

## 5. DATA REPORT: COMPOSITION OF AUTHIGENIC CARBONATES IN SEDIMENTS OF THE CASCADIA ACCRETIONARY PRISM, ODP LEG 204<sup>1</sup>

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### ABSTRACT

Carbonate mineralogy and carbonate content were determined on 65 samples from Sites 1244–1252, which were drilled on southern Hydrate Ridge and in an adjacent slope basin at the Cascadia accretionary prism. X-ray diffraction analyses data indicate varying carbonate compositions. Pure calcites are rare but were found at Sites 1246 and 1252. Low- and high-magnesium calcites are the dominant carbonate mineralogies and occur at all sites. The presence of dolomite is characteristic for the slope basin sites. The sampling depth of the carbonates varies from near seafloor to deep within the accretionary complex, suggesting different modes of carbonate formation. The summit, flank, and slope basin sites show characteristic carbonate compositions with different carbonate contents in distinct depth intervals.

### INTRODUCTION

This report presents the results of X-ray diffraction (XRD) analyses of samples from nine sites cored during Ocean Drilling Program Leg 204 (Tréhu, Bohrmann, Rack, Torres, et al., 2003). Based on the stratigraphic and structural setting, the sites can be grouped into three different environments. Sites 1248–1250 on the southern summit of Hydrate Ridge represent locations of active seafloor seepage. At Site 1248, high backscatter reflectivity was interpreted to indicate authigenic carbonates at

<sup>1</sup> Teichert, B.M.A., and Bohrmann, G., 2006. Data report: Composition of authigenic carbonates in sediments of the Cascadia accretionary prism, ODP Leg 204. In Tréhu, A.M., Bohrmann, G., Torres, M.E., and Colwell, F.S. (Eds.), *Proc. ODP, Sci. Results*, 204, 1–8 [Online]. Available from World Wide Web: <[http://www-odp.tamu.edu/publications/204\\_SR/VOLUME/CHAPTERS/116.PDF](http://www-odp.tamu.edu/publications/204_SR/VOLUME/CHAPTERS/116.PDF)>. [Cited YYYY-MM-DD]

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the seafloor (Johnson et al., 2003). Characteristics for Site 1249 are massive gas hydrate accumulations at the seafloor accompanied by carbonate precipitates (Bohrmann et al., 1998; Teichert et al., 2005). Site 1250 is located between the summit and a prominent chemoherm called the Pinnacle. Sites 1244–1247 represent the flanks of southern Hydrate Ridge, and Sites 1251 and 1252 represent a slope basin to the east. Authigenic carbonates have been previously recognized at the Cascadia margin (e.g., Sample and Kopf, 1995) and may serve as a record of the fluid evolution at these sites. Therefore, mineral and chemical composition of authigenic carbonates may help to evaluate the diagenetic environment and the paleofluid composition during carbonate precipitation.

## SAMPLING AND ANALYTICAL METHODS

A total of 65 carbonate samples were taken as semi-indurated sediments (mostly with lighter color than surrounding sediments) or as solid carbonate pieces aboard the *JOIDES Resolution*.

Carbonate samples were washed with distilled water, dried, and ground in an agate mortar for analysis of total and organic carbon (used to calculate the total carbonate content) with a Carlo Erba elemental analyzer NA1500 at the IFM-GEOMAR Leibniz-Institute of Marine Sciences (Germany). Depending on the carbon concentration, 3–20 mg of sample was measured. Organic carbon is determined after removing carbonate carbon by acidification with 0.01-N hydrochloric acid. The reproducibility ( $1\sigma$ ) of total carbon measurements is 0.13%. The reproducibility ( $1\sigma$ ) of organic carbon is 0.10%.

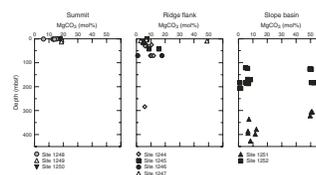
A total of 62 carbonate samples were analyzed using XRD on a Philips PW 1820 instrument ( $\text{CoK}\alpha$ ) at the IFM-GEOMAR Leibniz-Institute of Marine Sciences. Instrument parameters were set to 40-kV accelerating voltage and 35-mA current. Samples were dried, crushed in an agate mortar, homogenized with ethanol, and prepared as randomly oriented powder slides. Scans were run from  $20^\circ$  to  $60^\circ$   $2\theta$  at a scanning speed of  $0.01^\circ/\text{sec}$ . The shift in the  $d(104)$  peak was used to determine the Mg content of magnesium calcite and dolomite minerals (Lumsden, 1979).

## RESULTS

XRD analyses indicate various carbonate compositions ranging from pure calcite over low-magnesium to high-magnesium calcite (HMC) (as much as 18 mol%  $\text{MgCO}_3$ ) and dolomite, as well as mixtures of different calcitic phases and calcitic and dolomitic phases (Table T1). The grouping of all samples into the three end-member settings (summit, flank, and slope basin) shows significant changes in the mineralogic composition between the settings (Fig. F1). The summit sites are dominated by near-seafloor carbonate precipitation of HMC (12–18 mol%  $\text{MgCO}_3$ ). The flank sites indicate carbonate formation in mostly shallow depths to 70 meters below seafloor (mbsf), with various mineralogic compositions ranging from calcite to dolomite. At Site 1244, a calcitic carbonate sample was found in the deep part of the section within highly deformed underthrust sediments of the accretionary complex. The slope basin sites show a bimodal distribution of calcitic and dolomitic carbonates at medium depths at Site 1252 and within the accretionary complex at Site 1251. Carbonates of mixed composition were

**T1.** Carbon, total carbonate, and mineral content, p. 7.

**F1.** Carbonate mineralogy, p. 5.



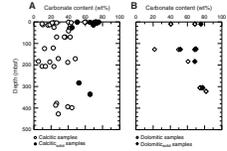
found at Site 1252 (121–207 mbsf) and in the deeper part of the section at Site 1251, both within the accretionary complex.

Carbonate contents vary between 4 and 74 wt% for the calcitic samples and between 20 and 80 wt% for the dolomitic samples, respectively (Table T1). A clear depth dependency cannot be established (Fig. F2). In general, the solid calcitic pieces have the highest carbonate contents (43–74 wt%). The same holds true for the dolomitic samples (50–76 wt%). In the four depth intervals where dolomites occur (~9, 127, 183, and 305 mbsf) the solid samples always show the highest carbonate content (Fig. F2).

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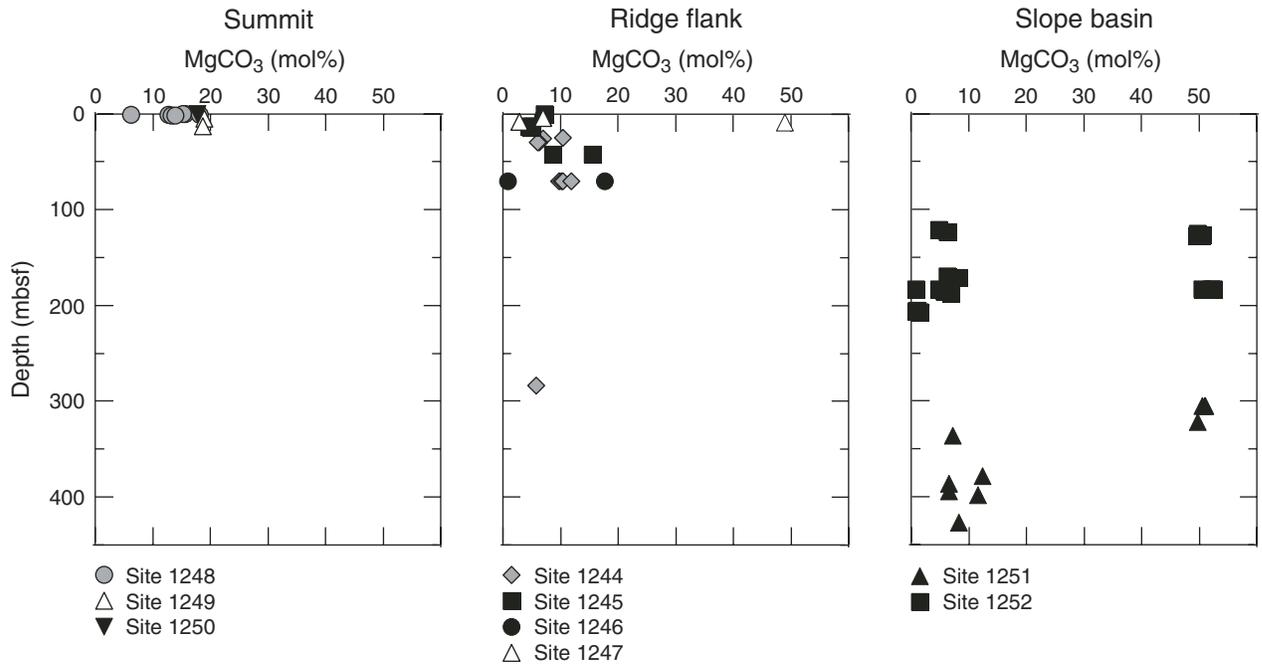
**F2.** Total carbonate content, p. 6.



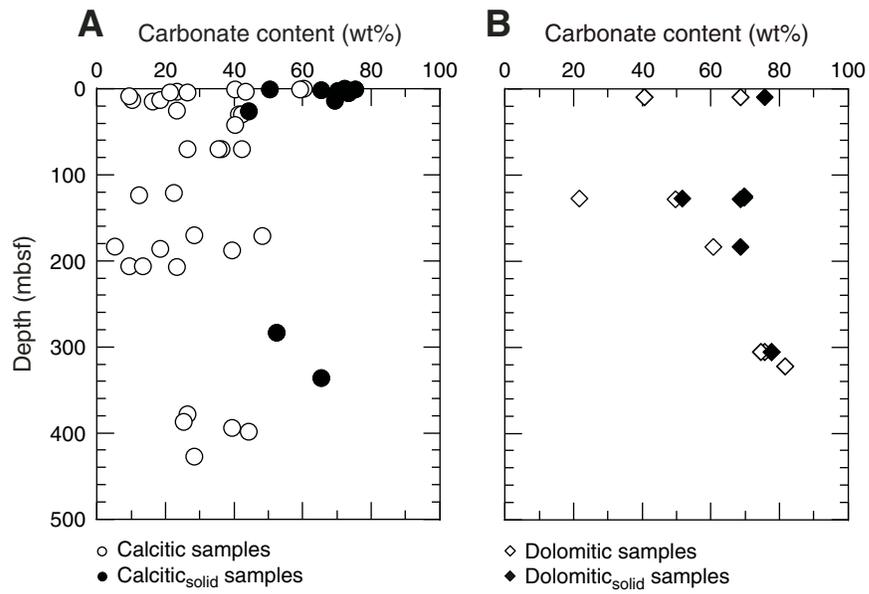
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**Figure F1.** Carbonate mineralogy of all samples from each site in the three environments.



**Figure F2.** Total carbonate content of all (A) calcitic and (B) dolomitic samples.



**Table T1.**  $C_{total}$ ,  $C_{org}$ , carbonate, and mineral composition of carbonate samples. (See table note. Continued on next page.)

Core, section, interval (cm)	Depth (mbsf)	Carbon (wt%)		Total calcium carbonate (wt%)	Mineral composition	Calcite d(104) (Å)	MgCO <sub>3</sub> (mol%)	Calcite d(104) (Å)	MgCO <sub>3</sub> (mol%)	Dolomite d(104) (Å)	MgCO <sub>3</sub> (mol%)
		Total	Organic								
204-1244B-3H-7, 73-77	25.83	6.37	1.25	43	Calcite	3.017	6.2				
204-1244C-34X-1, 53-55	283.83	6.89	0.79	51	Calcite	3.020	5.0				
204-1244E-4H-4, 48-50	25.18	3.87	1.17	22	Calcite	3.007	9.6				
4H-7, 41-43	29.61	6.12	1.29	40	Calcite	3.019	5.6				
4H-7, 48-50	29.68	6.17	1.29	41	Calcite	3.020	5.3				
10H-6, 53-55	70.13	5.44	1.28	35	Calcite	3.009	9.0				
10H-6, 61-62	70.21	5.55	1.37	35	Calcite	3.008	9.4				
10H-6, 62-64	70.22	6.15	1.18	41	Calcite	3.007	9.6				
10H-6, 86-88	70.46	4.28	1.34	25	Calcite	3.003	11.1				
204-1245B-1H-5, 56-59	0.56	5.48	0.85	39	Calcite	3.016	6.5				
2H-4, 39-40	14.37	3.18	1.40	15	Calcite	3.023	4.1				
204-1245C-2H-4, 80-82	12.80	2.50	1.38	9	Calcite	3.024	3.9				
2H-4, 86-88	12.86	3.31	1.26	17	Calcite	3.022	4.4				
6H-4, 103-105	42.15	5.91	1.29	39	Calcite	3.012	8.0	2.991	14.9		
204-1246B-1H-3, 39-41	3.39	3.74	1.15	22	Calcite	3.017	6.2				
1H-3, 60-62	3.60	6.00	0.91	42	Calcite	3.016	6.5				
8H-5, 3-5	67.73	2.15	0.94	10	ND						
8H-6, 84-86	70.04	5.14	1.01	34	Calcite	3.035	0.1	2.985	17.0		
204-1247B-2H-1, 31-33	3.91	3.86	0.92	25	Calcite	3.017	6.2				
2H-1, 43-44	4.03	3.42	1.05	20	Calcite	3.017	6.2				
2H-4, 55-56	8.65	2.11	1.10	8	Calcite	3.029	2.1				
2H-4, 102-104	9.12	8.62	0.53	67	Dolomite					2.894	48.2
2H-4, 121-123	9.31	9.55	0.72	74	Dolomite					2.894	48.2
2H-4, 126-128	9.36	5.52	0.85	39	Dolomite					2.894	48.2
204-1248B-1H-1, 5-7	0.05	7.66	0.57	59	Calcite	2.992	14.8				
1H-1, 100-120	1.00	6.76	0.92	49	Calcite	3.019	5.4				
1H-1, 107-112	1.07	9.19	0.33	74	Calcite	3.000	11.9				
1H-1, 0-100	0.00	8.83	0.36	71	Calcite	2.993	14.4				
1H-2, 10-15	1.30	8.32	0.62	64	Calcite	2.984	17.3				
1H-2, 45-48	1.65	8.09	0.46	64	Calcite	2.998	12.5				
1H-CC, 5-10	2.27	8.76	0.50	69	Calcite	2.997	13.1				
204-1249C-2H-CC, 8-9	4.85	9.09	0.40	72	Calcite	2.982	18.2				
204-1249K-3H-CC, 0-15	13.50	9.06	0.90	68	Calcite	2.983	17.9				
204-1250D-1H-1, 72-76	0.72	7.70	0.79	58	Calcite	2.985	17.0				
204-1251B-37X-4, 32-33	305.38	9.69	0.52	76	Dolomite					2.888	50.1
37X-4, 32-33	305.38	10.19	1.32	74	Dolomite					2.889	49.8
37X-4, 32-33	305.40	10.18	1.45	73	Dolomite					2.888	50.3
39X-2, 68-69	322.08	10.11	0.54	80	Dolomite					2.891	49.0
41X-4, 102-104	336.12	8.56	0.83	64	Calcite	3.016	6.5				
46X-1, 96-98	378.56	4.08	1.12	25	Calcite	3.001	11.6				
46X-CC, 7-9	386.77	4.08	1.20	24	Calcite	3.018	5.9				
47X-5, 124-127	394.51	5.72	1.16	38	Calcite	3.018	5.9				
49X-1, 86-90	398.76	6.37	1.22	43	Calcite	3.003	10.9				
52X-1, 133-136	427.13	4.49	1.20	27	Calcite	3.013	7.6				
204-1252A-14H-2, 92-94	121.32	3.90	1.34	21	Calcite	3.023	4.1				
14H-4, 27-29	123.59	2.39	1.08	11	Calcite	3.019	5.6				
14H-6, 67-69	126.76	9.26	1.37	68	Dolomite					2.889	49.8
14H-6, 74-76	126.83	3.90	1.49	20	Dolomite					2.892	49.0
14H-6, 105-107	127.14	7.05	1.07	50	Dolomite					2.891	49.0
14H-7, 21-23	127.80	10.72	2.46	67	Dolomite					2.892	48.8
14H-7, 27-29	127.86	6.73	0.99	48	Dolomite					2.890	49.6
15X-1, 2-4	125.02	10.41	2.19	68	Dolomite					2.891	49.0
19X-5, 42-44	170.22	1.87	1.22	5	ND						

**Table T1 (continued).**

Core, section, interval (cm)	Depth (mbsf)	Carbon (wt%)		Total calcium carbonate (wt%)	Mineral composition	Calcite d(104) (Å)	MgCO <sub>3</sub> (mol%)	Calcite d(104) (Å)	MgCO <sub>3</sub> (mol%)	Dolomite d(104) (Å)	MgCO <sub>3</sub> (mol%)
		Total	Organic								
19X-5, 47-49	170.27	4.16	0.91	27	Calcite	3.019	5.6				
19X-6, 21-23	171.51	6.03	0.40	47	Calcite	3.013	7.6				
19X-6, 26-28	171.56	1.31	0.87	4	ND						
21X-1, 0-10	183.10	9.61	1.38	67	Dolomite					2.889	49.8
21X-1, 29-31	183.39	1.32	0.88	4	Calcite	3.035	0.1				
21X-1, 40-42	183.50	7.26	0.56	56	Calcite and dolomite	3.023	4.1			2.884	51.7
21X-1, 43-45	183.53	8.84	1.80	59	Dolomite					2.884	51.4
21X-3, 13-15	186.23	3.44	1.39	17	Calcite	3.020	5.0				
21X-4, 3-5	187.59	5.58	0.97	38	Calcite	3.017	6.2				
23X-4, 13-15	206.11	1.99	1.05	8	Calcite	3.034	0.3				
23X-4, 24-26	206.22	2.44	1.02	12	Calcite	3.035	0.1				
23X-4, 144-146	207.42	3.54	0.87	22	Calcite	3.033	0.8				

Note: ND = not determined.