Richter, C. (Ed.)
*Proceedings of the Ocean Drilling Program, Scientific Results* Volume 181

# 9. DATA REPORT: INORGANIC GEOCHEMISTRY OF MIOCENE TO RECENT SAMPLES FROM CHATHAM RISE, SOUTHWEST PACIFIC, SITE 1123[1]

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## INTRODUCTION

In 1998 Ocean Drilling Program Leg 181 off southwest New Zealand obtained cores from Site 1123 (41°47.2′S, 171°29.9′W; 3290 m water depth) on the Chatham Rise. Site 1123 sampled the North Chatham Sediment Drift, which is located between 169°W and 175°W at depths of 2200–4500 m (Carter, McCave, Richter, Carter, et al., 1999). This site is located just north of the productive surface waters associated with the Subtropical Front. The cores provide a relatively complete record of sedimentation on the Chatham Drift back to the early Miocene and beyond a stratigraphic gap into the early Oligocene. Drift sedimentation is partly indicated by modern paleoceanographic observations and by extensive microfossil reworking throughout the recovered sediment (Carter and McCave, 1994; Carter, McCave, Richter, Carter, et al., 1999).

Approximately 1000 sediment samples from the lower Oligocene, lower Miocene, middle Miocene, and upper Pleistocene have been analyzed geochemically for elemental concentrations. The stratigraphic intervals sampled at 5- to 10-cm intervals are listed in Table T1. The elemental concentrations, normalized by aluminium concentrations, provide proxies for factors such as nutrient levels, siliciclastic and volcaniclastic sediment composition, and bottom-water redox conditions. This approach was prompted by successes with Miocene and Oligocene deep-sea sediment elemental ratios obtained from the Ceara Rise in the western equatorial Atlantic (Weedon and Shackleton, 1997). The results for Ba/Al in the Pleistocene were discussed by Hall et al. (2001), and an

**T1.** Location of samples analyzed geochemically, p. 6.

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[1] Weedon, G.P., and Hall, I.R., 2002. Data report: Inorganic geochemistry of Miocene to recent samples from Chatham Rise, southwest Pacific, Site 1123. *In* Richter, C. (Ed.), *Proc. ODP, Sci. Results,* 181, 1–10 [Online]. Available from World Wide Web: <http://www-odp.tamu.edu/publications/181_SR/VOLUME/CHAPTERS/209.PDF>. [Cited YYYY-MM-DD]

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Initial receipt: 3 January 2002
Acceptance: 21 February 2002
Web publication: 14 June 2002
Ms 181SR-209

interpretation of a selection of additional elemental ratios from all the stratigraphic intervals was provided by Weedon and Hall (submitted [N1]). However, many components listed here, particularly the trace elements and rare earth elements, were not considered by Weedon and Hall (submitted [N1]).

## METHODOLOGY AND RESULTS

Approximately 1 g of sediment sample was fused and dissolved for analysis using a Perkin Elmer Plasma 40 Philips PV8060 inductively coupled plasma–atomic emission spectrophotometer following the procedures described by Thompson and Walsh (1989). Note that all the results reported here are elemental concentrations and ratios and not elemental oxide concentrations and ratios. A total of 13 repeat analyses of upper Pleistocene sediment samples were used to establish the analytical precision. Precision for each element was determined as a percentage of the standard deviation of the relative concentrations (the concentrations divided by the sample mean concentration) (Table T2). The precision is generally very good (usually <2%, except in the case of P, which is about 5%). A list of all the samples analyzed and their elemental concentrations is provided in Table T3.

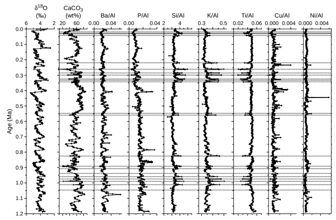
**T2.** Precision estimates for selected geochemical analyses, p. 7.

**T3.** Geochemical data, p. 9.

Measurements of weight percent $CaCO_3$ were obtained from inorganic carbon measurements by elemental CHN analyses using a Carlo Erba EA1106 analyzer by methods in King et al. (1998). The age models used for dating the samples differ according to the sample set involved. Hall et al. (2001) used orbital tuning of oxygen isotopes from benthic foraminifers to date samples spanning the last 1.2 m.y. The samples from the lower Miocene and lower Oligocene were dated by linear interpolation between the ages for paleomagnetic reversals (Carter, McCave, Richter, Carter, et al., 1999). The ages for reversal events were obtained from the Berggren et al. (1995) chronology. For the mid-Miocene section, Hall et al. (submitted [N2]) tuned a record of sortable silt mean size to the orbital tilt history calculated using the Laskar et al. (1993) orbital solution.

As an example of the type of results obtained, Figure F1 shows elemental ratios from samples of the upper Pleistocene at Site 1123 plotted against time. These data are plotted beside the oxygen isotopes from benthic foraminifers obtained by Hall et al. (2001). Particularly striking are the coincidence of relatively high Si/Al and K/Al values and low Ti/Al values occurring in several thin horizons. In some cases these thin horizons have relatively low calcium carbonate contents. Many of these samples are located close to macroscopic tephra layers and are presumably sediments that contain variable amounts of bioturbated tephra (Weedon and Hall, submitted [N1]). The macroscopic tephra layers described during Leg 181 are further discussed by Carter et al. (submitted [N3]). The tephra-bearing samples should be removed from these records prior to analysis of the samples for the background or pelagic sediment history as recorded by the elemental ratios. No tephras were encountered in the samples from the pre-Pleistocene stratigraphic intervals.

**F1.** Oxygen isotopes, weight percent calcium carbonate, and elemental ratios, upper Pleistocene samples, p. 5.



# ACKNOWLEDGMENTS

Our thanks to Nick Walsh at the NERC ICP facility at Royal Holloway College for conducting the elemental analyses. This research used samples provided by the Ocean Drilling Program (ODP). ODP is sponsored by the U.S. National Science Foundation (NSF) and participating countries under management of Joint Oceanographic Institutions (JOI), Inc. Both authors acknowledge receipt of research grants from the NERC under the ODP Thematic Programme (GST/02/2565 and GST/02/2287).

# REFERENCES

Berggren, W.A., Kent, D.V., Swisher, C.C., III, and Aubry, M.-P., 1995. A revised Cenozoic geochronology and chronostratigraphy. *In* Berggren, W.A., Kent, D.V., Aubry, M.-P., and Hardenbol, J. (Eds.), *Geochronology, Time Scales and Global Stratigraphic Correlation.* Spec. Publ.—Soc. Econ. Paleontol. Mineral., 54:129–212.

Carter, L., and McCave, I.N., 1994. Development of sediment drifts approaching an active plate margin under the SW Pacific deep western boundary current. *Paleoceanography,* 9:1061–1085.

Carter, R.M., McCave, I.N., Richter, C., Carter, L., et al., 1999. *Proc. ODP, Init. Repts.,* 181 [CD-ROM]. Available from: Ocean Drilling Program, Texas A&M University, College Station, TX 77845-9547, U.S.A.

Hall, I.R., McCave, I.N., Shackleton, N.J., Weedon, G.P., and Harris, S.E., 2001. Intensified deep Pacific inflow and ventilation in Pleistocene glacial times. *Nature,* 412:809–812.

King, P., Kennedy, H., Newton, P.P., Jickells, T.D., Brand, T., Calvert, S., Cauwet, G., Etcheber, H., Head, B., Khripounoff, A., Manighetti, B., and Miquel, J.C., 1998. Analysis of total and organic carbon and total nitrogen in settling oceanic particles and a marine sediment: an interlaboratory comparison. *Mar. Chem.,* 60:203–216.

Laskar, J., Joutel, F., and Boudin, F., 1993. Orbital, precessional, and insolation quantities for the Earth from –20 Myr to +10 Myr. *Astron. Astrophys.,* 270:522–533.

Thompson, M., and Walsh, J.N., 1989. *Handbook of Inductively Coupled Plasma Spectrometry* (2nd ed.): Glasgow (Blackie).

Weedon, G.P., and Shackleton, N.J., 1997. Inorganic geochemical composition of Oligocene to Miocene sediments and productivity variations in the western equatorial Atlantic: results from Sites 926 and 929. *In* Shackleton, N.J., Curry, W.B., Richter, C., and Bralower, T.J. (Eds.), *Proc. ODP, Sci. Results,* 154: College Station, TX (Ocean Drilling Program), 507–526.

**Figure F1.** Oxygen isotopes ($\delta^{18}O$) (Hall et al., 2001), weight percent calcium carbonate, and elemental ratios in samples from the upper Pleistocene at ODP Site 1123. The dashed lines indicating tephra events are located at the bases of stratigraphic intervals with anomalously high Si/Al and K/Al and anomalously low Ti/Al values.

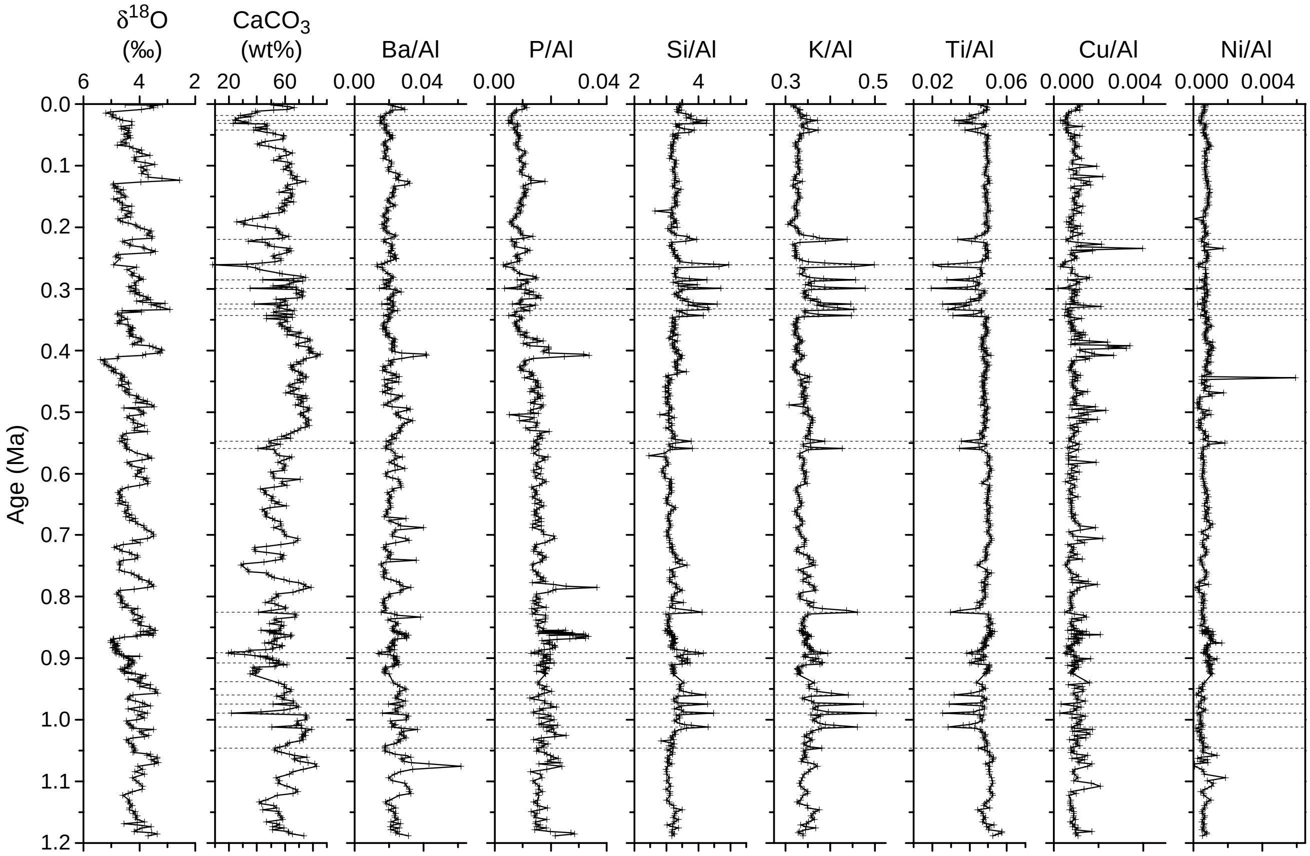


**Table T1.** Location of samples from ODP Site 1123 analyzed geochemically.

| Epoch | Lithologic unit | Splice | Hole, core, section, interval (cm) | Depth (mbsf) | Age (Ma) |
|---|---|---|---|---|---|
| late Pleistocene | IA | Top | 1123C-1H-1, 4–6 | 0.04 | 0.001 |
| late Pleistocene | IA | Base | 1123C-1H-5, 110–112 | 7.10 | 0.169 |
| late Pleistocene | IA | Top | 1123B-2H-4, 4–6 | 7.94 | 0.171 |
| late Pleistocene | IA | Base | 1123B-2H-6, 64–66 | 11.54 | 0.256 |
| late Pleistocene | IA | Top | 1123C-2H-2, 113–115 | 11.63 | 0.266 |
| late Pleistocene | IA | Base | 1123C-2H-5, 92–94 | 15.92 | 0.351 |
| late Pleistocene | IA | Top | 1123B-3H-1, 114–116 | 14.02 | 0.353 |
| late Pleistocene | IA | Base | 1123B-3H-6, 88–90 | 21.29 | 0.507 |
| late Pleistocene | IA | Top | 1123C-3H-3, 80–82 | 22.31 | 0.509 |
| late Pleistocene | IA | Base | 1123C-3H-6, 29–31 | 26.30 | 0.620 |
| late Pleistocene | IA | Top | 1123B-4H-3, 107–108 | 26.47 | 0.622 |
| late Pleistocene | IA | Base | 1123B-4H-5, 126–128 | 26.67 | 0.720 |
| late Pleistocene | IA | Top | 1123C-4H-2, 27–29 | 29.78 | 0.723 |
| late Pleistocene | IA | Base | 1123C-4H-7, 40–42 | 37.40 | 0.926 |
| late Pleistocene | IA | Top | 1123B-5H-1, 67–69 | 32.58 | 0.929 |
| late Pleistocene | IA | Base | 1123B-5H-4, 139–141 | 37.80 | 1.058 |
| late Pleistocene | IA | Top | 1123C-5H-3, 115–117 | 41.66 | 1.060 |
| late Pleistocene | IA | Base | 1123C-5H-6, 15–17 | 45.16 | 1.178 |
| late Pleistocene | IA | Top | 1123B-6H-1, 139–141 | 42.80 | 1.181 |
| late Pleistocene | IA | Base | 1123B-6H-2, 17–19 | 43.08 | 1.188 |
| middle Miocene | IIIA | Top | 1123B-49X-2, 129–130 | 453.59 | 13.87 |
| middle Miocene | IIIA | Base | 1123B-51X-3, 149–150 | 474.49 | 15.46 |
| early Miocene | IIIC | Top | 1123C-27X-1, 0–2 | 565.40 | 19.97 |
| early Miocene | IIIC | Base | 1123C-29X-2, 100–102 | 587.20 | 20.65 |
| early Oligocene | IV | Top | 1123C-29X-2, 120–122 | 587.40 | 32.82 |
| early Oligocene | IV | Base | 1123C-29X-6, 52–54 | 592.72 | 33.12 |

**Table T2.** Precision estimates for selected geochemical analyses. For each element, precision equals 100% times the standard deviation of the relative concentrations (i.e., the concentrations divided by the mean concentration). (Continued on next page.)

| Core, section, interval (cm) | Measured concentration | Relative concentration |
|---|---|---|
| Al (wt%): | | |
| 181-1123B- | | |
| 3H-4, 82 | 2.01 | 1.008 |
| 3H-4, 82 | 1.93 | 0.971 |
| 3H-4, 82 | 2.00 | 1.006 |
| 3H-4, 82 | 1.99 | 1.000 |
| 3H-4, 82 | 2.00 | 1.006 |
| 3H-4, 82 | 2.01 | 1.008 |
| Mean: | 1.99 | |
| 1H-1, 4 | 3.24 | 1.003 |
| 1H-1, 4 | 3.24 | 1.001 |
| 1H-1, 4 | 3.24 | 1.001 |
| 1H-1, 4 | 3.25 | 1.006 |
| 1H-1, 4 | 3.24 | 1.003 |
| 1H-1, 4 | 3.23 | 0.998 |
| 1H-1, 4 | 3.19 | 0.987 |
| Mean: | 3.23 | |
| Relative precision (%): | 1.03 | |
| Ba (µg/g): | | |
| 181-1123B- | | |
| 3H-4, 82 | 502 | 1.015 |
| 3H-4, 82 | 481 | 0.972 |
| 3H-4, 82 | 490 | 0.991 |
| 3H-4, 82 | 487 | 0.985 |
| 3H-4, 82 | 507 | 1.025 |
| 3H-4, 82 | 501 | 1.013 |
| Mean: | 494.7 | |
| 1H-1, 4 | 721 | 1.005 |
| 1H-1, 4 | 723 | 1.008 |
| 1H-1, 4 | 703 | 0.980 |
| 1H-1, 4 | 724 | 1.009 |
| 1H-1, 4 | 722 | 1.007 |
| 1H-1, 4 | 727 | 1.013 |
| 1H-1, 4 | 701 | 0.977 |
| Mean: | 717.3 | |
| Relative precision (%): | 1.69 | |
| Ca (wt%): | | |
| 181-1123B- | | |
| 3H-4, 82 | 28.0 | 1.011 |
| 3H-4, 82 | 27.0 | 0.975 |
| 3H-4, 82 | 27.7 | 0.998 |
| 3H-4, 82 | 27.9 | 1.006 |
| 3H-4, 82 | 27.8 | 1.002 |
| 3H-4, 82 | 28.0 | 1.008 |
| Mean: | 27.7 | |
| 1H-1, 4 | 21.8 | 1.011 |
| 1H-1, 4 | 21.6 | 1.004 |
| 1H-1, 4 | 21.2 | 0.985 |
| 1H-1, 4 | 21.7 | 1.008 |
| 1H-1, 4 | 21.9 | 1.017 |
| 1H-1, 4 | 21.2 | 0.988 |
| 1H-1, 4 | 21.2 | 0.987 |
| Mean: | 21.5 | |
| Relative precision (%): | 1.27 | |
| Cu (µg/g): | | |
| 181-1123B- | | |
| 3H-4, 82 | 19 | 1.000 |
| 3H-4, 82 | 19 | 1.000 |
| 3H-4, 82 | 19 | 1.000 |
| 3H-4, 82 | 19 | 1.000 |
| 3H-4, 82 | 19 | 1.000 |
| 3H-4, 82 | 19 | 1.000 |
| Mean: | 19.0 | |
| 1H-1, 4 | 36 | 1.027 |
| 1H-1, 4 | 35 | 1.000 |
| 1H-1, 4 | 34 | 0.971 |
| 1H-1, 4 | 35 | 1.000 |
| 1H-1, 4 | 36 | 1.027 |
| 1H-1, 4 | 35 | 1.000 |
| 1H-1, 4 | 34 | 0.971 |
| Mean: | 35.0 | |
| Relative precision (%): | 1.65 | |
| Fe (wt%): | | |
| 181-1123B- | | |
| 3H-4, 82 | 0.797 | 1.009 |
| 3H-4, 82 | 0.769 | 0.973 |
| 3H-4, 82 | 0.790 | 1.000 |
| 3H-4, 82 | 0.787 | 1.009 |
| 3H-4, 82 | 0.783 | 0.991 |
| Mean: | 0.790 | |
| 3H-4, 82 | 0.804 | 1.018 |
| 1H-1, 4 | 1.419 | 1.001 |
| 1H-1, 4 | 1.419 | 1.001 |
| 1H-1, 4 | 1.384 | 0.977 |
| 1H-1, 4 | 1.440 | 1.016 |
| 1H-1, 4 | 1.447 | 1.021 |
| 1H-1, 4 | 1.405 | 0.991 |
| 1H-1, 4 | 1.405 | 0.991 |
| Mean: | 1.417 | |
| Relative precision (%): | 1.49 | |
| K (wt%): | | |
| 181-1123B- | | |
| 3H-4, 82 | 0.664 | 1.013 |
| 3H-4, 82 | 0.631 | 0.962 |
| 3H-4, 82 | 0.656 | 1.000 |
| 3H-4, 82 | 0.656 | 1.000 |
| 3H-4, 82 | 0.664 | 1.013 |
| 3H-4, 82 | 0.664 | 1.013 |
| Mean: | 0.656 | |
| 1H-1, 4 | 1.013 | 1.008 |
| 1H-1, 4 | 1.004 | 1.000 |
| 1H-1, 4 | 1.004 | 1.000 |
| 1H-1, 4 | 1.013 | 1.008 |
| 1H-1, 4 | 1.013 | 1.008 |
| 1H-1, 4 | 0.996 | 0.992 |
| 1H-1, 4 | 0.988 | 0.983 |
| Mean: | 1.004 | |
| Relative precision (%): | 1.43 | |
| Mg (wt%): | | |
| 181-1123B- | | |
| 3H-4, 82 | 0.434 | 1.012 |
| 3H-4, 82 | 0.416 | 0.970 |
| 3H-4, 82 | 0.428 | 0.998 |
| 3H-4, 82 | 0.434 | 1.012 |
| 3H-4, 82 | 0.428 | 0.998 |
| 3H-4, 82 | 0.434 | 1.012 |
| Mean: | 0.429 | |
| 1H-1, 4 | 0.603 | 1.000 |
| 1H-1, 4 | 0.603 | 1.000 |
| 1H-1, 4 | 0.591 | 0.980 |
| 1H-1, 4 | 0.609 | 1.010 |
| 1H-1, 4 | 0.621 | 1.030 |
| 1H-1, 4 | 0.597 | 0.990 |
| 1H-1, 4 | 0.597 | 0.990 |
| Mean: | 0.603 | |
| Relative precision (%): | 1.57 | |

**Table T2 (continued).**

| Core, section, interval (cm) | Measured concentration | Relative concentration |
|---|---|---|
| Ni (µg/g) | | |
| 181-1123B- | | |
| 3H-4, 82 | 18 | 0.982 |
| 3H-4, 82 | 18 | 0.982 |
| 3H-4, 82 | 18 | 0.982 |
| 3H-4, 82 | 19 | 1.036 |
| 3H-4, 82 | 18 | 0.982 |
| 3H-4, 82 | 19 | 1.036 |
| Mean: | 18 | |
| 1H-1, 4 | 27 | 1.038 |
| 1H-1, 4 | 25 | 0.961 |
| 1H-1, 4 | 26 | 1.000 |
| 1H-1, 4 | 26 | 1.000 |
| 1H-1, 4 | 26 | 1.000 |
| 1H-1, 4 | 26 | 1.000 |
| 1H-1, 4 | 26 | 1.000 |
| Mean: | 26 | |
| Relative precision (%): | 2.40 | |
| P (wt%): | | |
| 181-1123B- | | |
| 3H-4, 82 | 0.0262 | 0.947 |
| 3H-4, 82 | 0.0262 | 0.947 |
| 3H-4, 82 | 0.0305 | 1.105 |
| 3H-4, 82 | 0.0262 | 0.947 |
| 3H-4, 82 | 0.0262 | 0.947 |
| 3H-4, 82 | 0.0305 | 1.105 |
| Mean: | 0.0276 | |
| 1H-1, 4 | 0.0349 | 1.0007 |
| 1H-1, 4 | 0.0349 | 1.000 |
| 1H-1, 4 | 0.0349 | 1.000 |
| 1H-1, 4 | 0.0349 | 1.000 |
| 1H-1, 4 | 0.0349 | 1.000 |
| 1H-1, 4 | 0.0349 | 1.000 |
| 1H-1, 4 | 0.0349 | 1.000 |
| Mean: | 0.0349 | |
| Relative precision (%): | 5.26 | |
| Ti (wt%): | | |
| 181-1123B- | | |
| 3H-4, 82 | 0.0959 | 1.000 |
| 3H-4, 82 | 0.0959 | 1.000 |
| 3H-4, 82 | 0.0959 | 1.000 |
| 3H-4, 82 | 0.0959 | 1.000 |
| 3H-4, 82 | 0.0959 | 1.000 |
| Mean: | 0.0959 | |
| 3H-4, 82 | 0.0959 | 1.000 |
| 1H-1, 4 | 0.1499 | 0.978 |
| 1H-1, 4 | 0.1559 | 1.017 |
| 1H-1, 4 | 0.1559 | 1.017 |
| 1H-1, 4 | 0.1559 | 1.017 |
| 1H-1, 4 | 0.1559 | 1.017 |
| 1H-1, 4 | 0.1499 | 0.978 |
| 1H-1, 4 | 0.1499 | 0.978 |
| Mean: | 0.1533 | |
| Relative precision (%): | 1.48 | |
| V (µg/g): | | |
| 181-1123B- | | |
| 3H-4, 82 | 25 | 0.987 |
| 3H-4, 82 | 26 | 1.026 |
| 3H-4, 82 | 25 | 0.987 |
| 3H-4, 82 | 25 | 0.987 |
| 3H-4, 82 | 25 | 0.987 |
| 3H-4, 82 | 26 | 1.026 |
| Mean: | 25.3 | |
| 1H-1, 4 | 41 | 1.011 |
| 1H-1, 4 | 40 | 0.986 |
| 1H-1, 4 | 40 | 0.986 |
| 1H-1, 4 | 41 | 1.011 |
| 1H-1, 4 | 41 | 1.011 |
| 1H-1, 4 | 41 | 1.011 |
| 1H-1, 4 | 40 | 0.986 |
| Mean: | 40.6 | |
| Relative precision (%): | 1.61 | |

**Table T3.** Geochemical data for late Pleistocene samples.

| Leg | Site | Hole | Core | Core type | Section | Top (cm) | Bottom (cm) | Depth (mbsf) | Depth (mcd.new*) | Age (Ma) | $CaCO_3$ (wt%) | Si (wt%) | Al (wt%) | Fe (wt%) | Mg (wt%) | Ca (wt%) | Na (wt%) | K (wt%) | Ti (wt%) | P (wt%) | Mn (wt%) | Ba (µg/g) | Co (µg/g) | Cr (µg/g) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 181 | 1123 | C | 1 | H | 1 | 4 | 6 | 0.04 | 0.04 | 0.001 | 58.6 | 11.1 | 3.24 | 1.42 | 0.603 | 21.8 | 1.68 | 1.01 | 0.150 | 0.0349 | 0.124 | 721 | 5 | 15 |
| 181 | 1123 | C | 1 | H | 1 | 9 | 11 | 0.09 | 0.09 | 0.002 | 51.8 | 11.2 | 3.27 | 1.41 | 0.603 | 21.7 | 1.71 | 1.04 | 0.150 | 0.0349 | 0.085 | 686 | 5 | 16 |
| 181 | 1123 | C | 1 | H | 1 | 21 | 23 | 0.21 | 0.21 | 0.004 | 62.0 | 10.0 | 2.93 | 1.32 | 0.585 | 23.4 | 1.53 | 0.94 | 0.144 | 0.0305 | 0.085 | 694 | 6 | 14 |
| 181 | 1123 | C | 1 | H | 1 | 29 | 31 | 0.29 | 0.29 | 0.006 | 66.5 | 9.1 | 2.67 | 1.24 | 0.567 | 24.3 | 1.54 | 0.86 | 0.132 | 0.0305 | 0.023 | 722 | 2 | 15 |
| 181 | 1123 | C | 1 | H | 1 | 42 | 44 | 0.42 | 0.42 | 0.009 | 61.5 | 10.5 | 3.16 | 1.41 | 0.669 | 23.3 | 1.62 | 1.05 | 0.156 | 0.0305 | 0.023 | 919 | 3 | 18 |
| 181 | 1123 | C | 1 | H | 1 | 49 | 51 | 0.49 | 0.49 | 0.010 | 51.9 | 13.6 | 3.91 | 1.82 | 0.796 | 19.6 | 1.74 | 1.30 | 0.192 | 0.0305 | 0.023 | 871 | 5 | 25 |
| 181 | 1123 | C | 1 | H | 1 | 58 | 60 | 0.58 | 0.58 | 0.012 | 39.0 | 13.5 | 4.03 | 1.71 | 0.790 | 17.4 | 1.79 | 1.32 | 0.192 | 0.0305 | 0.023 | 855 | 5 | 25 |
| 181 | 1123 | C | 1 | H | 1 | 68 | 70 | 0.68 | 0.68 | 0.014 | 40.2 | 14.6 | 4.30 | 1.82 | 0.844 | 16.6 | 2.02 | 1.43 | 0.204 | 0.0305 | 0.023 | 874 | 5 | 28 |
| 181 | 1123 | C | 1 | H | 1 | 78 | 80 | 0.78 | 0.78 | 0.016 | 36.3 | 17.2 | 4.79 | 2.02 | 0.874 | 14.0 | 2.18 | 1.59 | 0.216 | 0.0305 | 0.023 | 870 | 6 | 28 |
| 181 | 1123 | C | 1 | H | 1 | 90 | 92 | 0.90 | 0.90 | 0.019 | 28.1 | 19.4 | 5.13 | 2.05 | 0.844 | 11.7 | 2.43 | 1.79 | 0.204 | 0.0305 | 0.031 | 893 | 6 | 26 |
| 181 | 1123 | C | 1 | H | 1 | 102 | 104 | 1.02 | 1.02 | 0.021 | 35.3 | 20.0 | 5.30 | 2.05 | 0.838 | 11.4 | 2.33 | 1.79 | 0.216 | 0.0305 | 0.031 | 793 | 6 | 27 |
| 181 | 1123 | C | 1 | H | 1 | 109 | 111 | 1.09 | 1.09 | 0.022 | 26.8 | 18.6 | 5.12 | 2.08 | 0.856 | 12.4 | 2.21 | 1.71 | 0.222 | 0.0305 | 0.031 | 847 | 6 | 28 |
| 181 | 1123 | C | 1 | H | 1 | 122 | 124 | 1.22 | 1.22 | 0.025 | 24.2 | 19.6 | 4.96 | 1.82 | 0.718 | 12.0 | 2.32 | 1.77 | 0.192 | 0.0305 | 0.031 | 847 | 5 | 21 |
| 181 | 1123 | C | 1 | H | 1 | 128 | 130 | 1.28 | 1.28 | 0.026 | 24.9 | 24.0 | 5.62 | 1.69 | 0.621 | 8.7 | 2.64 | 2.09 | 0.180 | 0.0262 | 0.039 | 828 | 3 | 16 |
| 181 | 1123 | C | 1 | H | 1 | 142 | 144 | 1.42 | 1.42 | 0.029 | 33.9 | 18.8 | 4.92 | 1.82 | 0.766 | 12.9 | 2.31 | 1.70 | 0.204 | 0.0305 | 0.039 | 775 | 5 | 22 |
| 181 | 1123 | C | 1 | H | 2 | 4 | 6 | 1.54 | 1.54 | 0.032 | 23.1 | 22.3 | 5.26 | 1.67 | 0.663 | 11.1 | 2.55 | 1.84 | 0.180 | 0.0262 | 0.039 | 782 | 4 | 17 |
| 181 | 1123 | C | 1 | H | 2 | 9 | 11 | 1.59 | 1.59 | 0.033 | 45.4 | 14.5 | 4.42 | 2.17 | 0.911 | 16.4 | 2.09 | 1.50 | 0.216 | 0.0349 | 0.031 | 766 | 6 | 29 |

| Leg | Site | Hole | Core | Core type | Section | Top (cm) | Bottom (cm) | Depth (mbsf) | Depth (mcd.new*) | Cu (µg/g) | Li (µg/g) | Ni (µg/g) | Sc (µg/g) | Sr (µg/g) | V (µg/g) | Y (µg/g) | Zn (µg/g) | Zr (µg/g) | La (µg/g) | Ce (µg/g) | Nd (µg/g) | Sm (µg/g) | Eu (µg/g) | Dy (µg/g) | Yb (µg/g) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 181 | 1123 | C | 1 | H | 1 | 4 | 6 | 0.04 | 0.04 | 36 | 31 | 27 | 5 | 1075 | 41 | 19 | 50 | 31 | 13 | 34 | 12.1 | 2.39 | 0.58 | 2.5 | 1.1 |
| 181 | 1123 | C | 1 | H | 1 | 9 | 11 | 0.09 | 0.09 | 38 | 32 | 22 | 5 | 1038 | 41 | 19 | 51 | 37 | 13 | 35 | 12.5 | 2.09 | 0.48 | 2.5 | 1.2 |
| 181 | 1123 | C | 1 | H | 1 | 21 | 23 | 0.21 | 0.21 | 34 | 29 | 17 | 5 | 1127 | 37 | 18 | 45 | 27 | 11 | 31 | 13.0 | 2.53 | 0.49 | 2.1 | 1.1 |
| 181 | 1123 | C | 1 | H | 1 | 29 | 31 | 0.29 | 0.29 | 28 | 28 | 16 | 4 | 1166 | 34 | 17 | 44 | 33 | 11 | 32 | 11.0 | 2.07 | 0.49 | 2.1 | 1.1 |
| 181 | 1123 | C | 1 | H | 1 | 42 | 44 | 0.42 | 0.42 | 31 | 34 | 21 | 5 | 1103 | 45 | 19 | 52 | 45 | 13 | 32 | 11.2 | 2.19 | 0.48 | 2.2 | 1.2 |
| 181 | 1123 | C | 1 | H | 1 | 49 | 51 | 0.49 | 0.49 | 45 | 43 | 25 | 7 | 925 | 62 | 19 | 65 | 78 | 15 | 36 | 17.2 | 2.82 | 0.64 | 2.4 | 1.2 |
| 181 | 1123 | C | 1 | H | 1 | 58 | 60 | 0.58 | 0.58 | 32 | 43 | 25 | 7 | 830 | 62 | 18 | 66 | 29 | 15 | 36 | 13.8 | 1.87 | 0.75 | 2.2 | 1.2 |
| 181 | 1123 | C | 1 | H | 1 | 68 | 70 | 0.68 | 0.68 | 29 | 46 | 25 | 7 | 789 | 58 | 19 | 68 | 27 | 16 | 38 | 15.7 | 3.62 | 0.74 | 2.5 | 1.2 |
| 181 | 1123 | C | 1 | H | 1 | 78 | 80 | 0.78 | 0.78 | 31 | 49 | 25 | 8 | 686 | 62 | 20 | 71 | 74 | 16 | 40 | 19.2 | 2.63 | 0.83 | 2.7 | 1.3 |
| 181 | 1123 | C | 1 | H | 1 | 90 | 92 | 0.90 | 0.90 | 29 | 49 | 26 | 8 | 598 | 56 | 21 | 70 | 78 | 17 | 42 | 20.1 | 3.62 | 0.62 | 2.6 | 1.3 |
| 181 | 1123 | C | 1 | H | 1 | 102 | 104 | 1.02 | 1.02 | 28 | 49 | 24 | 8 | 562 | 58 | 22 | 69 | 105 | 18 | 43 | 25.0 | 3.72 | 0.92 | 2.9 | 1.3 |
| 181 | 1123 | C | 1 | H | 1 | 109 | 111 | 1.09 | 1.09 | 32 | 49 | 26 | 8 | 639 | 64 | 22 | 74 | 91 | 17 | 43 | 18.9 | 4.31 | 0.52 | 3.1 | 1.3 |
| 181 | 1123 | C | 1 | H | 1 | 122 | 124 | 1.22 | 1.22 | 25 | 43 | 23 | 7 | 602 | 48 | 24 | 68 | 94 | 18 | 43 | 25.8 | 3.42 | 0.54 | 3.1 | 1.5 |
| 181 | 1123 | C | 1 | H | 1 | 128 | 130 | 1.28 | 1.28 | 17 | 41 | 18 | 7 | 445 | 38 | 28 | 63 | 106 | 20 | 48 | 26.8 | 4.48 | 0.86 | 3.8 | 2.0 |
| 181 | 1123 | C | 1 | H | 1 | 142 | 144 | 1.42 | 1.42 | 30 | 45 | 23 | 7 | 638 | 52 | 22 | 66 | 71 | 17 | 41 | 20.2 | 3.62 | 0.84 | 3.2 | 1.4 |
| 181 | 1123 | C | 1 | H | 2 | 4 | 6 | 1.54 | 1.54 | 22 | 43 | 20 | 6 | 573 | 42 | 25 | 64 | 136 | 18 | 43 | 26.1 | 3.78 | 0.76 | 3.2 | 1.5 |
| 181 | 1123 | C | 1 | H | 2 | 9 | 11 | 1.59 | 1.59 | 29 | 47 | 32 | 7 | 821 | 67 | 19 | 73 | 77 | 15 | 37 | 19.1 | 3.07 | 0.51 | 2.6 | 1.2 |

Notes: Mcd.new = revised meters composite depth (mcd) as described by Hall et al. (2001). Only a portion of this table appears here. The complete table is available in ASCII.

# CHAPTER NOTES*

**N1.** Weedon, G.P., and Hall, I.R., submitted. *Mar. Geol.*

**N2.** Hall, I.R., McCave, I.N., Zahn, R., Carter, L., Knutz, P.C., and Weedon, G.P., submitted. *Paleoceanography.*

**N3.** Carter, L., Shane, P., Alloway, B., Hall, I.R., and Harris, S.E., submitted. *Geology.*

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*Dates reflect file corrections or revisions.