Anselmetti, F.S., Isern, A.R., Blum, P., and Betzler, C. (Eds.)
Proceedings of the Ocean Drilling Program, Scientific Results Volume 194

3. Data Report: Variations in Bulk Carbonate Content, Hole 1198A, 0–23.69 mbsf[1]

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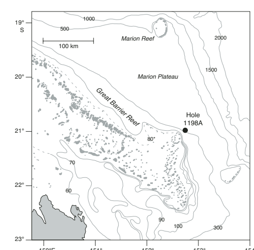
ABSTRACT

Upper Quaternary sediment sequences east of the Great Barrier Reef are characterized by alternating siliciclastic- and carbonate-rich horizons caused by changes in the input of various sedimentary components and reflected in cores by variations in bulk carbonate content. A total of 153 measurements of bulk carbonate content were determined using the carbonate-bomb technique for late Pleistocene sediments between 0 and 23.69 meters below sea floor (mbsf) in Ocean Drilling Program Hole 1198A. Average sample resolution was 15 cm and multiple analyses were performed on each sample. Bulk carbonate content ranges from a maximum of 94 wt% at 13.63 mbsf to a minimum of 73 wt% at 14.54 mbsf. Five cyclic trends are observed that may relate to five major glacial events during the last 500 k.y. of the Quaternary.

INTRODUCTION

The northeast Australian margin is the largest extant tropical mixed siliciclastic-carbonate depositional system. For more than 500 k.y. (Davies and McKenzie, 1993; International Consortium for Great Barrier Reef Drilling, 2001), rivers have discharged large masses of clay, quartz, and other weathered residue from the Australian continent into a region with an extensive network of carbonate reefs on the outer shelf, the Great Barrier Reef (GBR). The Marion Plateau (Fig. F1) lies east of the main GBR system, acting as a repository for carbonate material shed from the GBR platform as well as siliciclastic sediments sourced

F1. Marion Plateau, p. 5.



[1] Page, M.C., 2004. Data report: Variations in bulk carbonate content, Hole 1198A, 0–23.69 mbsf. *In* Anselmetti, F.S., Isern, A.R., Blum, P., and Betzler, C. (Eds.), *Proc. ODP, Sci. Results,* 194, 1–9 [Online]. Available from World Wide Web: <http://www-odp.tamu.edu/publications/194_SR/VOLUME/CHAPTERS/004.PDF>. [Cited YYYY-MM-DD]

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Initial receipt: 7 July 2003
Acceptance: 2 April 2004
Web publication: 6 August 2004
Ms 194SR-004

from the Australian landmass (Shipboard Scientific Party, 2002a). The plateau also accumulates carbonate sediments sourced from pelagic rain and local reef systems detached from the high-density reef network on the adjoining GBR shelf.

Fluctuations in eustatic sea level are widely believed to be the primary control on off-shelf fluxes of siliciclastic and carbonate sediments along passive continental margins (e.g., Vail et al., 1977; Walker, 1992). The northeast Australian margin is no exception, although considerable conjecture surrounds the specific processes affecting sediment transport and the timing of off-shelf sediment fluxes in relation to specific phases of eustatic sea level (e.g., Harris et al., 1990; Peerdeman and Davies, 1993; Dunbar et al., 2000; Kronen and Glenn, 2000; Page et al., 2003). Ocean Drilling Program Hole 1198A (Fig. F1) provides a relatively expanded record of mixed siliciclastic-carbonate deposition on the Marion Plateau from the late Pliocene to Pleistocene (Shipboard Scientific Party, 2002b). The site contrasts with the more heavily investigated Queensland and Townsville troughs north of the plateau because a significantly wider shelf separates it from fluvial sources of siliciclastic sediment.

This data report does not attempt to quantify the rates of sediment accumulation at Hole 1198A or resolve the question of off-shelf sediment fluxes and their relation to variations in eustatic sea level (cf. Page et al., 2003). The high-resolution record of variations in bulk carbonate content, however, should prove useful for future studies that may address these questions, as well as other problems relating to the evolution of the mixed siliciclastic-carbonate margin of northeastern Australia.

METHODS

A total of 153 samples from the upper part of Subunit 1A of Megasequence D were taken at an average 15-cm resolution between 0 and 23.69 meters below seafloor (mbsf) in Hole 1198A (Table T1). Based on shipboard biostratigraphic datums (Shipboard Scientific Party, 2002b), this interval approximately represents the last 500 k.y. of deposition on the Marion Plateau. This period is also thought to be roughly congruous with the presence of large barrier reef systems, analogous to the present GBR, on the adjacent continental shelf during sea level highstands (International Consortium for Great Barrier Reef Drilling, 2001).

T1. Bulk carbonate content, p. 7.

Approximately 3 cm^3 of sediment was subsampled from nominally 10 cm^3 of bulk sample and freeze-dried to remove pore fluids. Subsamples were crushed using a ceramic hand mortar and pestle and ground into a fine powder. From each sample, 150–250 mg of powder was weighed and utilized for the determination of bulk carbonate content following the principles of the carbonate-bomb technique (Mueller and Gastner, 1971). Duplicate sample analyses and comparisons with laboratory standards place the accuracy and precision of reported carbonate contents within a maximum of ±2.6%, with an average reproducibility of ±0.9% (Table T1).

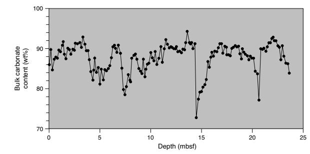
Sediment on the northeast Australian margin comprises two basic components, terrigenous siliciclastic sediment and biogenic carbonate, with only trace amounts of other material (Harris et al., 1990; Dunbar et al., 2000; Heap et al., 2001). Consequently, within the precision of the technique, quantification of bulk carbonate content also renders accurate values for siliciclastic abundance.

RESULTS

Bulk carbonate content in the upper part of Subunit 1A of Megasequence D in Hole 1198A is generally very high (Table T1, Fig. F2). More than 95% of the 153 intervals sampled between 0 and 23.69 mbsf have bulk carbonate concentrations >80 wt%, with over 76% of these intervals being >85 wt% carbonate. Maximum bulk carbonate content of 94.1 wt% occurs at 13.63 mbsf and minimum bulk carbonate content of 72.7 wt% occurs at 14.54 mbsf. The interval between 14.54 and 14.35 mbsf shows the highest short-term range in bulk carbonate content with a variation of ~20 wt% occurring in samples separated by <20 cm.

Variations in bulk carbonate content occur with a general cyclicity that has a period of between 3 and 7 m and an amplitude of between 10 and 20 wt%. Overall, five cyclic trends are observed. Peaks occur at 3.35, 6.85, 13.63, 17.00, and 22.04 mbsf, and troughs occur at 0.35, 5.04, 7.50, 14.54, and 20.69 mbsf. The five cyclic variations in bulk carbonate content in Hole 1198A are potentially related to the five major glacial events that have occurred in the last 500 k.y. of the Quaternary. Based on shipboard biostratigraphic datums, including the fact that it is likely that the Holocene sediment section is missing from Hole 1198A (Shipboard Scientific Party, 2002b), peaks in bulk carbonate content may loosely correlate with peaks in fifth-order sea level and marine isotope stages 3, 5, 7, 9, and 11.

F2. Bulk carbonate content, p. 6.



ACKNOWLEDGMENTS

This research used samples and/or data 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.

I would sincerely like to thank Co-Chief Scientists Flavio Anselmetti and Alexandra Isern, Staff Scientist Peter Blum, and the entire shipboard scientific party for the opportunity to be a part of ODP Leg 194 and participate in shipboard and postcruise scientific meetings. The knowledge, experience, and enjoyment gained from these endeavors are currently unparalleled and have been instrumental in my enthusiasm for science since.

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Figure F1. Major physiographic and bathymetric features of the Marion Plateau and the location of Site 1198.

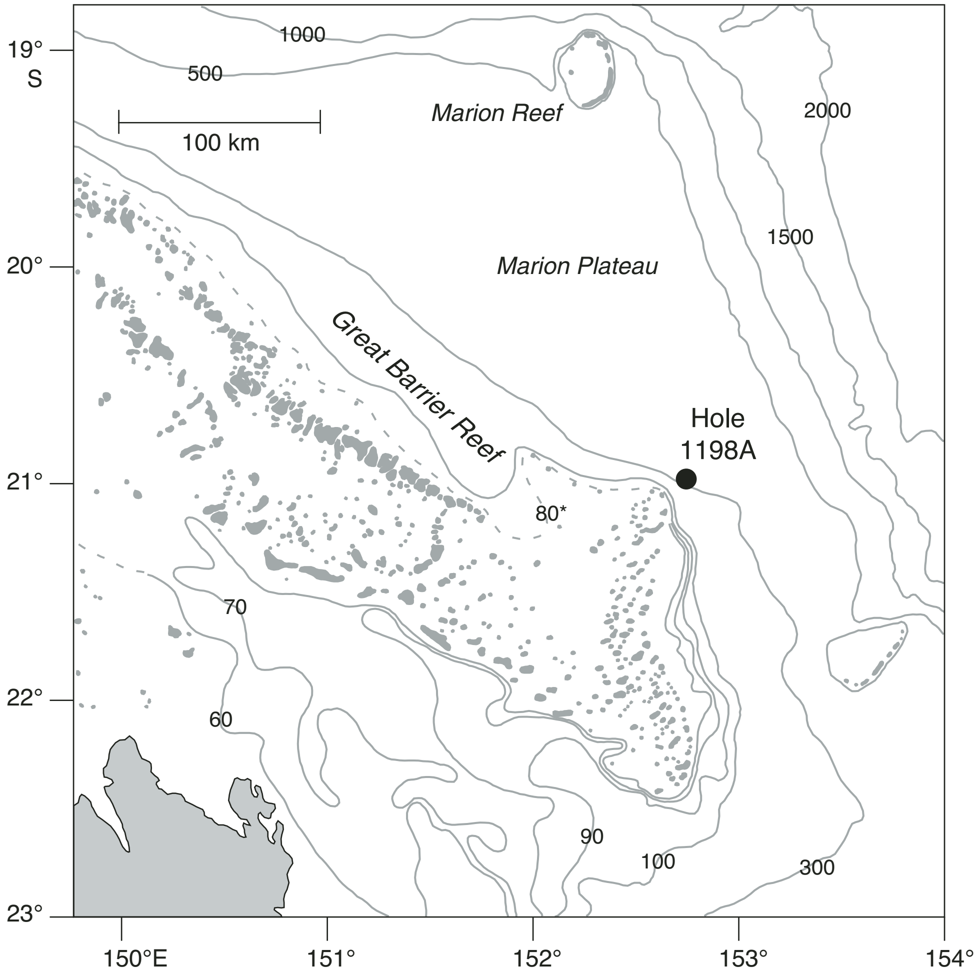

Figure F2. Variations in bulk carbonate content from 0 to 23.69 mbsf, Hole 1198A.

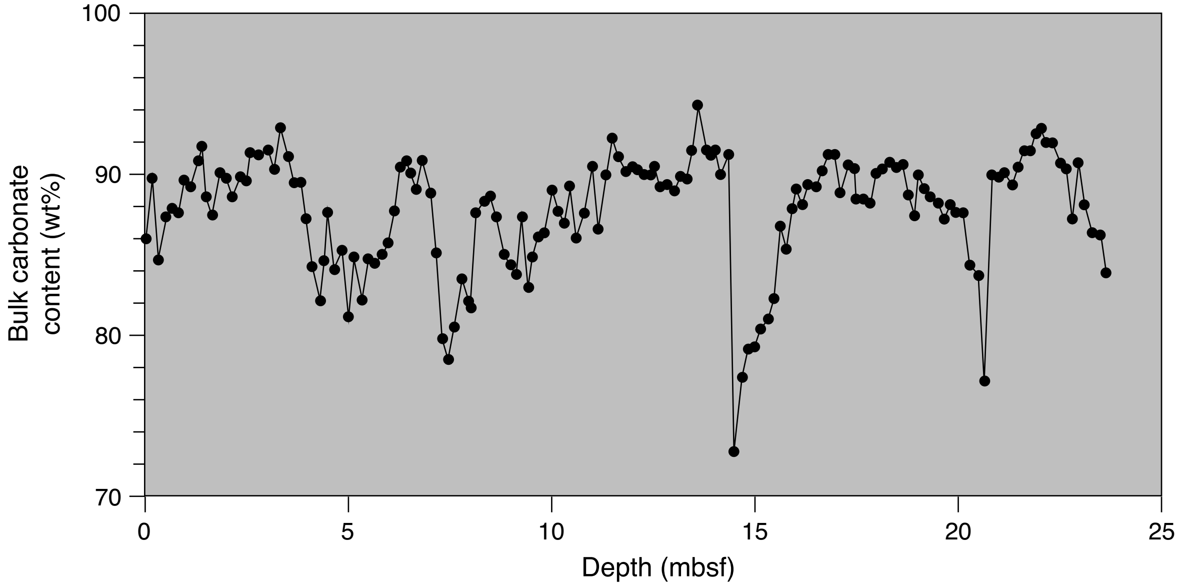

Table T1. Bulk carbonate content, Hole 1198A, 0–23.69 mbsf.

Core, section, interval (cm)	Depth (mbsf)	Bulk carbonate (wt%)				Standard deviation (wt%)
		Analysis 1	Analysis 2	Analysis 3	Average	
194-1198A-						
1H-1, 3–5	0.04	86.0	85.9		86.0	0.1
1H-1, 18–20	0.19	89.5	89.4	90.2	89.7	0.4
1H-1, 34–36	0.35	84.9	84.6		84.8	0.2
1H-1, 51–53	0.52	88.5	86.1		87.3	1.7
1H-1, 66–68	0.67	87.2	88.5	87.7	87.8	0.7
1H-1, 83–85	0.84	87.9	87.9	86.8	87.5	0.6
1H-1, 99–101	1.00	89.2	90.4	89.0	89.5	0.8
1H-1, 112–114	1.13	90.7	87.6		89.2	2.2
1H-1, 130–132	1.31	90.5	90.1	91.7	90.8	0.8
1H-1, 144–146	1.45	90.8	92.4	91.8	91.7	0.8
1H-2, 153–155	1.54	85.7	89.6	90.2	88.5	2.4
1H-2, 168–170	1.69	85.3	88.9	88.0	87.4	1.9
1H-2, 184–186	1.85	90.3	89.7		90.0	0.4
1H-2, 201–203	2.02	90.5	90.5	87.9	89.6	1.5
1H-2, 216–218	2.17	89.1	88.1		88.6	0.7
1H-2, 233–235	2.34	88.8	89.5	91.1	89.8	1.2
1H-2, 249–251	2.50	89.8	89.3		89.6	0.4
1H-2, 262–264	2.63	89.8	91.3	92.8	91.3	1.5
1H-2, 280–282	2.81	91.0	91.3		91.2	0.2
1H-3, 303–305	3.04	91.1	91.6		91.4	0.4
1H-3, 318–320	3.19	90.5	90.2		90.4	0.2
1H-3, 334–336	3.35	91.5	94.7	92.3	92.8	1.7
1H-3, 351–353	3.52	90.6	91.5		91.1	0.6
1H-3, 366–368	3.67	90.0	90.0	88.3	89.4	1.0
1H-3, 383–385	3.84	87.8	90.1	90.2	89.4	1.4
1H-3, 399–401	4.00	87.2	87.2		87.2	0.0
1H-3, 412–414	4.13	83.2	85.1		84.2	1.3
1H-3, 430–432	4.31	81.6	82.7		82.2	0.8
1H-3, 444–446	4.45	82.9	85.1	85.8	84.6	1.5
1H-4, 453–455	4.54	87.2	87.2	88.4	87.6	0.7
1H-4, 468–470	4.69	84.0	83.4	84.9	84.1	0.8
1H-4, 484–486	4.85	85.2	83.6	86.7	85.2	1.6
2H-1, 503–505	5.04	81.7	80.5		81.1	0.8
2H-1, 518–520	5.19	85.7	83.7		84.7	1.4
2H-1, 534–536	5.35	81.2	81.5	83.8	82.2	1.4
2H-1, 551–553	5.52	83.5	84.3	86.2	84.7	1.4
2H-1, 566–568	5.67	83.8	84.1	85.4	84.4	0.9
2H-1, 583–585	5.84	85.8	83.6	85.6	85.0	1.2
2H-1, 599–601	6.00	85.7	86.1	85.1	85.6	0.5
2H-1, 612–614	6.13	86.5	88.9		87.7	1.7
2H-1, 630–632	6.31	89.4	88.6	93.4	90.5	2.6
2H-1, 644–646	6.45	89.1	92.4	90.7	90.7	1.7
2H-2, 653–655	6.54	91.1	91.1	87.9	90.0	1.8
2H-2, 668–670	6.69	89.3	88.9		89.1	0.3
2H-2, 684–686	6.85	90.7	91.7	90.0	90.8	0.9
2H-2, 701–703	7.02	88.2	89.5	88.8	88.8	0.7
2H-2, 716–718	7.17	83.8	85.5	85.8	85.0	1.1
2H-2, 733–735	7.34	79.6	79.9		79.8	0.2
2H-2, 749–751	7.50	78.4	78.6		78.5	0.1
2H-2, 762–764	7.63	80.0	80.9		80.5	0.6
2H-2, 780–782	7.81	82.5	84.0	84.0	83.5	0.9
2H-2, 794–796	7.95	81.8	82.4		82.1	0.4
2H-3, 803–805	8.04	83.0	83.0	79.3	81.8	2.1
2H-3, 818–820	8.19	87.4	89.2	86.2	87.6	1.5
2H-3, 834–836	8.35	88.1	88.6		88.4	0.4
2H-3, 851–853	8.52	88.3	90.2	87.2	88.6	1.5
2H-3, 866–868	8.67	87.3	87.4		87.4	0.1
2H-3, 883–885	8.84	85.5	84.4		85.0	0.8
2H-3, 899–901	9.00	85.5	83.2		84.4	1.6
2H-3, 912–914	9.13	84.9	84.9	81.3	83.7	2.1
2H-3, 930–932	9.31	87.0	87.6	87.4	87.3	0.3
2H-3, 944–946	9.45	83.6	82.4		83.0	0.8
2H-4, 953–955	9.54	83.9	85.8		84.9	1.3
2H-4, 968–970	9.69	85.7	86.5		86.1	0.6
2H-4, 984–986	9.85	86.1	86.6		86.4	0.4
2H-4, 1001–1003	10.02	89.2	89.2	88.3	88.9	0.5
2H-4, 1016–1018	10.17	89.3	86.0		87.7	2.3
2H-4, 1033–1035	10.34	88.4	85.5		87.0	2.1

Table T1 (continued).

Core, section, interval (cm)	Depth (mbsf)	Bulk carbonate (wt%)				Standard deviation (wt%)
		Analysis 1	Analysis 2	Analysis 3	Average	
2H-4, 1049–1051	10.50	88.5	88.8	89.9	89.1	0.7
2H-4, 1062–1064	10.63	85.7	86.3		86.0	0.4
2H-4, 1080–1082	10.81	88.1	86.9		87.5	0.8
2H-5, 1103–1105	11.04	89.9	91.4	89.8	90.4	0.9
2H-5, 1118–1120	11.19	86.5	87.4	85.8	86.6	0.8
2H-5, 1134–1136	11.35	91.1	91.1	87.4	89.9	2.1
2H-5, 1151–1153	11.52	90.7	92.2	93.4	92.1	1.4
2H-5, 1166–1168	11.67	90.3	91.3	91.6	91.1	0.7
2H-5, 1183–1185	11.84	89.3	91.0		90.2	1.2
2H-5, 1199–1201	12.00	90.0	88.5	92.8	90.4	2.2
2H-5, 1212–1214	12.13	89.7	89.0	92.1	90.3	1.6
2H-5, 1230–1232	12.31	89.7	88.4	91.6	89.9	1.6
2H-5, 1244–1246	12.45	89.3	88.7	91.7	89.9	1.6
2H-6, 1253–1255	12.54	89.7	90.8	90.8	90.4	0.6
2H-6, 1268–1270	12.69	89.4	89.0		89.2	0.3
2H-6, 1284–1286	12.85	90.0	90.0	87.9	89.3	1.2
2H-6, 1301–1303	13.02	88.7	89.3	88.8	88.9	0.3
2H-6, 1316–1318	13.17	90.6	89.0		89.8	1.1
2H-6, 1333–1335	13.34	90.8	88.6		89.7	1.6
2H-6, 1349–1351	13.50	92.2	90.5		91.4	1.2
2H-6, 1362–1364	13.63	93.3	93.6	95.5	94.1	1.2
2H-6, 1380–1382	13.81	92.1	90.8		91.5	0.9
2H-6, 1394–1396	13.95	92.1	90.2		91.2	1.3
2H-7, 1403–1405	14.04	91.7	91.1		91.4	0.4
2H-7, 1418–1420	14.19	91.3	91.3	87.3	90.0	2.3
2H-7, 1434–1436	14.35	91.4	91.0		91.2	0.3
3H-1, 1453–1455	14.54	72.6	72.6	72.9	72.7	0.2
3H-1, 1468–1470	14.69	78.4	76.2		77.3	1.6
3H-1, 1484–1486	14.85	80.1	78.1		79.1	1.4
3H-1, 1501–1503	15.02	79.1	79.2		79.2	0.1
3H-1, 1516–1518	15.17	81.1	79.6		80.4	1.1
3H-1, 1533–1535	15.34	82.7	80.0	80.2	81.0	1.5
3H-1, 1549–1551	15.50	83.0	81.3		82.2	1.2
3H-1, 1562–1564	15.63	87.5	85.8		86.7	1.2
3H-1, 1580–1582	15.81	85.8	84.7		85.3	0.8
3H-1, 1594–1596	15.95	88.6	87.0		87.8	1.1
3H-2, 1603–1605	16.04	88.9	89.2		89.1	0.2
3H-2, 1618–1620	16.19	88.0	88.1		88.1	0.1
3H-2, 1634–1636	16.35	90.3	90.3	87.3	89.3	1.7
3H-2, 1651–1653	16.52	88.9	89.4		89.2	0.4
3H-2, 1666–1668	16.67	89.7	90.6		90.2	0.6
3H-2, 1683–1685	16.84	92.0	90.2		91.1	1.3
3H-2, 1699–1701	17.00	91.6	90.6		91.1	0.7
3H-2, 1712–1714	17.13	89.2	88.5		88.9	0.5
3H-2, 1730–1732	17.31	89.8	91.2		90.5	1.0
3H-2, 1744–1746	17.45	90.2	90.4		90.3	0.1
3H-3, 1753–1755	17.54	89.4	87.5		88.5	1.3
3H-3, 1768–1770	17.69	88.7	88.7	87.7	88.4	0.6
3H-3, 1784–1786	17.85	88.5	87.8		88.2	0.5
3H-3, 1801–1803	18.02	90.9	89.2		90.1	1.2
3H-3, 1816–1818	18.17	90.9	89.6		90.3	0.9
3H-3, 1833–1835	18.34	91.4	90.0		90.7	1.0
3H-3, 1849–1851	18.50	90.0	90.9		90.5	0.6
3H-3, 1862–1864	18.63	90.3	90.8		90.6	0.4
3H-3, 1880–1882	18.81	88.2	89.1		88.7	0.6
3H-3, 1894–1896	18.95	87.6	87.3		87.5	0.2
3H-4, 1903–1905	19.04	89.6	90.2		89.9	0.4
3H-4, 1918–1920	19.19	89.0	89.0		89.0	0.0
3H-4, 1934–1936	19.35	88.0	89.1		88.6	0.8
3H-4, 1951–1953	19.52	87.3	89.0		88.2	1.2
3H-4, 1966–1968	19.67	86.7	87.6		87.2	0.6
3H-4, 1983–1985	19.84	88.0	88.1		88.1	0.1
3H-4, 1999–2001	20.00	87.3	87.7		87.5	0.3
3H-4, 2012–2014	20.13	87.5	87.7		87.6	0.1
3H-4, 2030–2032	20.31	84.1	84.6		84.4	0.4
3H-5, 2053–2055	20.54	82.3	85.2		83.8	2.1
3H-5, 2068–2070	20.69	75.4	79.0	77.0	77.1	1.8
3H-5, 2084–2086	20.85	89.4	90.4		89.9	0.7
3H-5, 2101–2103	21.02	88.6	91.0		89.8	1.7

Table T1 (continued).

Core, section, interval (cm)	Depth (mbsf)	Bulk carbonate (wt%)				Standard deviation (wt%)
		Analysis 1	Analysis 2	Analysis 3	Average	
3H-5, 2116–2118	21.17	89.5	90.5		90.0	0.7
3H-5, 2133–2135	21.34	89.5	89.5	89.0	89.3	0.3
3H-5, 2149–2151	21.50	88.7	92.2		90.5	2.5
3H-5, 2162–2164	21.63	89.8	92.9		91.4	2.2
3H-5, 2180–2182	21.81	89.8	93.1		91.5	2.3
3H-5, 2194–2196	21.95	92.4	92.7		92.6	0.2
3H-6, 2203–2205	22.04	92.4	93.1		92.8	0.5
3H-6, 2218–2220	22.19	92.1	91.7		91.9	0.3
3H-6, 2234–2236	22.35	91.7	92.0		91.9	0.2
3H-6, 2251–2253	22.52	90.8	90.6		90.7	0.1
3H-6, 2266–2268	22.67	90.3	90.3	90.1	90.2	0.1
3H-6, 2283–2285	22.84	87.4	87.0		87.2	0.3
3H-6, 2299–2301	23.00	90.7	90.7		90.7	0.0
3H-6, 2312–2314	23.13	87.4	88.7		88.1	0.9
3H-6, 2330–2332	23.31	86.2	86.5		86.4	0.2
3H-7, 2353–2355	23.54	85.8	85.8	87.1	86.2	0.8
3H-7, 2368–2370	23.69	83.9	83.7		83.8	0.1
			Average standard deviation:			0.9