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Indian winter and summer monsoon strength over the 4.2 ka BP event in foraminifer isotope records from the Indus River delta in the Arabian Sea

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Supplemental figures and tables

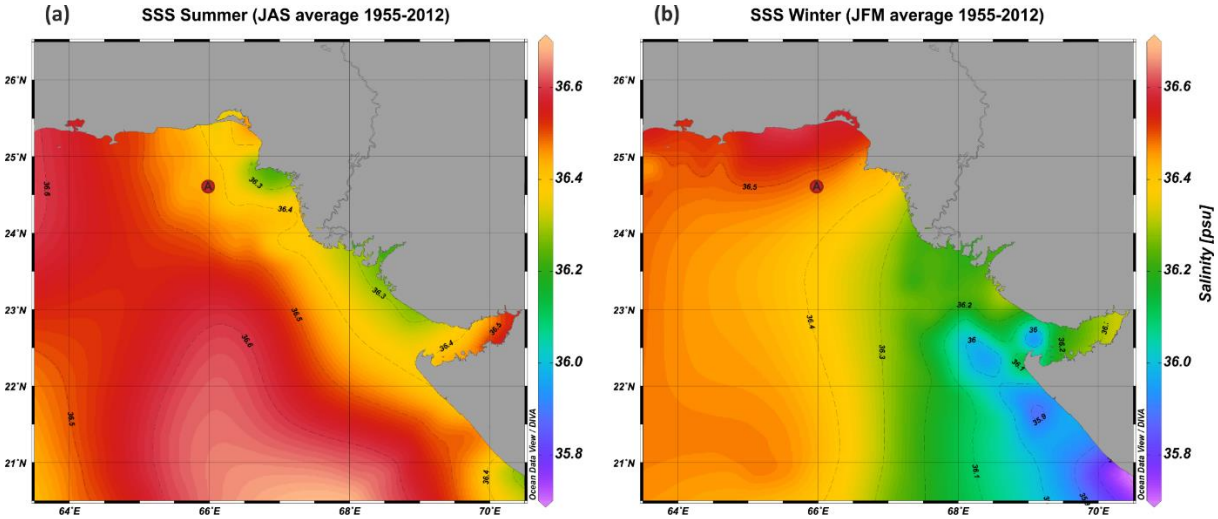

Figure S1. Mean surface salinity for 1955-2012, with data from the 2013 World Ocean Atlas (WOA) at 0.25° resolution (Zweng et al., 2013). Salinity contours are shown for **a.** summer (JAS) and **b.** winter (JFM). The Indus River is outlined. Note that over the time window of this dataset, modern Indus River discharge has been reduced by >50% due to barrages and irrigation (Ahmad et al., 2001). Plots created with Ocean Data Viewer (ODV).

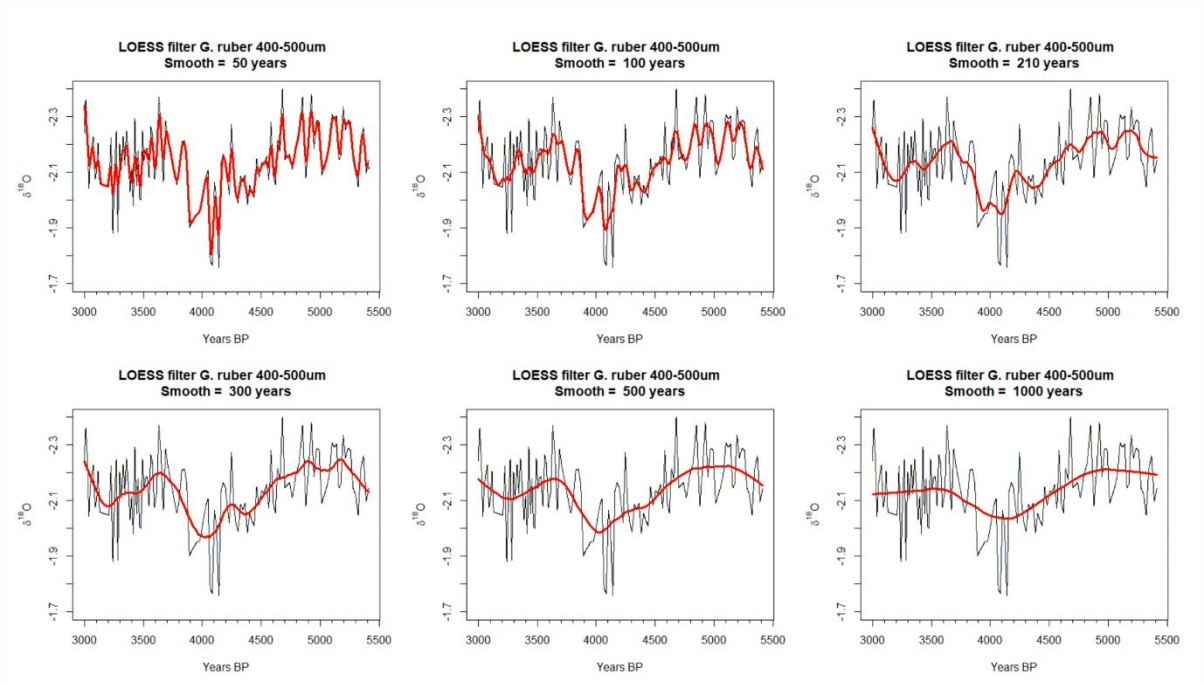

Figure S2. Comparison of loess smoothing windows of 50, 100, 210, 300, 500, and 1000 years for *G. ruber* in the 400-500µm fraction.

Figure S3. Modern $\delta^{18}O$ values of calcite, spanning approximately the last 200 years, measured from surface sediment samples for all three species at the size fractions 315-400µm. Averages values for the last 200 years (~1780-1993 AD) are compared to the period 5.4-3.0 ka BP: -2.01‰ (modern) and -1.90‰ (old) for *G. ruber* (orange), -1.28‰ (modern) and -1.31‰ (old) for *G. sacculifer* (green), and -0.72‰ (modern) and -0.76‰ (old) for *N. dutertrei* (blue).

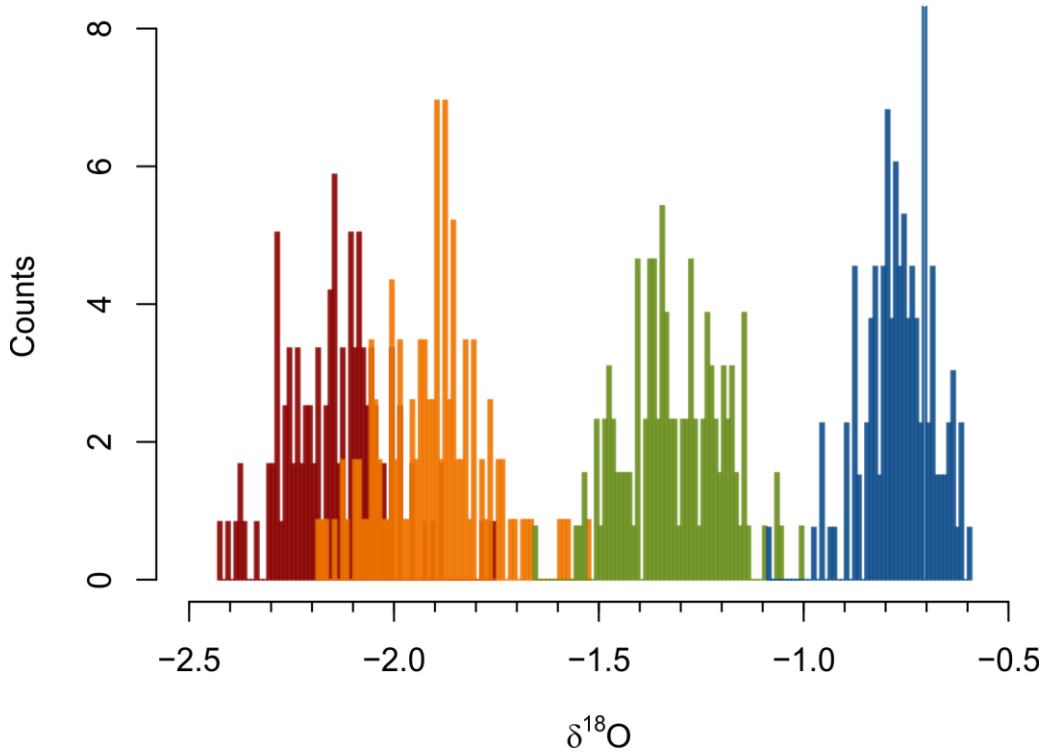

Figure S4. Frequency distributions of $\delta^{18}O$ data during 5.4-3.0 ka BP for *G. ruber* 400-500µm (red), *G. ruber* 315-400µm (orange), *G. sacculifer* 315-400µm (green), *N. dutertrei* 315-400µm (blue).

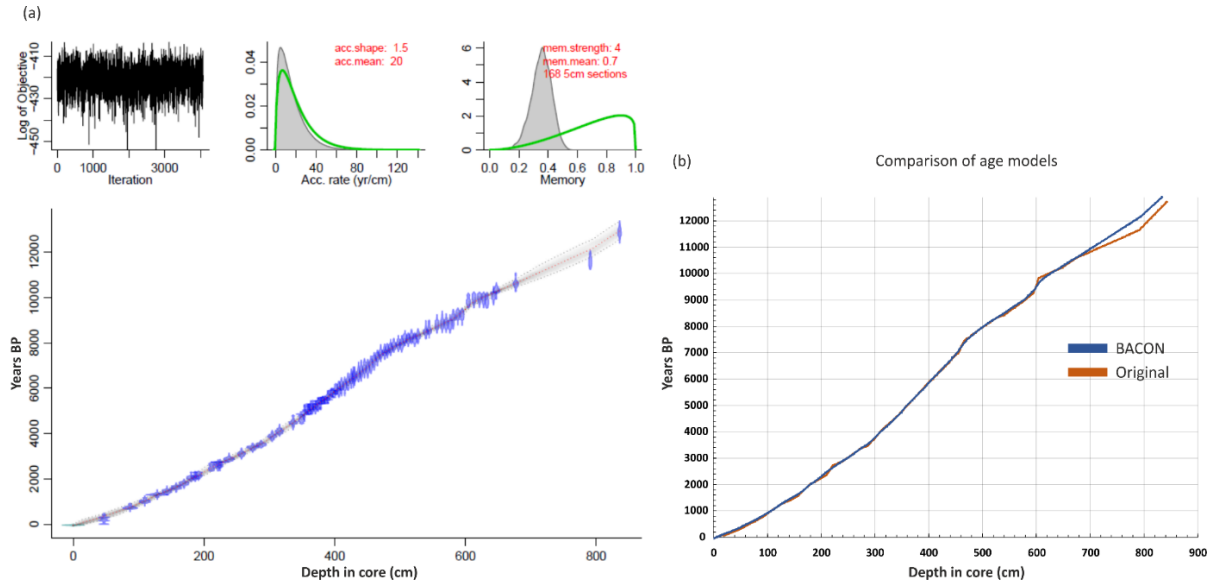

Figure S5. a. BACON age-depth model with calibrated dates shown in blue **b.** Age-depth model comparison with the original published age model from Staubwasser et al. (2003) (orange) and the new age model based on BACON software (blue).

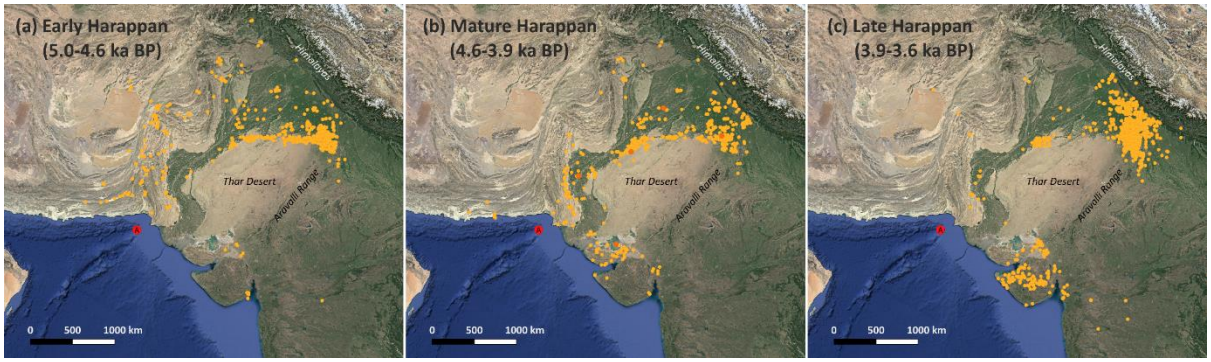

Figure S6. Indus site distributions (yellow points) during the **a.** Early Harappan (~5.0-4.6 ka BP), **b.** Mature Harappan (~4.6-3.9 ka BP), and **c.** Late Harappan (~3.9-3.6 ka BP). Orange sites show larger Harappan cities during the Mature Harappan period (Dholavira, Mohenjo Daro, Ganweriwala, Harappa, and Rakhigarhi from bottom to top), core 63KA shown by red circle, background terrain from Google Earth.

Table S1. Main statistical parameters of the $\delta^{18}O$ data.

	G. ruber 400-500µm	*G. ruber 315-400µm*	*G. sacculifer 315-400µm*	*N. dutertrei 315-400µm*
n	119	115	129	132
Minimum	-2.423	-2.190	-1.660	-1.090
Maximum	-1.752	-1.520	-1.000	-0.590
1st Quartile	-2.232	-1.995	-1.400	-0.810
3rd Quartile	-2.068	-1.830	-1.220	-0.700
Mean	-2.139	-1.901	-1.312	-0.761
Median	-2.144	-1.890	-1.320	-0.760
Sum	-254.58	-218.66	-169.26	-100.46
SE Mean	0.012	0.012	0.011	0.007
LCL Mean	-2.163	-1.926	-1.333	-0.776
UCL Mean	-2.116	-1.877	-1.291	-0.746
Variance	0.016	0.017	0.015	0.007
Stdev	0.128	0.131	0.122	0.085
Skewness	0.408	0.288	-0.011	-0.592
Kurtosis	0.511	0.174	-0.364	0.850

Table S2. Age-Model calibration with BACON software.

Depth (cm)	***^{14}C date***	***Error (±1σ)***	***Reservoir (years)***	***IntCal13 min age BP***	***IntCal13 max age BP***	***IntCal13 mean age BP***
surface	-	-	-	-	-	-43
47	790	30	565	267	309	288
87	1370	35	565	678	780	729
109.5	1665	30	565	952	1062	1007
128.5	1955	25	565	1283	1339	1311
143.5	2115	35	565	1369	1529	1449
157.5	2270	25	565	1552	1634	1593
169.5	2430	25	565	1728	1869	1799
180.5	2640	25	565	1988	2122	2055
186.5	2675	35	565	1993	2154	2074
191.5	2720	30	565	2044	2184	2114
211.5	3000	35	565	2356	2541	2449
221.5	3110	40	565	2491	2602	2547
224.5	3145	25	565	2708	2758	2733
238.5	3340	25	565	2836	2929	2883
257.5	3510	30	565	2999	3181	3090
274.5	3730	30	565	3343	3451	3397
287.5	3850	30	565	3450	3576	3513
304.5	4145	30	565	3828	3975	3902
315.5	4310	30	565	4062	4159	4111
336.5	4570	40	565	4408	4578	4493
349.5	4655	40	565	4512	4711	4612
353.5	4870	30	565	4832	4892	4862
357.5	5005	35	565	4952	5079	5016
360.5	4980	30	565	4868	5057	4963
363.5	5080	30	565	5050	5194	5122

366.5	5105	35	565	5053	5189	5121
370.5	5070	35	565	5046	5300	5173
374.5	5160	40	565	5372	5463	5418
378.5	5210	40	565	5303	5469	5386
381.5	5315	30	565	5460	5585	5523
385.5	5315	35	565	5453	5586	5520
389.5	5420	35	565	5580	5654	5617
395.5	5635	35	565	5741	5907	5824
398.5	5610	35	565	5713	5904	5809
402	5750	40	565	5891	6008	5950
406.5	5830	35	638	5899	6002	5951
410.5	5965	40	638	5994	6210	6102
415.5	5980	45	638	5997	6216	6107
420.5	6120	45	638	6201	6351	6276
425.5	6265	45	638	6311	6490	6401
428.5	6335	55	638	6395	6639	6517
430.5	6345	60	638	6396	6657	6527
436.5	6440	40	638	6495	6678	6587
440.5	6540	55	638	6627	6883	6755
445.5	6665	45	638	6773	6984	6879
450.5	6650	40	638	6749	6948	6849
455.5	6960	45	824	6912	7162	7037
460.5	7155	45	824	7166	7331	7249
465.5	7310	45	824	7308	7480	7394
470.5	7480	55	824	7438	7606	7522
476.5	7550	50	824	7551	7670	7611
480.5	7815	55	1011	7571	7743	7657
485.5	7920	70	1011	7617	7867	7742
490.5	8070	50	1011	7788	7976	7882
497.5	8130	55	1011	7837	8027	7932
502.5	8115	55	1011	7828	8020	7924
507.5	8400	60	1011	8148	8345	8247
512.5	8350	50	1011	8020	8218	8119
517.5	8490	50	1011	8194	8381	8288
522.5	8355	60	1011	8023	8312	8168
527.5	8510	60	1011	8194	8400	8297
539.5	8790	60	1118	8384	8563	8474
544.5	8880	55	1118	8425	8631	8528
556.5	9060	50	1118	8637	8986	8812
564.5	9120	70	1118	8636	9026	8831
570.5	9110	50	1118	8698	9007	8853
576.5	9060	50	1118	8637	8986	8812
581.5	9260	50	1118	8999	9153	9076
588.5	9390	50	1118	9119	9430	9275
595	9370	60	1118	9076	9419	9248
604.5	9570	50	781	9602	9952	9777

613	9660	70	781	9736	10194	9965
621.5	9670	50	781	9884	10189	10037
628	9650	70	781	9732	10188	9960
633	9570	80	781	9581	9963	9772
643	9770	70	781	9906	10251	10079
647.5	9920	60	781	10206	10436	10321
677	10160	60	781	10480	10752	10616
791	11145	50	1095	11325	11806	11566
836	12285	55	1300	12726	12995	12861