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9. Data Report: Late Pleistocene Stable Isotope Studies of ODP Sites 1054, 1055, and 1063[1]

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INTRODUCTION

This data report describes the results of post–Leg 172 sampling of Sites 1054, 1055, and 1063 for two purposes: to investigate the climatic significance of red-colored intervals in the hemipelagic sediments cored during Leg 172 and to better understand the stratigraphy and chronology of Carolina Slope Sites 1054 and 1055. Gravity cores collected from the Carolina Slope on site survey cruise *Knorr* 140/2 show very high rates of sedimentation during the Holocene and lower rates during the last glacial maximum (LGM). Because of the high rates, many of the sediments in the recovered cores never reached the LGM. In other cores, it is possible that deglacial oscillations have been mistaken for the LGM. Although radiocarbon dating could solve that problem, some of the gravity cores are at or very close to the Ocean Drilling Program (ODP) sites, and it is useful to compare the isotope stratigraphies among them before proceeding with dating. Furthermore, some of the site survey cores have red-colored intervals and others do not, even though there is some indication they are time equivalent. Either the stratigraphy is wrong, diagenesis has affected the color of the sediment, or red sediment is carried to some sites but not to others that differ in depth by only a few hundred meters.

STABLE ISOTOPE METHODS

Oxygen and carbon isotopic analyses were made at Woods Hole Oceanographic Institution using a partially automated VG-903 mass

[1]Keigwin, L.D., 2001. Data report: Late Pleistocene stable isotope studies of ODP Sites 1054, 1055, and 1063. *In* Keigwin, L.D., Rio, D., Acton, G.D., and Arnold, E. (Eds.), *Proc. ODP, Sci. Results,* 172, 1–14 [Online]. Available from World Wide Web: <http://www-odp.tamu.edu/publications/172_SR/VOLUME/CHAPTERS/SR172_09.PDF>. [Cited YYYY-MM-DD]
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spectrometer. This instrument is fitted with a high-sensitivity source and a Pentabloc inlet manufactured by Europa Scientific. Clean samples (without pretreatment) are introduced into a common reservoir of orthophosphoric acid maintained at 90°C by a water bath. The long term analytical precision is better than ±0.10‰, and results are converted to Peedee belemnite (PDB) through analysis of the standard NBS-19. Results are listed in Tables T1, T2, and T3.

T1. Stable isotope results, Hole 1054B, p. 11.

T2. Stable isotope results, Hole 1055B, p. 12.

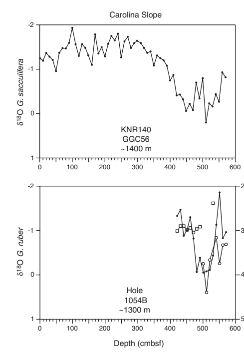
T3. Stable isotope and faunal results, Hole 1063D, p. 13.

CAROLINA SLOPE HOLE 1054B

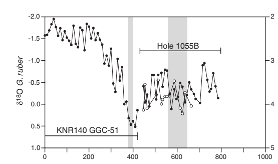
At ~1300 m water depth, Site 1054 is at the shallow end-member of the Leg 172 depth transect. This site was defined in part by KNR140 giant gravity core (GGC)-56, which is ~4 miles to the south and 100 m deeper (32°56.339′N, 76°17.738′W; 1400 m). GGC-56 has maximum $\delta^{18}O$ of *Globigerinoides sacculifera* (150–250 mm) in the 450–500 cm range (Fig. F1). However, these results (~0‰ PDB) are ~0.5‰ lower than the LGM value at deeper site survey cores, and the mud has no reddish color.

Based on core descriptions, I estimated where the equivalent level would be at Hole 1054B. At this site I analyzed *Globigerinoides ruber* (white; 150–250 µm), which has the same $\delta^{18}O$ as *G. sacculifera* in many of my site survey cores. At Site 1054, the maximum $\delta^{18}O$ is reached at about the same depth downcore as GGC-56, and the value is likewise ~0‰ (Fig. F1). Below ~530 cm, the $\delta^{18}O$ decreases rapidly, suggesting by comparison to GGC-51 (Fig. F2) that this represents the LGM level and that it is a short condensed interval on the Carolina Slope. Oxygen isotope analyses on individual *Cibicidoides pachyderma* and *Cibicidoides wuellerstorfi* at Hole 1054B suggest an abrupt increase from deglacial results of ~3‰ to ~4‰ (excluding the lowest $\delta^{18}O$ result, which might reflect downslope transport of some interglacial foraminifers). The maximum $\delta^{18}O$ in benthic and planktonic $\delta^{18}O$ also supports the notion that the LGM is ~500 cm in this core. If this interpretation is supported by future ^{14}C dating, then the lower planktonic $\delta^{18}O$ at the shallowest and most shoreward of Leg 172 sites could result from higher sea surface temperature (SST). This makes sense because surface waters at Site 1054 are close to the core of the Gulf Stream. The lack of red sediment during the LGM or other levels at these shallow locations (Fig. F2) may indicate that the shallowest components of the deep western boundary current were deeper than ~1400 m during the LGM.

F1. Oxygen isotope stratigraphy of Hole 1054B, p. 5.



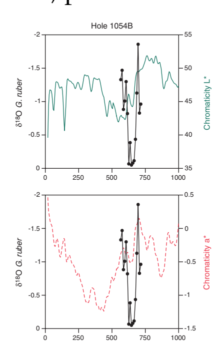
F2. Oxygen isotope stratigraphy of Hole 1055B, p. 6.



CAROLINA SLOPE HOLE 1055B

Site 1055 and KNR140 GGC-56 are at exactly the same location, at ~1800 m water depth on the Carolina Slope. The gravity core has been the subject of extensive accelerator ^{14}C dating (L.D. Keigwin, unpubl. data), from which it is clear that the Holocene rate of sedimentation is ~30 cm/k.y., the deglaciation is half that, and the LGM (at ~400 cm) is a condensed interval with a rate of ~4 cm/k.y. (Fig. F3). The LGM is pale red in other GGCs from about this depth on the Carolina Slope, as it is at ODP Site 1055. According to the shipboard visual core descriptions, pale red intervals are found at ~4.2, 6.3, 4.0–4.7, and 4.2–4.5 m at Holes 1055B, 1055A, 1055D and 1055C, respectively. At all but Hole 1055A, these red intervals are almost certainly the LGM level. At Hole 1055A, however, the red interval is >1.5 m deeper than at the other holes, and

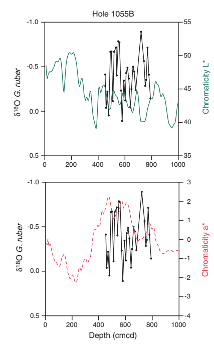
F3. Comparison of shipboard color reflectance data with $\delta^{18}O$ data at Hole 1054B, p. 7.



a substantial (1.35 m) correction to meters composite depth (mcd) makes the mismatch even worse.

Hole 1055B was chosen for detailed study because in addition to the LGM, sediment was pale red between 5.67 and 6.40 meters below seafloor (mbsf). I estimated this deeper interval was part of isotope Stage 3, a conjecture that is supported by the $\delta^{18}O$ on *G. ruber* (Fig. F3). Despite the high accumulation rates in the Holocene, the overall late Pleistocene rate of sedimentation at Site 1055 is only ~4 cm/k.y., so it is unlikely that the red interval at ~600 centimeters composite depth (cmcd) is a single Stage 3 stadial event. As expected, the Stage 3 red event (as visually identified) is marked by increased $\delta^{18}O$, suggesting the color was associated with lower SST, some combination of oxidizing conditions on the seafloor, and (probably) southerly advection of iron minerals. However, at 500 and 600 cmcd, two intervals of maximum redness were measured by color reflectance aboard ship (Fig. F4). Unfortunately, older events may have lost their color from reduction diagenesis because shipboard results showed that the only red color at this site is in the upper 10 m of the hole. When the red:yellow balance (chromaticity a*) and lightness are compared to the $\delta^{18}O$ of *G. ruber*, it is evident that there must be some loss of resolution in the shipboard color reflectance data because of data smoothing. Nevertheless, the two red peaks in Stage 3 are each associated with maximum $\delta^{18}O$. Whereas it is difficult to imagine that the distinctive but short LGM red level in these cores was not measured for reflectance, it is indeed clear that there is no red peak at ~400 cmcd (Fig. F4).

F4. Comparison of shipboard color reflectance data with $\delta^{18}O$ data at Hole 1055B, p. 8.



BERMUDA RISE HOLE 1063D

The Bermuda Rise has long been known as a repository of red-colored sediment transported from eastern Canada and as a location where sediment accumulates rapidly enough to resolve surprisingly brief climate events (on the order of centuries to millennia). During shipboard core description, it was noted that the generally dark sediment comprising isotope Stage 6 contained some red layers, and that Stage 6 was well-enough recovered that sampling restrictions could be relaxed. Accordingly, I sampled two intervals continually across the working half of Hole 1063D in the depth ranges of 35.50 to 35.88 mbsf and 38.70 to 40.56 mbsf. These large samples (~35–40 g dry) were sufficient to yield enough *G. ruber* for stable isotopes (Fig. F5), but benthic foraminifers were too rare and too small to generate a useful stable isotope series. Visual core description identified red intervals between 35.54 mbsf (38.08 mcd)–35.70 mbsf (38.24 mcd) and 38.82 mbsf (41.36 mcd)–38.90 mbsf (41.44 mcd). These intervals do have maximum $\delta^{18}O$, suggesting lower SST, but shipboard spectral reflectance data identify many more red intervals in Stage 6, and there are many maxima in $\delta^{18}O$ (Fig. F5). In general, the isotopic maxima coincide with the redder sediment.

F5. Comparison of shipboard color reflectance data with $\delta^{18}O$ results on *G. ruber*, p. 9.

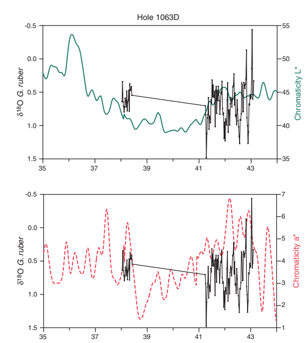
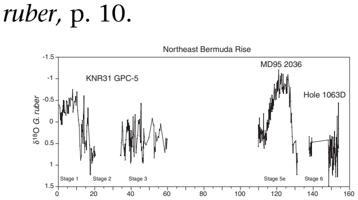


Figure F6 shows the Hole 1063D isotopic results in time series with other published *G. ruber* data from the Bermuda Rise. Whereas GPC-5 data show the Stage 1–3 millennial scale SST variability discussed previously, on this age scale it is difficult to appreciate the Stage 6 variability from Hole 1063D because the samples are so closely spaced. Consider the following. The oldest continuous data, from ~150 ka, represent only ~5 k.y. of accumulation (Fig. F6), yet there are at least three cycles that are evident in Figure F5 between 41 and 43 mcd. Thus, these "cycles"

F6. Oxygen isotope results on *G. ruber*, p. 10.



are evident in Figure F5 between 41 and 43 mcd. Thus, these "cycles" may have a period of ~1500 yr, making them about twice as frequent as those in Stage 3. (An alternative interpretation would be that the age model is off by a factor of two, which seems unlikely.) The amplitude is ~1‰, as it is in Stage 3, suggesting 4°C SST oscillations, and the coincidence with sediment redness suggests that, as in Stage 3, there may be some connection between SST and deep circulation activity.

Figure F1. Oxygen isotope stratigraphy of Carolina Slope Hole 1054B compared to nearby site survey core KNR140 GGC-56. Maximum $\delta^{18}O$ of ~0‰ in Hole 1054B *G. ruber* (solid points) suggests that the LGM at that hole is ~500 cmbsf. That interpretation is supported further by benthic $\delta^{18}O$. Open squares = *C. pachyderma,* open circles = *C. wuellerstorfi*.

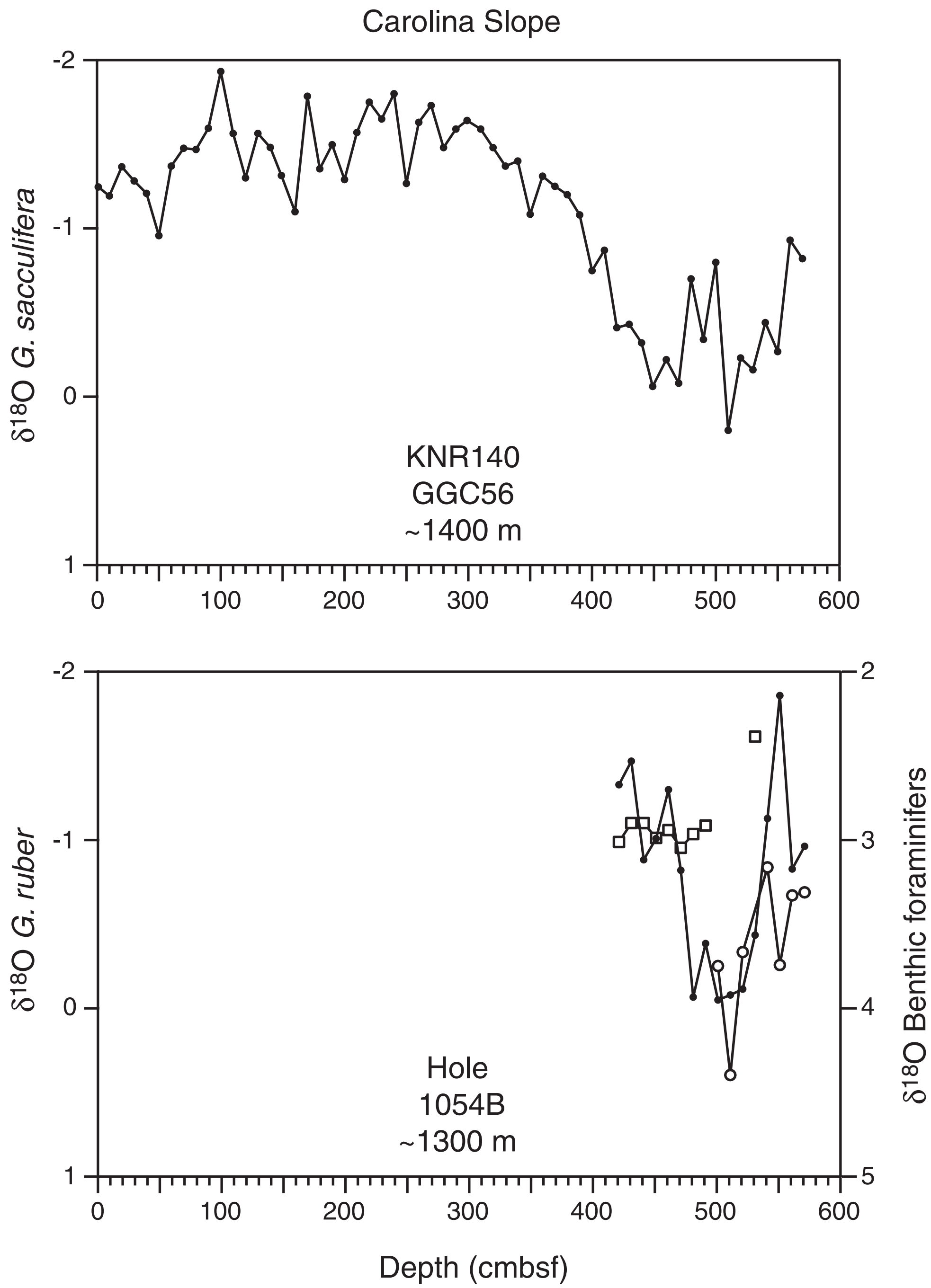


Figure F2. Oxygen isotope stratigraphy of Carolina Slope Hole 1055B compared to nearby site survey core KNR140 GGC-51. The combination of maximum $\delta^{18}O$ of *G. ruber* and red sediment in the site survey core at ~400 cm clearly identifies the LGM interval. Therefore, a red interval at about the same depth in Hole 1055B probably also marks the LGM, an interpretation that is supported by $\delta^{18}O$ of *G. ruber* (solid circles) and *C. wuellerstorfi* (open circles).

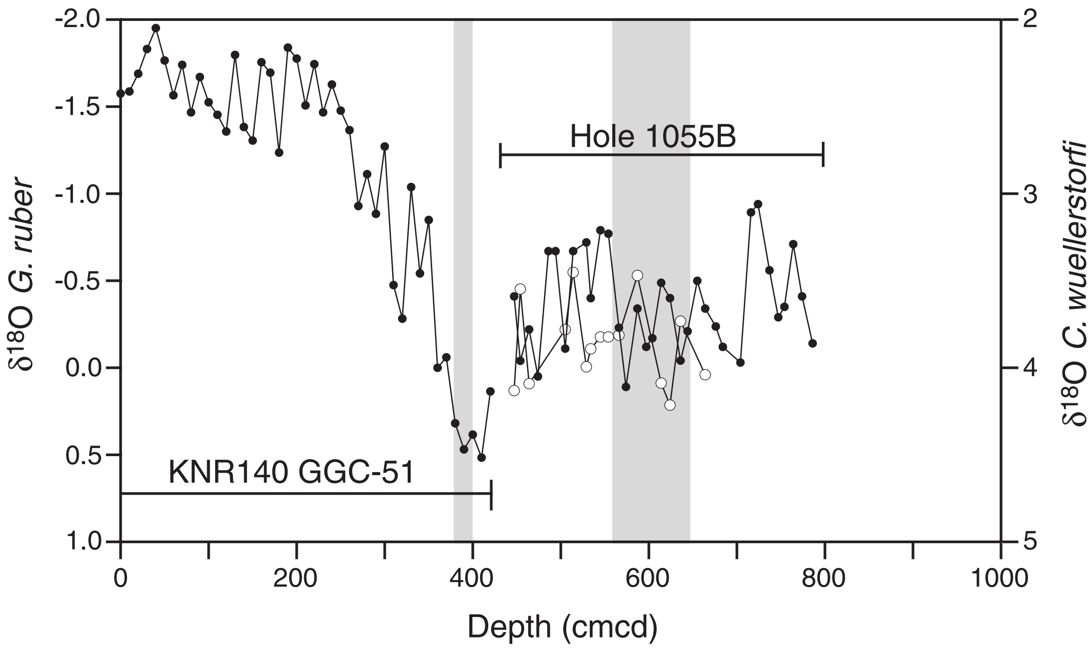


Figure F3. Comparison of shipboard color reflectance data with δ[18]O data (from Fig. **F1,** p. 5) at Hole 1054B. There is little variability in the lightness (chromaticity L*; solid line). LGM sediment has no evidence of red color (chromaticity a*; dashed line). Solid circles = δ[18]O of *G. ruber*.

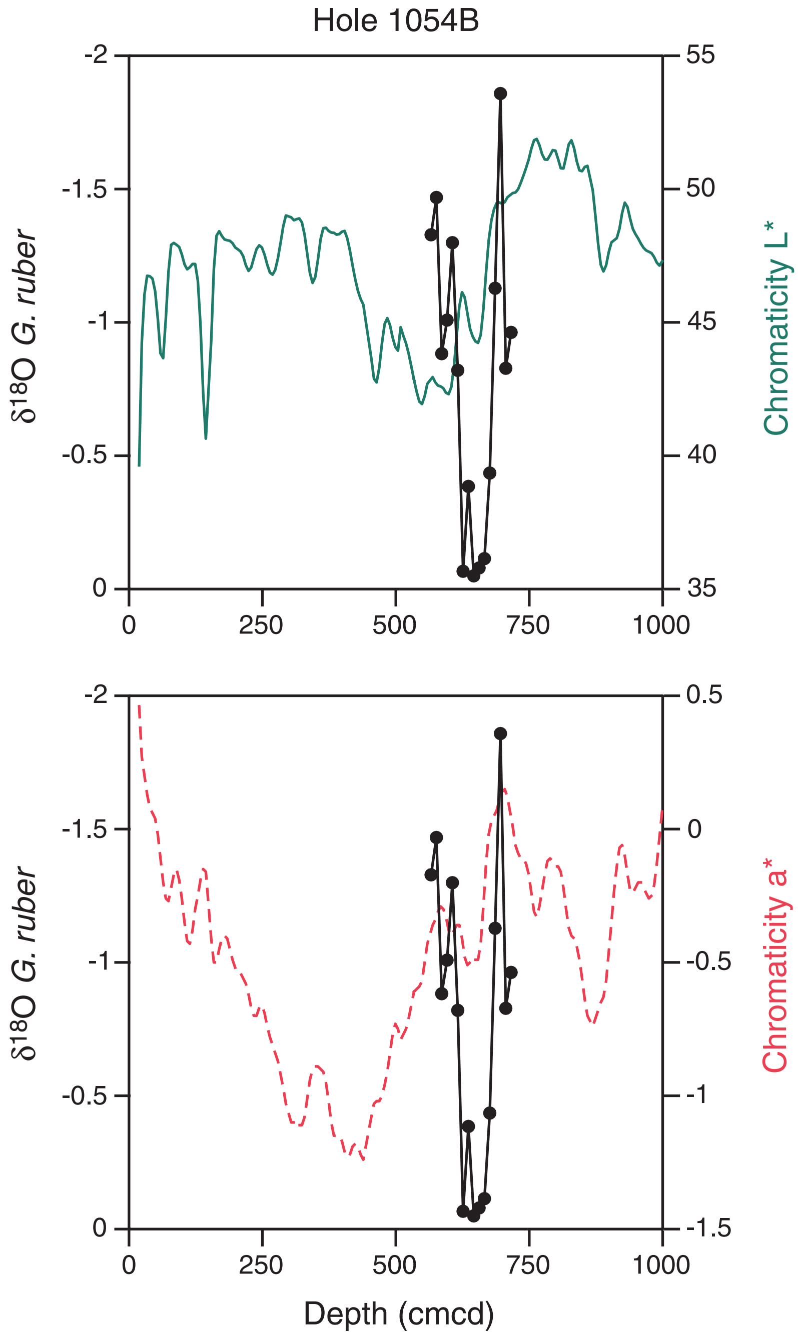


Figure F4. Comparison of shipboard color reflectance data with δ¹⁸O data (from Fig. F3, p. 7) at Hole 1055B. Note that the LGM is marked by dark sediment at ~400 cm (lower chromaticity L*; solid line), but that the reddest sediment (higher chromaticity a*; dashed line) occurs in Stage 3. Two peaks, at ~500 and 600 cmcd, are matched by maximum δ¹⁸O. This strengthens the association between cooling climate and red sediment in Leg 172 sites. Solid circles = δ¹⁸O of *G. ruber.*

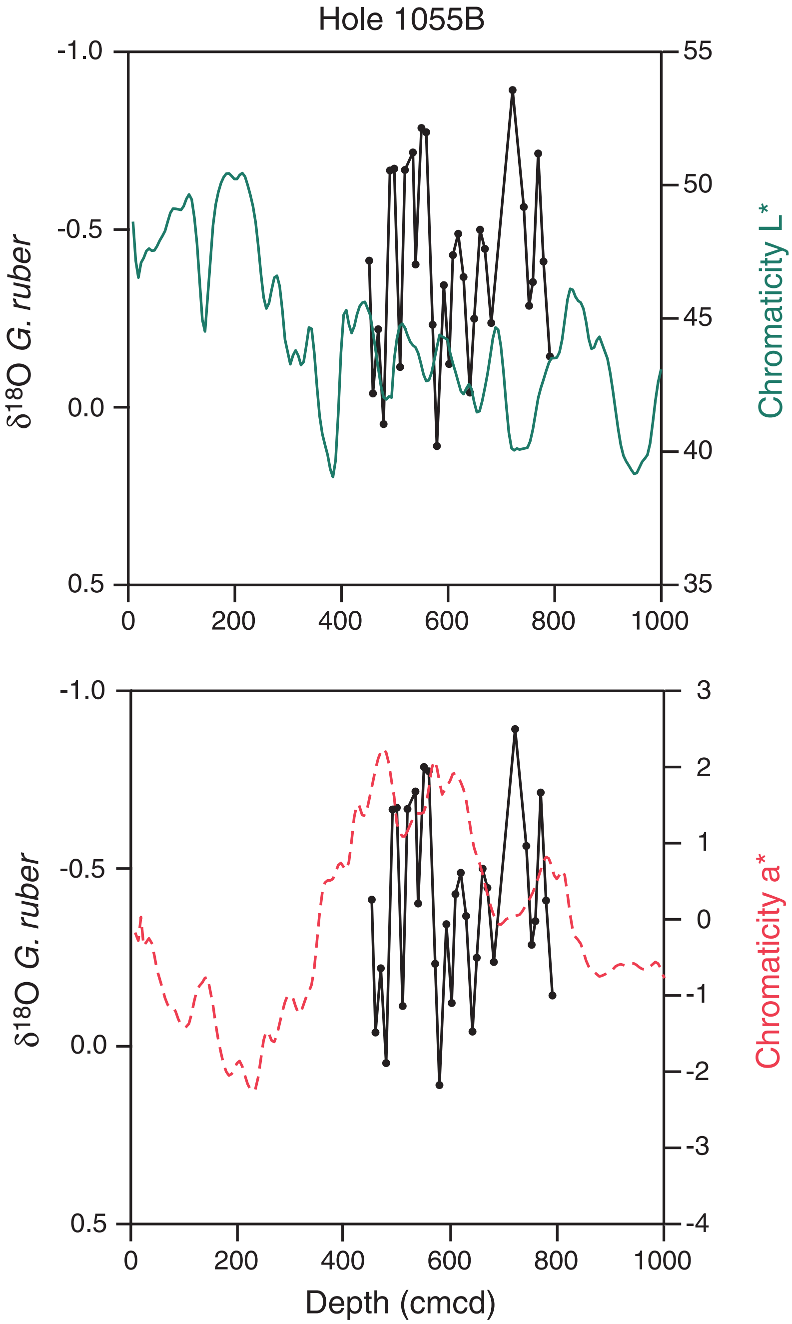


Figure F5. Comparison of shipboard color reflectance data with δ^{18}O results on *G. ruber* in isotope Stage 6 at Hole 1063D. Whereas there is no obvious relationship between sediment lightness (chromaticity L*; solid line) and δ^{18}O, it does appear that redder intervals (higher chromaticity a*; dashed line) are associated with higher δ^{18}O. Solid circles = δ^{18}O of *G. ruber*.

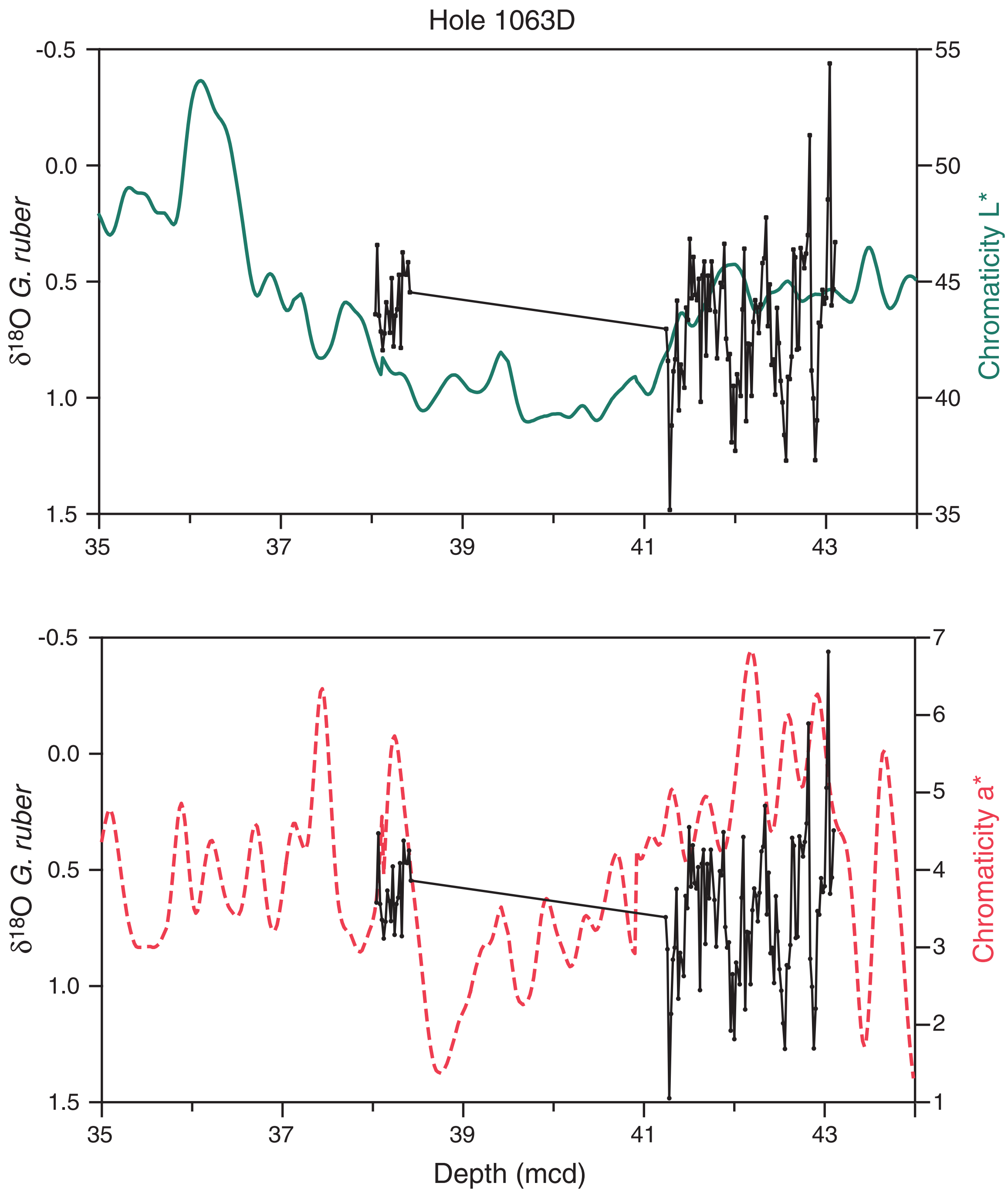


Figure F6. Oxygen isotope results on *G. ruber* from Stage 6 at Hole 1063D compared to results from other late Pleistocene time intervals on the Bermuda Rise.

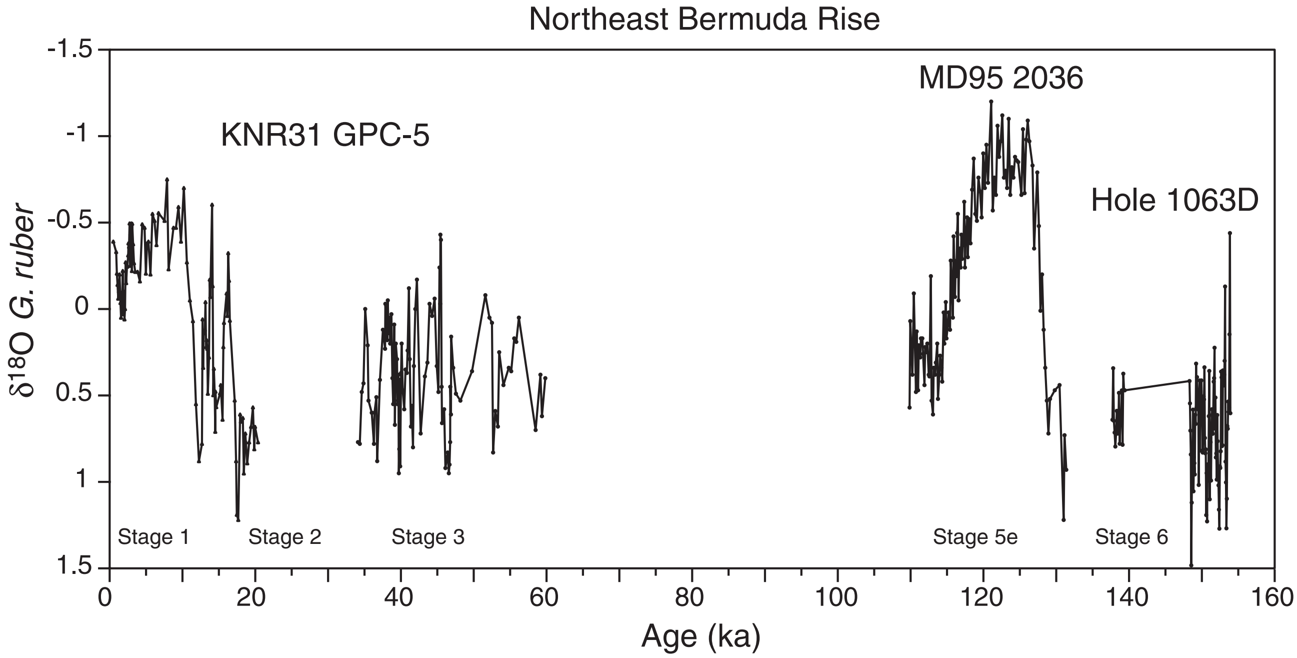


Table T1. Stable isotope results, Hole 1054B.

Core, section, interval (cm)	Depth (mbsf)	Depth (cmcd)	Dry mass (g)	$\delta^{13}C$ *G. ruber*	$\delta^{13}C$ *G. ruber*	$\delta^{18}O$ single *C. pachyderma*	$\delta^{13}C$ single *C. pachyderma*	$\delta^{18}O$ single *C. wuellerstorfi*	$\delta^{13}C$ single *C. wuellerstorfi*
172-1054B-									
2H-2, 0-2	4.21	566	10.60	–1.32	0.02	3.01	0.44		
2H-2, 10-12	4.31	576	10.60	–1.47	–0.14	2.90	0.30		
2H-2, 20-22	4.41	586	11.29	–0.88	0.27	2.90	0.78		
2H-2, 30-32	4.51	596	11.55	–1.01	0.22	2.99	0.73		
2H-2, 40-42	4.61	606	10.83	–1.30	0.19	2.94	0.59		
2H-2, 50-52	4.71	616	11.88	–0.82	0.63	3.05	0.69		
2H-2, 60-62	4.81	626	10.98	–0.07	0.27	2.96	0.66		
2H-2, 70-72	4.91	636	9.55	–0.38	0.48	2.91	0.60		
2H-2, 80-82	5.01	646	10.86	–0.05	–0.05			3.75	1.22
2H-2, 90-92	5.11	656	9.84	–0.08	0.22			4.40	1.49
2H-2, 100-102	5.21	666	12.89	–0.11	0.24			3.67	0.94
2H-2, 110-112	5.31	676	12.19	–0.44	0.38	2.39	0.55		
2H-2, 120-122	5.41	686	8.93	–1.13	0.34			3.16	1.34
2H-2, 130-132	5.51	696	9.92	–1.86	–0.17			3.74	1.45
2H-2, 140-142	5.61	706	9.15	–0.83	0.10			3.33	1.31
2H-2, 148-150	5.71	716	10.11	–0.96	–0.12			3.31	1.33

Table T2. Stable isotope results, Hole 1055B.

Core, section, interval (cm)	Depth (mcd)	Dry mass (g)	$\delta^{18}O$ *G. ruber*	$\delta^{13}C$ *G. ruber*	$\delta^{18}O$ single *P. wuellerstorfi*	$\delta^{13}O$ single *P. wuellerstorfi*
172-1055B-						
2H-1, 1-3	4.47	5.27	–0.41	0.00	4.13	1.34
2H-1, 8-10	4.54	11.24	–0.04	0.34	3.55	1.20
2H-1, 18-20	4.64	4.65	–0.22	0.14	4.09	1.39
2H-1, 28-30	4.74	13.07	0.05	0.32		
2H-1, 40-42	4.86	8.59	–0.67	–0.42		
2H-1, 48-50	4.94	11.48	–0.67	–0.13		
2H-1, 59-61	5.05	10.81	–0.11	0.57	3.78	1.10
2H-1, 68-70	5.14	12.26	–0.67	–0.18	3.45	0.91
2H-1, 83-85	5.29	8.82	–0.72	0.41	3.99	1.23
2H-1, 88-90	5.34	10.09	–0.40	–0.08	3.89	1.25
2H-1, 99-101	5.45	9.64	–0.79	0.23	3.82	1.35
2H-1, 108-110	5.54	11.65	–0.78	–0.15	3.82	1.21
2H-1, 120-122	5.66	9.44	–0.23	0.40	3.81	1.21
2H-1, 128-130	5.74	11.16	0.11	0.39		
2H-1, 141-143	5.87	11.79	–0.34	0.07	3.47	0.68
2H-2, 1-3	5.97	8.46	–0.12	0.30		
2H-2, 8-10	6.04	12.77	–0.43	0.11		
2H-2, 8-10	6.04	12.77	0.10	0.29		
2H-2, 18-20	6.14	10.73	–0.49	0.18	4.09	1.27
2H-2, 28-30	6.24	13.13	–0.37	0.50	4.21	1.25
2H-2, 28-30			–0.44	0.25		
2H-2, 40-42	6.36	11.73	–0.04	–0.02	3.73	0.75
2H-2, 48-50	6.44	13.13	–0.25	–0.18		
2H-2, 48-50			–0.17	–0.42		
2H-2, 59-61	6.55	8.77	–0.50	–0.09		
2H-2, 68-70	6.64	12.25	–0.45	0.28	4.04	1.34
2H-2, 68-70			–0.24	–0.09		
2H-2, 80-82	6.76	9.95	–0.24	–0.03		
2H-2, 88-90	6.84	14.21	–0.12	0.44		
2H-2, 100-102	6.96	11.79				
2H-2, 108-110	7.04	11.64	–0.03	0.08		
2H-2, 120-122	7.16	9.64	–0.89	–0.25		
2H-2, 128-130	7.24	10.37				
2H-2, 141-143	7.37	9.73	–0.56	–0.29		
2H-3, 1-3	7.47	9.88	–0.29	0.04		
2H-3, 8-10	7.54	12.63	–0.35	0.08		
2H-3, 18-20	7.64	9.91	–0.71	–0.27		
2H-3, 28-30	7.74	11.04	–0.41	0.34		
2H-3, 40-42	7.86	9.97	–0.14	0.28		

Table T3. Stable isotope and faunal results, Hole 1063D. (Continued on next page.)

Core, section, interval (cm)	Depth (mbsf)	Depth (mcd)	Age (ka)	Dry mass (g)	*G. ruber* picked	*Cibicidoides* total	*N. umbonifera* total	*G. ruber* $\delta^{18}O$	*G. ruber* $\delta^{13}C$
172-1063D-									
5H-4, 20-22	35.50	38.04	137.72	35.11	27	0	0	0.64	0.02
5H-4, 22-24	35.52	38.06	137.81	34.15	11	0	0	0.34	–1.20
5H-4, 24-26	35.54	38.08	137.91	36.20	44	1	0	0.65	–0.41
5H-4, 26-28	35.56	38.10	138.01	37.75	20	1	0	0.71	–0.44
5H-4, 28-30	35.58	38.12	138.11	38.92	20	3	0	0.80	–0.40
5H-4, 30-32	35.60	38.14	138.21	35.80	20	0	0	0.72	–0.43
5H-4, 32-34	35.62	38.16	138.31	39.28	20	0	1	0.59	–0.58
5H-4, 34-36	35.64	38.18	138.41	36.95	20	3	0	0.63	–0.45
5H-4, 36-38	35.66	38.20	138.51	39.60	20	0	0	0.72	–0.82
5H-4, 38-40	35.68	38.22	138.61	34.59	20	0	0	0.49	–1.64
5H-4, 40-42	35.70	38.24	138.71	41.88	20	0	0	0.78	–0.40
5H-4, 42-44	35.72	38.26	138.81	39.24	20	1	0	0.65	–0.39
5H-4, 44-46	35.74	38.28	138.91	36.94	20	0	0	0.62	–0.89
5H-4, 46-48	35.76	38.30	139.01	38.26	20	2	0	0.47	–0.89
5H-4, 48-50	35.78	38.32	139.10	38.96	20	3	0	0.79	–0.76
5H-4, 50-52	35.80	38.34	139.20	34.02	20	0	0	0.37	–0.81
5H-4, 52-54	35.82	38.36	139.30	37.63	20	1	2	0.47	–0.52
5H-4, 54-56	35.84	38.38	139.40	36.78	20	0	5	0.47	–0.50
5H-4, 56-58	35.86	38.40	148.30	35.00	20	0	0	0.42	–0.77
5H-4, 58-60	35.88	38.42	148.36	37.35	20	0	1	0.55	–0.46
5H-6, 40-42	38.70	41.24	148.42	34.34	20	1	0	0.70	–0.79
5H-6, 42-44	38.72	41.26	148.48	38.95	20	0	0	0.84	–0.52
5H-6, 44-46	38.74	41.28	148.54	36.54	20	0	0	1.48	–0.63
5H-6, 46-48	38.76	41.30	148.60	32.47	16	0	0	1.12	–0.82
5H-6, 48-50	38.78	41.32	148.66	34.58	20	2	0	0.89	–0.78
5H-6, 50-52	38.80	41.34	148.72	41.47	20	0	0	0.83	–0.72
5H-6, 52-54	38.82	41.36	148.78	36.79	20	1	0	0.58	–0.91
5H-6, 54-56	38.84	41.38	148.84	39.24	20	0	0	1.05	–0.29
5H-6, 56-58	38.86	41.40	148.90	38.93	18	1	0	0.86	–0.57
5H-6, 58-60	38.88	41.42	148.96	39.71	18	0	0	0.89	–0.29
5H-6, 60-62	38.90	41.44	149.02	35.29	20	0	0	0.96	–0.30
5H-6, 62-64	38.92	41.46	149.08	38.66	20	0	0	0.61	–0.58
5H-6, 64-66	38.94	41.48	149.14	35.23	11	2	0	0.66	–0.54
5H-6, 66-68	38.96	41.50	149.20	36.50	20	0	0	0.32	–0.92
5H-6, 68-70	38.98	41.52	149.26	39.03	20	0	0	0.57	–0.36
5H-6, 70-72	39.00	41.54	149.32	34.94	20	0	0	0.39	–0.61
5H-6, 72-74	39.02	41.56	149.38	33.77	20	0	0	0.56	–0.47
5H-6, 74-76	39.04	41.58	149.44	35.48	20	0	1	0.58	–0.72
5H-6, 76-78	39.06	41.60	149.50	37.19	20	0	0	0.49	–0.53
5H-6, 78-80	39.08	41.62	149.56	33.39	20	1	0	1.02	–0.93
5H-6, 80-82	39.10	41.64	149.63	27.41	9	0	0	0.47	–0.92
5H-6, 82-84	39.02	41.66	149.69	21.89	10	0	0	0.41	–0.89
5H-6, 84-86	39.04	41.68	149.75	20.05	10	0	0	0.82	–0.70
5H-6, 86-88	39.06	41.70	149.81	22.64	21	0	0	0.47	–1.03
5H-6, 88-90	39.08	41.72	149.87	22.64	12	0	0	0.62	–0.43
5H-6, 90-92	39.20	41.74	149.93	23.02	9	0	0	0.41	–1.03
5H-6, 92-94	39.22	41.76	149.99	20.36	3	0	0		
5H-6, 94-96	39.24	41.78	150.05	21.58	16	0	0	0.63	–0.65
5H-6, 96-98	39.26	41.80	150.11	25.92	17	0	0	0.83	–0.43
5H-6, 98-100	39.28	41.82	150.17	21.15	3	1	0		
5H-6, 100-102	39.30	41.84	150.23	20.99	6	0	0	0.51	–0.60
5H-6, 102-104	39.32	41.86	150.29	21.96	9	0	1	0.52	–0.77
5H-6, 104-106	39.34	41.88	150.35	21.20	5	2	1	0.34	–0.98
5H-6, 106-108	39.36	41.90	150.41	19.54	10	2	1	0.75	–0.88
5H-6, 108-110	39.38	41.92	150.47	22.27	8	5	0	0.83	–0.52
5H-6, 110-112	39.40	41.94	150.53	21.92	6	2	0	0.81	–0.79
5H-6, 112-114	39.42	41.96	150.59	21.31	14	0	1	1.19	–0.38
5H-6, 114-116	39.44	41.98	150.65	21.32	22	5	0	0.95	–0.38
5H-6, 116-118	39.46	42.00	150.71	22.72	37	8	0	1.23	–0.39
5H-6, 118-120	39.48	42.02	150.77	21.75	31	4	0	0.90	–0.14
5H-6, 120-122	39.50	42.04	150.83	20.61	20	0	0	0.93	–0.58
5H-6, 122-124	39.52	42.06	150.89	21.12	22	3	0	0.99	–1.04
5H-6, 124-126	39.54	42.08	150.95	20.29	20	3	0	0.62	–0.73
5H-6, 126-128	39.56	42.10	151.01	24.81	20	3	0	0.36	–1.11
5H-6, 128-130	39.58	42.12	151.07	24.28	21	3	0	1.10	–0.48
5H-6, 130-132	39.60	42.14	151.13	20.85	26	2	0	0.77	–0.33
5H-6, 132-134	39.62	42.16	151.19	21.11	21	0	0	0.77	–0.74
5H-6, 134-136	39.64	42.18	151.25	23.50	20	2	0	0.99	–0.28

Table T3 (continued).

Core, section, interval (cm)	Depth (mbsf)	Depth (mcd)	Age (ka)	Dry mass (g)	*G. ruber* picked	*Cibicidoides* total	*N. umbonifera* total	*G. ruber* $\delta^{18}O$	*G. ruber* $\delta^{13}C$
5H-6, 136-138	39.66	42.20	151.31	26.99	20	0	0	0.67	–1.00
5H-6, 138-140	39.68	42.22	151.37	25.69	25	1	0	0.58	–0.47
5H-6, 140-142	39.70	42.24	151.44	22.72	20	0	0	0.61	–0.65
5H-6, 142-144	39.72	42.26	151.50	25.54	20	0	0	0.72	–0.36
5H-6, 144-146	39.74	42.28	151.56	24.91	20	0	0	0.60	–0.76
5H-6, 146-148	39.76	42.30	151.62	23.46	20	1	0	0.42	–0.48
5H-6, 148-150	39.78	42.32	151.68	24.48	20	0	0	0.40	–0.75
5H-7, 0-2	39.80	42.34	151.74	20.48	18	0	0	0.22	–1.20
5H-7, 2-4	39.82	42.36	151.80	23.00	22	0	0	0.69	–0.87
5H-7, 4-6	39.84	42.38	151.86	24.68	25	0	1	0.51	–0.63
5H-7, 6-8	39.86	42.40	151.92	25.18	8	0	0	0.86	–1.07
5H-7, 8-10	39.88	42.42	151.98	21.73	20	1	0	0.84	–0.86
5H-7, 10-12	39.90	42.44	152.04	24.14	20	0	0	0.99	–0.43
5H-7, 12-14	39.92	42.46	152.10	22.89	20	0	0	0.61	–0.78
5H-7, 14-16	39.94	42.48	152.16	21.17	25	1	0	0.76	–0.35
5H-7, 16-18	39.96	42.50	152.22	21.97	27	0	0	0.93	–0.98
5H-7, 18-20	39.98	42.52	152.28	20.66	24	3	0	1.02	–0.32
5H-7, 20-22	40.00	42.54	152.34	22.37	24	1	0	1.16	–0.77
5H-7, 22-24	40.02	42.56	152.40	23.85	27	3	0	1.27	–0.68
5H-7, 24-26	40.04	42.58	152.46	22.84	20	1	0	0.91	–0.68
5H-7, 26-28	40.06	42.60	152.52	26.52	24	1	0	0.92	–0.44
5H-7, 28-30	40.08	42.62	152.58	24.33	20	2	0	0.82	–0.65
5H-7, 30-32	40.10	42.64	152.64	25.35	23	0	0	0.36	–0.92
5H-7, 32-34	40.12	42.66	152.70	23.10	31	1	0	0.40	–0.76
5H-7, 34-36	40.14	42.68	152.76	23.67	26	0	0	0.79	–0.77
5H-7, 36-38	40.16	42.70	152.82	23.14	25	1	0	0.79	–0.58
5H-7, 38-40	40.18	42.72	152.88	23.98	8	0	0	0.36	–0.54
5H-7, 40-42	40.20	42.74	152.94	28.63	31	1	0	0.40	–1.10
5H-7, 42-44	40.22	42.76	153.00	23.40	17	0	0	0.44	–0.83
5H-7, 44-46	40.24	42.78	153.06	24.15	23	0	0	0.38	–0.76
5H-7, 46-48	40.26	42.80	153.12	19.65	21	0	0	0.30	–0.92
5H-7, 48-50	40.28	42.82	153.18	20.24	17	0	0	–0.13	0.83
5H-7, 50-52	40.30	42.84	153.24	20.91	31	0	0	0.88	–0.16
5H-7, 52-54	40.32	42.86	153.31	20.55	20	0	0	1.00	–0.64
5H-7, 54-56	40.34	42.88	153.37	22.85	19	3	0	1.27	–0.34
5H-7, 56-58	40.36	42.90	153.43	21.01	23	1	0	1.10	–0.63
5H-7, 58-60	40.38	42.92	153.49	16.39	21	1	0	0.68	–0.3
5H-7, 60-62	40.40	42.94	153.55	23.12	13	2	0	0.69	–0.78
5H-7, 62-64	40.42	42.96	153.61	24.79	28	1	0	0.54	–0.27
5H-7, 64-66	40.44	42.98	153.67	21.97	21	1	0	0.60	–0.66
5H-7, 66-68	40.46	43.00	153.73	22.86	27	0	0	0.57	–0.76
5H-7, 68-70	40.48	43.02	153.79	23.39	25	0	0	0.15	–0.55
5H-7, 70-72	40.50	43.04	153.85	24.19	27	1	0	–0.44	–0.94
5H-7, 72-74	40.52	43.06	153.91	21.41	30	0	0	0.60	–0.63
5H-7, 74-76	40.54	43.08	153.97	20.58	21	0	0	0.53	–0.47
5H-7, 76-78	40.56	43.10	154.03	21.14	12	1	0	0.33	–0.45