{234}\text{U}$ (pg/g)	$^{238}\text{U}$ ( $\mu\text{g/g}$ )	Error $^{238}\text{U}$ ( $\mu\text{g/g}$ )
12311	ROQV_1994.2	1993.5	144.91	0.33	155.65	0.31	2.50757	0.00011
12310	ROQV_1994.1	1994	144.80	0.35	155.54	0.30	2.50137	0.00011
12309	ROQV_1995.2	1994.5	144.40	0.39	160.49	0.35	2.59284	0.00010
12308	ROQV_1995.1	1995	144.65	0.33	161.45	0.33	2.60346	0.00011
12307	ROQV_1996.2	1995.5	145.88	0.54	160.79	0.48	2.58527	0.00014
12306	ROQV_1996.1	1996	144.92	0.36	156.80	0.36	2.53474	0.00009
12305	ROQV_1997.2	1996.5	145.03	0.33	158.56	0.37	2.56492	0.00011
12304	ROQV_1997.1	1997	144.70	0.33	154.98	0.34	2.50879	0.00011
12265	ROQV_1998.2	1997.5	143.99	0.55	298.41	1.15	4.87591	0.00025
12264	ROQV_1998.1	1998	146.77	0.57	154.54	0.32	2.49571	0.00015
12263	ROQV_1999.2	1998.5	144.45	0.47	96.14	0.16	1.55584	0.00009
12262	ROQV_1999.1	1999	146.33	0.55	149.29	0.36	2.40941	0.00013
12261	ROQV_2000.2	1999.5	146.66	0.57	147.11	0.41	2.36788	0.00015
12260	ROQV_2000.1	2000	144.82	0.47	128.50	0.44	2.08210	0.00011
12259	ROQV_2001.2	2000.5	142.82	1.29	147.49	1.14	2.39933	0.00152
12258	ROQV_2001.1	2001	144.23	0.48	146.22	0.53	2.36402	0.00015
12257	ROQV_2002.2	2001.5	146.18	0.58	146.95	0.61	2.37813	0.00030
12256	ROQV_2002.1	2002	145.82	0.56	138.28	0.31	2.23030	0.00044
12255	ROQV_2003.2	2002.5	145.47	0.44	146.68	0.56	2.35922	0.00054
12254	ROQV_2003.1	2003	145.22	0.58	147.75	0.40	2.38306	0.00012
12253	ROQV_2004.2	2003.5	144.82	0.60	144.22	0.50	2.32327	0.00017
12252	ROQV_2004.1	2004	145.25	0.48	146.90	0.33	2.36592	0.00014
12251	ROQV_2005.2	2004.5	145.19	0.42	147.42	0.45	2.36740	0.00016
13279	ROQV_seas_1996.75	1996.8	144.63	0.63	147.02	1.35	2.38661	0.00722
13281	ROQV_seas_1997.25	1997.3	146.02	0.79	156.56	1.62	2.49205	0.00145
13282	ROQV_seas_1997.5	1997.5	143.70	1.10	152.84	1.05	2.40777	0.00052

13283	ROQV_seas_1997.75	1997.8	144.69	0.82	153.31	0.15	2.46696	0.00018
13284	ROQV_seas_1998	1998	147.58	0.92	151.62	0.20	2.43739	0.00049
13286	ROQV_seas_1998.5	1998.5	145.32	0.47	152.61	0.22	2.44098	0.00011
13287	ROQV_seas_1998.75	1998.8	145.13	0.54	145.75	0.53	2.29657	0.00030
13288	ROQV_seas_1999	1999	143.69	0.74	148.44	1.07	2.36133	0.00169
13289	ROQV_seas_1999.25	1999.3	145.49	0.68	148.99	0.74	2.44441	0.00037
13290	ROQV_seas_1999.5	1999.5	144.27	0.66	148.19	0.88	2.41089	0.00045
13292	ROQV_seas_2000	2000	146.85	0.92	154.09	0.62	2.52346	0.00153
13293	ROQV_seas_2000.25	2000.3	145.29	0.62	153.35	1.81	2.43387	0.00109
13294	ROQV_seas_2000.5	2000.5	145.66	0.46	142.33	0.15	2.28296	0.00011
13295	ROQV_seas_2000.75	2000.8	145.81	0.43	157.09	0.43	2.43321	0.00021
13296	ROQV_seas_2001	2001	146.23	0.54	142.33	0.15	2.28296	0.00011

**Supplementary Table S4: BOC\_1 and BOC\_2  $\delta^{234}\text{U}$  measurements together with concentrations of  $^{238}\text{U}$  and  $^{234}\text{U}$  of annually integrated samples.  $\delta^{234}\text{U}$  values are given normalised after (Cheng et al., 2013). Measurement uncertainties are  $2\sigma$  analytical errors**

sample ID	sample lable	Year	$\delta^{234}\text{U}$ (‰)	Error $\delta^{234}\text{U}$ (‰)	$^{234}\text{U}$ (pg/g)	Error $^{234}\text{U}$ (pg/g)	$^{238}\text{U}$ (µg/g)	Error $^{238}\text{U}$ (µg/g)
12662	BOC_2_piece_1994	1994	145.36	0.41	176.39	0.57	2.84157	0.00016
12663	BOC_2_piece_1995	1995	145.70	0.46	173.85	0.40	2.79826	0.00012
12664	BOC_2_piece_1996	1996	145.20	0.46	170.72	0.45	2.76238	0.00013
12665	BOC_2_piece_1997	1997	145.35	0.40	176.94	0.58	2.85947	0.00020
12666	BOC_2_piece_1998	1998	145.38	0.43	179.63	0.67	2.91201	0.00017
12667	BOC_2_piece_1999	1999	144.98	0.45	180.57	0.48	2.91889	0.00018
12668	BOC_2_piece_2001	2001	144.14	0.40	171.35	0.51	2.78035	0.00014
12669	BOC_2_piece_2002	2002	145.04	0.42	173.65	0.54	2.82173	0.00016
12670	BOC_2_piece_2003	2003	145.03	0.20	181.23	0.23	2.92659	0.00007
12671	BOC_2_piece_2004	2004	144.95	0.52	174.24	0.43	2.82595	0.00014
12672	BOC_2_piece_2005	2005	144.70	0.49	176.21	0.70	2.86372	0.00013
12673	BOC_2_piece_2006	2006	145.18	0.54	180.24	0.70	2.94112	0.00022
12674	BOC_2_piece_2007	2007	145.19	0.49	173.31	0.51	2.81876	0.00015

12675	BOC_2_piece_2008	2008	145.00	0.42	168.10	0.50	2.73091	0.00015
12676	BOC_2_piece_2009	2009	144.65	0.49	174.77	0.53	2.83265	0.00017
12677	BOC_2_piece_2010	2010	144.34	0.47	170.15	0.55	2.75220	0.00016
12678	BOC_2_piece_2011	2011	145.91	0.44	165.29	0.52	2.68210	0.00011
12679	BOC_2_piece_2012	2012	145.82	0.44	163.26	0.44	2.64808	0.00019
12680	BOC_2_piece_2013	2013	145.26	0.45	164.58	0.44	2.66412	0.00016
12682	BOC_2_piece_2015	2015	144.62	0.46	159.45	0.47	2.58012	0.00019
12581	BOC_2_pulver_2005	2005	145.68	0.55	175.27	0.41	2.82260	0.00013
12582	BOC_2_pulver_2006	2006	145.17	0.60	182.29	0.79	2.93549	0.00025
12583	BOC_2_pulver_2007	2007	145.85	0.56	175.27	0.41	2.82260	0.00013
12584	BOC_2_pulver_2008	2008	145.34	0.56	167.96	0.60	2.71213	0.00019
12585	BOC_2_pulver_2009	2009	144.58	0.56	173.59	0.60	2.82018	0.00017
12586	BOC_2_pulver_2010	2010	144.05	0.54	160.24	0.58	2.57853	0.00017
12587	BOC_2_pulver_2011	2011	144.02	0.59	162.26	0.68	2.60320	0.00019
12588	BOC_2_pulver_2012	2012	145.53	0.60	159.20	0.67	2.56244	0.00018
12589	BOC_2_pulver_2013	2013	144.27	0.64	167.09	0.83	2.67359	0.00024
12590	BOC_2_pulver_2014	2014	144.78	0.46	167.60	0.52	2.68783	0.00015
12558	BOC_1_pulver_2007	2007	144.61	0.69	168.35	0.89	2.70404	0.00097
12559	BOC_1_pulver_2008	2008	144.90	0.53	181.16	0.68	2.91181	0.00020
12560	BOC_1_pulver_2009	2009	145.13	0.46	168.46	0.51	2.71257	0.00013
12561	BOC_1_pulver_2010	2010	144.72	0.51	175.53	0.68	2.81771	0.00018
12562	BOC_1_pulver_2011	2011	144.18	0.58	186.13	0.68	2.98531	0.00020
12563	BOC_1_pulver_2012	2012	146.12	0.61	169.52	0.46	2.72677	0.00013
12564	BOC_1_pulver_2013	2013	144.74	0.46	164.82	0.60	2.66585	0.00012
12565	BOC_1_pulver_2014	2014	145.00	0.57	158.26	0.70	2.53675	0.00016
12566	BOC_1_pulver_2015	2015	144.75	0.53	164.21	0.63	2.64247	0.00023
12567	BOC_1_pulver_2016	2016	145.38	0.49	159.24	0.50	2.55828	0.00012
12751	BOC_1_piece_1992	1992	144.69	0.69	175.97	0.57	2.85574	0.00017
12370	BOC_1_piece_1993	1993	144.27	0.66	164.35	0.38	2.65053	0.00012
12371	BOC_1_piece_1994	1994	143.98	0.62	159.80	0.40	2.57821	0.00011

12372	BOC_1_piece_1995	1995	144.61	0.50	169.01	0.54	2.72030	0.00013
12373	BOC_1_piece_1996	1996	143.73	0.40	148.60	0.38	2.40412	0.00010
12374	BOC_1_piece_1997	1997	144.76	0.41	168.31	0.32	2.69140	0.00011
12375	BOC_1_piece_1998	1998	144.89	0.43	168.37	0.49	2.72195	0.00013
12376	BOC_1_piece_1999	1999	143.94	0.38	146.78	2.67	2.58595	0.00077
12377	BOC_1_piece_2000	2000	144.28	0.70	158.83	0.72	2.57350	0.00020
12378	BOC_1_piece_2001	2001	144.05	0.52	168.47	0.33	2.72502	0.00013
12379	BOC_1_piece_2002	2002	144.19	0.53	174.09	0.36	2.81713	0.00013
12380	BOC_1_piece_2003	2003	144.60	0.38	171.94	1.39	2.75097	0.00028
12381	BOC_1_piece_2004	2004	143.56	0.48	164.71	0.59	2.65459	0.00015
12382	BOC_1_piece_2005	2005	144.17	0.57	166.32	0.33	2.68830	0.00011
12383	BOC_1_piece_2006	2006	143.66	0.62	120.66	0.25	1.94520	0.00008
12267	BOC_1_piece_2008	2008	144.79	0.44	165.45	0.21	2.65794	0.00006
12268	BOC_1_piece_2009	2009	144.94	0.37	165.95	0.18	2.65956	0.00006
12269	BOC_1_piece_2010	2010	143.60	0.31	171.61	0.21	2.75950	0.00006
12270	BOC_1_piece_2011	2011	143.09	0.28	173.96	0.17	2.79949	0.00006
12271	BOC_1_piece_2012	2012	145.77	0.45	173.31	0.31	2.77193	0.00022
12272	BOC_1_piece_2013	2013	145.78	0.38	174.60	0.44	2.79230	0.00013

Cheng, H., Lawrence Edwards, R., Shen, C.-C., Polyak, V. J., Asmerom, Y., Woodhead, J., Hellstrom, J., Wang, Y., Kong, X., Spötl, C., Wang, X., & Calvin Alexander, E. (2013). Improvements in 230Th dating, 230Th and 234U half-life values, and U–Th isotopic measurements by multi-collector inductively coupled plasma mass spectrometry. *Earth and Planetary Science Letters*, 371-372, 82-91. <https://doi.org/10.1016/j.epsl.2013.04.006>

Rico-Esenaro, S., Sanchez-Cabeza, J.-A., Ruiz-Fernández, A., Montagna, P., & Carricart-Ganivet, J. P. (2022). Comparison of 100 Years of Growth in Two Nearby Coral Colonies of *Orbicella Faveolata* and Their Relationship with Climatic Oscillations in the Mexican Caribbean. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.4264477>