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Data report: bulk carbonate content of sediments and mineralogy of authigenic carbonates along an east–west transect in the northern Cascadia margin, IODP Expedition 311[1]

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Chapter contents

Abstract

Carbonate content and mineralogical composition of sediment samples from Integrated Ocean Drilling Program Sites U1325–U1329 in the northern Cascadia margin were determined. The results document their low carbonate content (average ≈ 2–3 wt%), with decreasing values with distance to the shoreline. Carbonate content and carbonate mineralogy (calcite, dolomite, aragonite, siderite, and rhodochrosite) of 85 authigenic carbonate samples were also determined.

Introduction

This report presents the results of X-ray diffraction (XRD) and carbonatometry analyses of samples from five sites cored during Integrated Ocean Drilling Program (IODP) Expedition 311 (see the **"Expedition 311 summary"** chapter). Sites U1325–U1327 and U1329 are located along a southwest–northeast transect across the Cascadia margin, whereas Site U1328 corresponds to an active seafloor seepage near Site U1327 (Fig. **F1**).

Authigenic carbonates have been previously recognized at the Cascadia margin (e.g., Sample and Kopf, 1995; Bohrmann et al., 1998; Greinert et al., 2001; Teichert et al., 2005; Teichert and Bohrmann, 2006) and may help evaluate the environmental conditions (i.e., temperature and geochemistry of pore fluids) during carbonate formation.

Sampling and analytical methods

During Expedition 311, >500 samples of standard sediments (SED), usually one per section (~75–77 cm) regardless of facies sand or clay, and 85 samples (CARB) of semi-indurated sediments (<10% carbonate cement and mostly lighter color than the surrounding sediments), small concretions, or hard rock pieces were collected from several sites.

Some of the samples collected, inferred as carbonate nodules, were removed from the CARB sample set, as they contained no carbonate. These anomalous nodules were interpreted as dropstones. On the contrary, some SED samples were added to the CARB sample set because further investigations (XRD, smear slide

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observations, and examination of 50–250 µm and >250 µm sieved fractions) indicate that their carbonate fraction was mainly authigenic (not detrital or biogenic).

Samples were dried and ground in an agate mortar for carbonate content measurement using a Mano-Calcimeter Mélières (MCM) apparatus derived from the carbonate bomb technique first described by Müller and Gastner (1971).

Total carbonate content (in weight percent) was calculated from CO_2 volume evolved from the reaction of 100 mg of finely crushed sediment with 8 N HCl. The MCM apparatus is calibrated at 100% so that 1 mM of CO_2 corresponds to 100 mg of calcite or aragonite. For other carbonates with different molecular weights, 100 mg does not correspond to 1 mM of CO_2, and values must be corrected (e.g., percent dolomite = MCM/1.0855 and percent siderite = MCM/0.8639) to estimate the real weight percentages.

Analyses were performed at Muséum National d'Histoire Naturelle (MNHN), Paris (France). The run time was 5–15 min for each sample, depending on carbonate composition (dolomite-rich samples react more slowly).

Because of the low carbonate values observed in the first SED samples analyzed (Site U1328), the quantity of sediment powder used for carbonate determination was increased to 200 mg for Sites U1325–U1327 and U1329 sediments in order to improve measurement accuracy.

To visualize the carbonate content fluctuations measured on the MCM apparatus, uncorrected values were used. These values are equivalent to the $CaCO_3$ weight percent calculated from inorganic carbon determined with the Coulometrics 5011 coulometer on board the *JOIDES Resolution,* as described by Pimmel and Claypool (2001). Therefore, the shipboard data published in the site chapters and the shore-based MCM data can be used together to compare downhole carbonate fluctuations within and between holes.

All SED and CARB samples were analyzed by XRD to identify the minerals present and to give an estimation of the mineralogical composition of the carbonate fraction. XRD analyses of randomly oriented powders were performed using a Siemens D500 instrument (CuKα Ni filtered radiation) at MNHN. Instrument parameters were set to 40 kV accelerating voltage and 30 mA current. Scans were run from 2°2θ to 64°2θ with a step size of 0.02°2θ and counting time of 1 s for standard sediments or 2 s for authigenic carbonates. If necessary, the position of the peaks was corrected by reference to the main quartz peak present in all samples.

Identification of the main minerals present in the samples was determined with Eva 8.0 software and the International Centre for Diffraction Data (ICCD) Powder Diffraction File 2 database, release 2002.

The Mac Diff 4.2.5 program by Rainer Petschik (**server-mac.geologie.uni-frankfurt.de/Staff/Homepages/Petschick/RainerE.html**) was used to resolve the composite peaks by a peak-fitting technique and to measure the peak surface of carbonates.

Microfacies (smear slides or thin sections) were examined to determine the morphology and probable origin of the carbonates (detrital, biogenous, or authigenic). For the micritic fine-grained facies, scanning electron microscopy (SEM) images of selected samples (mainly from Sites U1328 and U1327) were used to illustrate crystal morphologies, and energy dispersive spectrometer (EDS) analyses was used to confirm the semiquantitative composition of the carbonates.

Semiquantitative carbonate percentages are given for carbonate-rich samples based on the surface of the main peak of each mineral corrected by arbitrary factors (I/Icor values given in the ICCD database for pure calcite, dolomite, siderite, and rhodochrosite) and on the MCM value for absolute weight percent. The relative error of the weight percent of a given carbonate phase is roughly estimated at ±5% but may be higher because

- Authigenic calcite and dolomite have highly variable characteristics, as reflected by the wide range of d_{104} values (Fig. **F2**);
- Siderite ($d_{104} \approx 2.796$ Å) and rhodochrosite ($d_{104} \approx 2.850$ Å), as determined from XRD, may correspond to other complex carbonate phases (Fe, Mg, Ca, and sometimes Mn in EDS analyses);
- I/Icor values for nonstoichiometric calcites or dolomites are not known; and
- Feldspars s.l. (Ca-albite, microcline, anorthite, etc.) or amphiboles (hornblende), which are sometimes abundant, have secondary peaks (around 2.99, 2.94, and 2.90 Å) superposed over the main carbonate peaks.

The d_{104} values of calcite were used to calculate their content in mol% $MgCO_3$ using a linear interpolation between interplanar spacings of stoichiometric dolomite ($d_{104} = 2.886$) and stoichiometric calcite ($d_{104} = 3.035$), as experimentally observed by Goldsmith and Graf (1958). This method was not used to estimate dolomite composition, as the position of the d_{104} peak depends on the incorporation of Mg^{2+},

Ca^{2+}, Mn^{2+}, and Fe^{2+}, and our microprobe analysis (EDS spectra) show that Fe is sometimes present in the dolomite crystal lattice.

Results

XRD analyses show that SED samples from Sites U1325–U1329 are dominated by detrital minerals, mainly quartz, plagioclases and potassium feldspars, micas, clay minerals, amphiboles, and sometimes pyroxenes (e.g., diopside). Some pyrite and carbonate minerals are also present as minor components. Magnetic minerals (magnetite and greigite) (Esteban and Enkin, 2007) are also present but were not identified in the raw samples analyzed by XRD, even if they sometimes seemed relatively abundant during clay fraction extraction.

Because of the inhomogeneous nature of the sediment (Expedition 311 Scientists, 2005) the mineralogical composition varies considerably vertically and laterally. We did not attempt to quantify the mineral phases present in the bulk samples because

- Phyllites, amphiboles, and feldspars s.l. have variable compositions;
- Many minerals are present near or below the detection limit; and
- Superposition of peaks is frequent.

In this report we focus only on the carbonate phases, whereas **Bartier et al.** focus on the clay mineralogy (<2 µm fraction) of selected samples.

SED samples

Carbonate (MCM) analyses indicate that SED samples are carbonate poor (mean values ≈ 2–3 wt%) (Table **T1**). Calcite, mainly low-Mg calcite (LMC) with a d_{104} peak between 3.035 and 3.030 Å (Table **T2**), is the dominant carbonate phase with some dolomite (d_{104} peak usually located between 2.885 and 2.900 Å); other carbonates were generally not detected. In these low-carbonate samples, the relative abundance of detrital minerals makes quantification of calcite and dolomite percentages uncertain, as albite interferes with high-Mg calcite (HMC) and microcline interferes with nonstoichiometric dolomite; therefore, only the total carbonate percentage is given.

Site U1326 is located on top of the first uplifted ridge of accreted sediments at the far western downslope end of the transect (Fig. **F1**). Sediments from this site show the lowest carbonate contents of the transect (Fig. **F3;** Table **T2**). Slightly higher values in lithostratigraphic Unit I may correspond to calcareous microfossil remains, as observed in Sample 311-U1326C-3H-5, 80–82 cm (5.5 wt% carbonate with nearly stoichiometric calcite and abundant foraminifers on sieved fractions). However, carbonate contents in Samples 311-U1326C-4H-3, 75–77 cm (26.65 meters below seafloor [mbsf]), 311-U1326D-2X-4, 75–77 cm (93.65 mbsf), and 15X-1, 73–75 cm (214.33 mbsf), may correspond to some authigenic carbonate cement scattered in the sediment, as suggested by the composition of calcite (5–7.7 mol% $MgCO_3$) (Table **T2**). Sample 311-U1326D-2X-1, 72–74 cm (MCM values ≈ 10 wt%), originally a SED sample, was added to the CARB series because irregular carbonate grains (~6 µm in diameter and 6.5 mol% $MgCO_3$ in calcite) and almost no calcareous microfossil remains were observed in sieved fractions and smear slides. In addition, the mousselike texture observed in the section may be associated with dissociation of gas hydrate.

Site U1325 is located within the first slope basin in the southwestern part of the transect cored during Expedition 311 (Fig. **F1**). In lithostratigraphic Units I and III (see the **"Site U1325"** chapter), biogenic components (very abundant foraminifers sometimes observed in the sieved fractions) are more abundant, as reflected by the slightly higher amount of carbonate observed in the sediments (Fig. **F4;** Table **T2**), although they drop to very low values in lithostratigraphic Units II and IV (almost no foraminifers observed in the sieved fractions). In sediments, calcite is generally nearly stoichiometric, except in Samples 311-U1325B-10X-1, 75–77 cm (73.55 mbsf), 311-U1325C-7X-6, 75–77 cm (233.42 mbsf), and 8X-4, 75–77 cm (241.40 mbsf), with 7.7, 5.0, and 4.4 mol% $MgCO_3$ in calcite, respectively (Table **T2**). This is interpreted as corresponding to biogenic components.

Site U1327 is located near the middle of the coring transect on a broad uplifted ridge of accreted sediments about mid-slope up the margin, near Ocean Drilling Program (ODP) Leg 146 Site 889 (375 m southeast from Hole 889C) (Fig. **F1**). In lithostratigraphic Unit I, interstitial water geochemistry results predict authigenic carbonate formation within the sulfate reduction and alkalinity generation zone (see the **"Site U1327"** chapter); however, no authigenic carbonate cement was found. Slightly higher carbonate contents were found in samples from 0 to 32.5 mbsf (0–2 mol% $MgCO_3$ in calcite). Carbonate contents of sediments throughout the lithostratigraphic units are generally low, with slightly higher values in Samples 311-U1327C-3H-1, 75–77 cm (16.35 mbsf), 4H-3, 75–77 cm (28.85 mbsf), 9H-6, 75–77 cm (73.35 mbsf), and 13X-4, 75–77 cm (107.75 mbsf), which are associated with foraminifer-rich intervals and substoichiometric calcite. However, as at Site U1326, carbonate contents in Samples 311-U1327C-12X-6, 75–77 cm (99.87 mbsf), 18X-3, 75–77 cm (144.60 mbsf), and 31X-5, 75–77 cm (263.81 mbsf), might correspond to some authigenic carbonate particles scattered in the sediment, as suggested by the composition of calcite (~6 mol% $MgCO_3$) (Table T2; Fig. F5). Sample 311-U1327C-19X-1, 75–77 cm (MCM value ≈ 20 wt%), was added to the original CARB series, as the carbonate value is not explained by calcareous organisms and corresponds mainly to HMC (11.8 mol% $MgCO_3$).

Site U1329 is the easternmost and shallowest site of the transect and is interpreted to be located near the eastern limit of gas hydrate occurrence on the northern Cascadia margin (Fig. F1). Moreover, it is the only site with Miocene sediments (lithostratigraphic Unit III) occurring in discordance below Pleistocene sediments. The sediments at Site U1329 have the highest carbonate values (up to 18.6 wt% in Sample 311-U1329C-3H-2, 75–77 cm) (Table T2; Fig. F4) of the transect and mainly correspond to foraminifer- or calcareous nannoplankton–rich levels, as shown by examination of some smear slides and sieved fractions and to substoichiometric calcite. Miocene sediments of lithostratigraphic Unit III contain almost no carbonates (0–3 wt%; average value ≈ 1 wt%) compared to the upper part of the series. At Site U1328, the average value of carbonates is 3.2 wt% (~3.7 wt% if Miocene sediments are excluded), whereas Sites U1326–U1327 contain lower carbonate contents (~2 wt%); along the transect, carbonate contents decrease with distance to the shoreline. As at Sites U1326 and U1327, some authigenic carbonate may be scattered in the sediment (calcite, siderite, and/or dolomite), but their identification is difficult except in Sample 311-U1329C-21X-1, 75–77 cm (170.05 mbsf), the carbonate paragenesis of which (5.4 mol% $MgCO_3$ calcite + siderite) is similar to nearby CARB Sample 311-U1329C-21X-2, 118–120 cm (mainly siderite + 7.4 mol% $MgCO_3$ calcite).

Site U1328 is an active cold seep (Bullseye vent site) associated with faults located 3.7 km southeast of Site U1327, on the mid-continental slope off Vancouver Island (British Columbia) (Fig. F1). It is characterized by a massive accumulation of gas hydrate in the upper ~40 m of the series. Carbonate contents of the sediments (average = 2.6 wt%) (Tables T1, T2; Fig. F7) are slightly higher than at nearby Site U1327 (average = 2.2 wt%). This may be due to the presence of dispersed authigenic carbonate crystals throughout the cores. For example, the presence of HMC in the upper part of the cores (0–38 mbsf) is inferred from the intensity of the peak around 3.0 Å (corresponding to 10–11 mol% $MgCO_3$ in calcite) (Table T2). However, LMC (0–3.5 mol% $MgCO_3$) is the main carbonate present, and most of the carbonate-rich sediments correspond to foraminifer-rich levels (Table T2).

CARB samples

XRD diffractograms of the carbonate-rich samples show that the d_{104} reflection peak for some calcites and dolomites is asymmetrical and formed by the superposition of two peaks. This indicates that those carbonates are heterogeneous, with different populations contributing to the composite diffractogram peaks.

From the distribution of d_{104} values (Fig. F2; Table T2) we distinguish the following:

- Stoichiometric to low-Mg calcite (3.035–3.025 Å) corresponding to 0–3.4 mol% $MgCO_3$ (associated with foraminifers and nannoplankton remains) or medium-Mg calcite (MMC) (3.025–3.01 Å) corresponding to 3.4–8.4 mol% $MgCO_3$;
- Very high magnesium calcite (3.010–2.984 Å) corresponding to 8.4–17.1 mol% $MgCO_3$;
- Nonstoichiometric dolomite (LMD) with d_{104} varying between 2.944 and 2.905 Å and variable chemical composition (Ca, Mg, some Fe, but no Mn in EDS spectra recorded); and
- More stoichiometric dolomite (HMD) with d_{104} varying between 2.905 and 2.887 Å.

Site U1326

At Site U1326, salinity and chlorinity data (see the "Site U1326" chapter) indicate that gas hydrate is present in the zone extending from ~45 to 270 mbsf, predominantly occurring in the sandy layers. Seven carbonate-rich samples were analyzed from Site U1326 (Table T3; Fig. F3); calcite, dolomite, and sometimes rhodochrosite and siderite were identified.

In lithostratigraphic Unit I, carbonates correspond mainly to unlithified carbonate cement, as well as partly lithified carbonate, observed between 0.97 and 2.15 mbsf in intervals 311-U1326B-1H-1, 95–102 cm; 1H-1, 149–150 cm; and 1H-2, 62–80 cm (see the "Site U1326" chapter). The concretion sampled at 6.32 mbsf (Sample 311-U1326C-2H-2, 92–93 cm) is composed of a mixture of LMD (d_{104} = 2.914 Å) and magnesian calcite (~7 mol% $MgCO_3$).

In lithostratigraphic Unit II, carbonates correspond mainly to unlithified carbonate cement, observed between 40 and 119 mbsf with some lithified carbonates (e.g., Sample 311-U1326C-9X-2, 92–93 cm).

Dolomite (d_{104} = 2.900–2.905 Å) is the main carbonate present.

In lithostratigraphic Unit III, carbonate contents are lower than above (16–33 wt%) and correspond to carbonate cements composed of magnesian calcite (8.7 and 7.7 mol% $MgCO_3$ in Samples 311-U1326D-9X-1, 0–1 cm, and 17X-3, 0–100 cm, respectively) or to a mixture of rhodochrosite (d_{104} ≈ 2.841 Å instead of 2.850 Å), very high magnesium calcite (13.8 mol% $MgCO_3$), siderite (d_{104} ≈ 2.795 Å), and dolomite in Sample 311-U1326D-20X-3, 0–1 cm, which is near the base of the gas hydrate stability zone (BGHSZ) (264 mbsf).

Site U1325

At Site U1325, salinity and chlorinity data (see the **"Site U1325"** chapter) indicate that gas hydrate is present from ~70 to 240 mbsf, predominantly occupying the sandy layers and some of it also being associated with the clay lithology in the 50 m above the bottom-simulating reflector (BSR) (~180–230 mbsf). No carbonate cement or concretion was observed in the upper part of these slope basin sediments (lithostratigraphic Units I and II), only one in Unit III (~127 mbsf), and two in Unit IV (~222 and 258 mbsf) (Table **T3;** Fig. **F4**). These carbonates contain variable proportions of calcite and dolomite.

In lithostratigraphic Unit III, a layer of cemented carbonate occurs in interval 311-U1325B-16X-6, 27–33 cm. XRD analysis of Sample 311-U1325B-16X-6, 28–30 cm, confirms a combination of LMD (d_{104} = 2.902 Å) and HMC (10.7 mol% $MgCO_3$).

In lithostratigraphic Unit IV, Sample 311-U1325C-6X-4, 47–48 cm, is mainly composed of a mixture of LMD (d_{104} = 2.924 Å) and HMD (d_{104} = 2.895 Å), whereas HMC (10.4 mol% $MgCO_3$) dominates in Sample 311-U1325C-11X-1, 119–122 cm.

Site U1327

At Site U1327, salinity and chlorinity data (see the **"Site U1327"** chapter) indicate that gas hydrate is present in the zone extending from ~128 mbsf to the BSR (~223 mbsf). Fifteen of the diagenetic carbonate levels sampled were analyzed and showed calcite, dolomite, and sometimes siderite (Table **T3;** Fig. **F4**). Most of them occur in the gas hydrate zone (see the **"Site U1327"** chapter). The first authigenic carbonate occurrence corresponds to a light-colored unlithified cement zone (interval 311-U1327C-10H-1, 95–103 cm) (see Fig. **F15** in the "Site U1327" chapter) and is mainly composed of 6.7 mol% $MgCO_3$ HMC and some dolomite at 96–98 cm.

In lithostratigraphic Unit II, few unlithified carbonate cements and numerous lithified carbonates are present. Magnesium calcite (6–16 mol% $MgCO_3$) and dolomite (HMD, d_{104} = 2.893–2.903 Å; LMD, d_{104} = 2.92–2.93 Å) are the dominant carbonate phases. Siderite is present either as a major component of the carbonate fraction (72% in Sample 311-U1327C-16X-2, 120–150 cm; d_{104} ≈ 2.794 Å) or as a minor phase (7% in Sample 311-U1327C-20X-5, 6–7 cm; d_{104} ≈ 2.786 Å).

In lithostratigraphic Unit III, few unlithified carbonate cements, visible as faint light spots, occur; XRD shipboard analyses shows a combination of HMC with LMD in most of the cores or a combination of rhodochrosite with HMC and calcium-rich dolomite in Samples 311-U1327C-29X-4, 59–60 cm, and 30X-3, 80–81 cm (~243 mbsf). Lithified carbonate rocks (Table **T3**) correspond to dolomite (d_{104} = 2.897 Å in Sample 311-U1327C-21X-7, 0–1 cm) or ~5.5 mol% $MgCO_3$ calcite (Samples 311-U1327E-16X-CC, 10–11 cm, and 18–19 cm). Previous shipboard analyses of lithified carbonate rocks from interval 311-U1327C-24P-1, 0–69 cm, show different carbonate mineralogies (substoichiometric dolomite to LMD and/or HMC).

Site U1329

Site U1329 is at the eastern limit of gas hydrate occurrence on the northern Cascadia margin. Seismic indicators of gas hydrate are present but more subdued than at all the other sites. Only minor cold anomalies were detected in the cores from this site, consistent with evidence of only minor amounts of gas hydrate based on logging-while-drilling resistivity measurements and chlorinity analyses (see the **"Site U1329"** chapter). Thirty-three carbonate samples were analyzed from this site (Table **T3;** Fig. **F6**) showing calcite, dolomite, and sometimes siderite.

In lithostratigraphic Unit I, authigenic carbonates correspond to unlithified carbonate cements, as well as lithified and partly lithified carbonates. All are mainly composed of HMD (d_{104} = 2.897–2.905 Å) with some LMD (d_{104} = 2.922–2.906 Å) and sometimes substoichiometric calcite. Previous interstitial water geochemistry results (Mg, Ca, and Mg/Ca values) suggesting dolomitization reactions at ~30 mbsf may explain these dolomite occurrences around 31 mbsf.

In lithostratigraphic Unit II, authigenic carbonates, more or less lithified, are dispersed throughout the series. Calcite (mainly HMC with 13–14 mol% $MgCO_3$) is the dominant phase except in two samples (311-U1329C-5H-6, 61–63 cm, and 311-U1329E-8Y-1, 35–37 cm), where HMD (d_{104} = 2.905 and 2.894 Å, respectively) is dominant.

In lithostratigraphic Unit III, unlithified carbonate cements and lithified and partly lithified carbonates are abundant throughout the cores. Pure dolomites (HMD; d_{104} = 2.894–2.897 Å) or calcites (~12.5 mol% $MgCO_3$ [160–165 mbsf], 5.4–6 mol% $MgCO_3$ [172.91 mbsf], and 2.3 mol% $MgCO_3$ [187.75 mbsf]) occur, as well as mixtures of calcite and/or dolomite and/or siderite. Sample 311-U1329C-22X-CC, 72–74 cm (187.75 mbsf), with pure LMC (2.3 mol% $MgCO_3$) exhibits a microsparitic facies quite different from the clotted micrite facies usually observed in the other sampled carbonate facies and may be related to the conglomerate deposit found just below in pressure Core 311-U1329C-23P and interpreted as a major event, possibly a debris flow (see the **"Site U1329"** chapter). HMD (d_{104} = 2.894–2.905 Å), HMC (10.4–13.4 mol% $MgCO_3$), and MMC (5.4–8.1 mol% $MgCO_3$) are the dominant carbonate phases present in lithostratigraphic Unit III, whereas siderite (4%–93% of the carbonate fraction; $d_{104} \approx$ 2.805–2.809 Å) is less abundant.

Site U1328

Site U1328 (Bullseye vent site) is located within an area of active cold vents, where previous dives conducted in 2000 and 2001 with the remotely operated vehicle *ROPOS* found 10–15 cm thick carbonate sheets covering an area of >10 m^2 of the seafloor. Gas hydrate distribution at Site U1328 is bimodal, as gas hydrates occur mainly close to the seafloor (0–35 mbsf) and just above the BSR (215–222 mbsf) (see the **"Site U1328"** chapter). Thirty-one authigenic carbonate samples were analyzed from this site (Table **T3;** Fig. **F7**) with calcite and/or dolomite and/or aragonite. The authigenic carbonates were found in lithostratigraphic Units I (1–37 mbsf) and III (220–277 mbsf) and Sample 311-U1328C-5P-1, 0–2 cm (92 mbsf?), probably originating from Unit I (fallen block?).

In lithostratigraphic Unit I, to 36.46 mbsf, HMC (8.7–17.1 mol% $MgCO_3$) is the dominant carbonate phase. The HMC is sometimes pure (Sample 311-U1328E-2X-1, 52–54 cm) but is most often mixed with dolomite (d_{104} = 2.894–2.939 Å) and/or aragonite.

In lithostratigraphic Unit III HMC (12.4–16.1 mol% $MgCO_3$) is the dominant carbonate phase near the BGHSZ, whereas near-stoichiometric dolomite (d_{104} = 2.887–2.895 Å) appears between 253 and 276 mbsf.

Site U1328 differs from the other sites because of the presence of aragonite (8%–46% of the carbonate fraction) between 6 and 16 mbsf. This site is also characterized by less abundant dolomite and the absence of siderite and rhodochrosite.

Main occurrences of authigenic carbonate minerals based on XRD analyses of CARB samples

Aragonite is only present in the upper 16 mbsf of the active vent site (U1328), and is associated with calcite and dolomite (Fig. **F8A, F8B**). The occurrence of aragonite fits well with the predicted gas hydrate content (highest in the upper 15 mbsf; see the **"Site U1328"** chapter). In the samples studied, aragonite is associated with abundant HMC (13.1–16.8 mol% $MgCO_3$) and with some LMD (d_{104} = 2.911–2.939 Å). The link between aragonite and gas hydrate or methane venting was often observed in recently studied sediments (e.g., Hydrate Ridge on the Cascadia continental margin) (Teichert et al., 2005; Teichert and Bohrmann, 2006).

Calcite is most abundant at the active vent Site U1328 (average content = ~68% in the carbonate fraction and 47%–53% in the transect sites), where it corresponds mainly to HMC (8.7–17.1 mol% $MgCO_3$) (Fig. **F8B–F8D**). Calcite at transect sites shows more variable compositions with MMC (5.4–8.1 mol% $MgCO_3$) and/or HMC (8.7–14.1 mol% $MgCO_3$). LMC is rare and is mainly associated with calcareous biological or detrital remains, based on thin section or smear slide examinations.

Dolomite is well represented in all trasect sites, whereas it is less abundant at Site U1328 (mean average value in carbonate fraction is ~28%, instead of 40%–53%). Dolomite shows variable compositions (d_{104} = 2.987–2.944 Å), sometimes with two phases associated in the same sample. LMD, mainly represented at Site U1328, often shows rounded dolomite grains with a knobbly surface (Fig. **F8E**), whereas HMD often shows euhedral crystals.

From our data, siderite (Fig. **F9A–F9C**) is mainly observed at Sites U1329 (associated with calcite) and U1327 (associated with calcite and dolomite). This phase was identified from XRD diagrams ($d_{104} \approx$ 2.795–2.809 Å instead of 2.796 Å), but EDS analyses of the more carbonate rich part of Sample 311-U1329C-21X-3, 129–131 cm ($d_{104} \approx$ 2.809 Å), reflect a high content of Mg, Fe, and Ca corresponding to an intermediate phase between magnesite, siderite, and calcite. Complementary analyses such as transmission electron microscopy coupled with microanalyses of individual particles are needed to better characterize what we are recognizing as siderite.

Rhodochrosite is briefly observed from our data at Sites U1326 and U1327 near or below the BGHSZ. This phase was identified from XRD diagrams (d_{104} ≈ 2.850 Å). As it is only a minor component (<15 wt%), SEM observation of this phase is difficult. A very fine grained facies was observed in Sample 311-U1326D-20X-3, 0–1 cm (d_{104} ≈ 2.841 Å instead of 2.850 Å), showing areas <1 µm in size composed of bladelike particles or euhedral nanocrystals (Fig. F9D, F9E, F9G, F9H). From EDS analyses (Fig. F9F) rhodochrosite may not exist, as these carbonate-rich areas are enriched in Ca, Mg, and Fe but show little Mn. As for the presence of siderite, further studies are needed.

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Figure F1. **A.** Plate tectonic setting of the Cascadia margin with general location of the drilling transect near previous Ocean Drilling Program (ODP) Sites 889/890. Gray shaded area = bottom-simulating reflector (~50% of the mid-continental slope). **B.** Multibeam bathymetry map along the transect across the accretionary prism with locations of transect Sites U1326–U1327 and U1329, cold vent Site U1328, and multichannel seismic (MCS) Line 89-08.

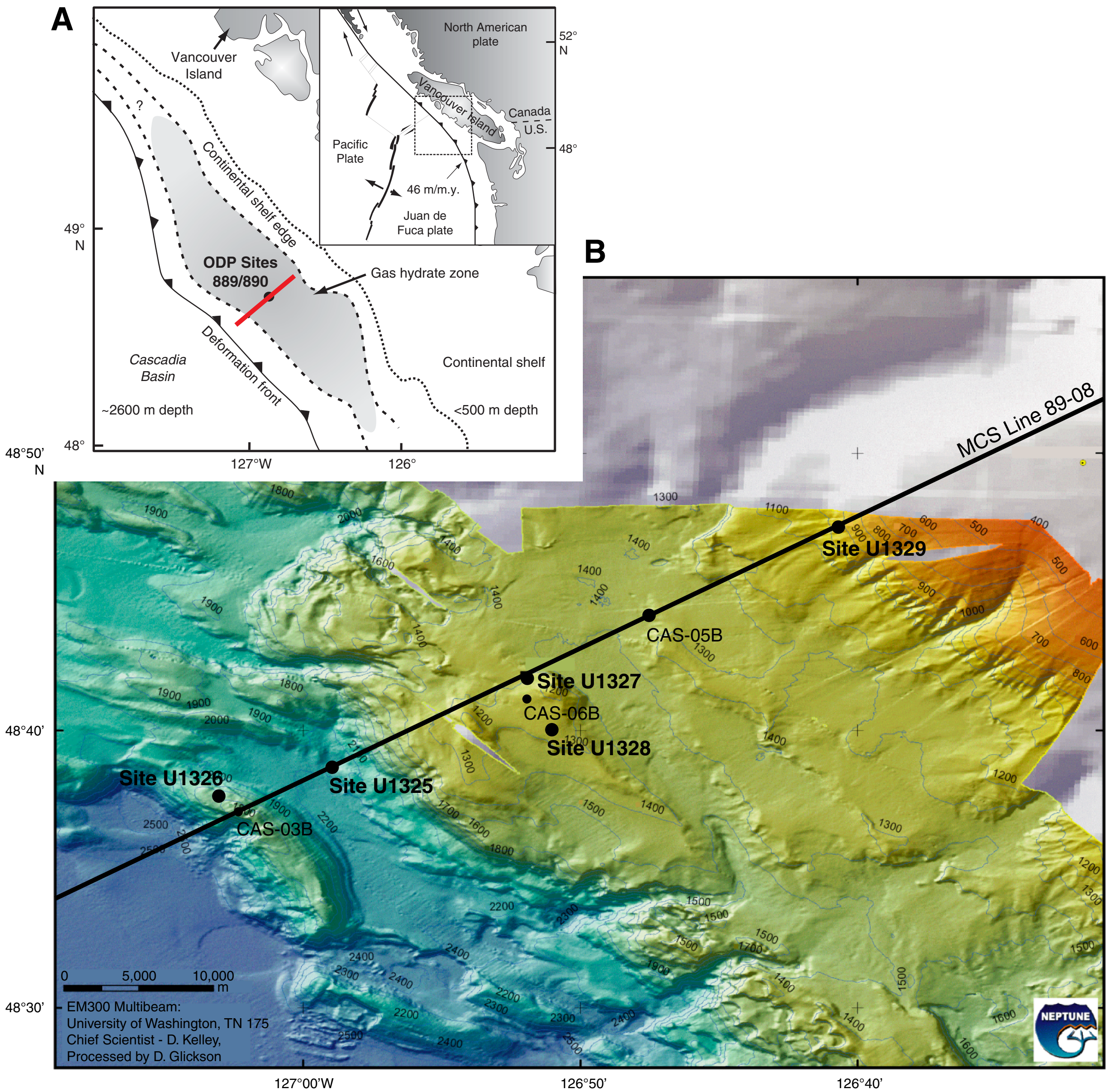

Figure F2. Frequency of observed d_{104} values for authigenic calcite and dolomite samples, Expedition 311. LMMC = stoichiometric calcite and low- to medium-magnesium calcite (d_{104} = 3.035–3.010 Å), HMC = high-magnesium calcite (d_{104} = 3.010–2.894 Å), LMD = low-magnesium dolomite (d_{104} = 2.944–2.905 Å), HMD = high-magnesium dolomite to stoichiometric dolomite (d_{104} = 2.905–2.887 Å).

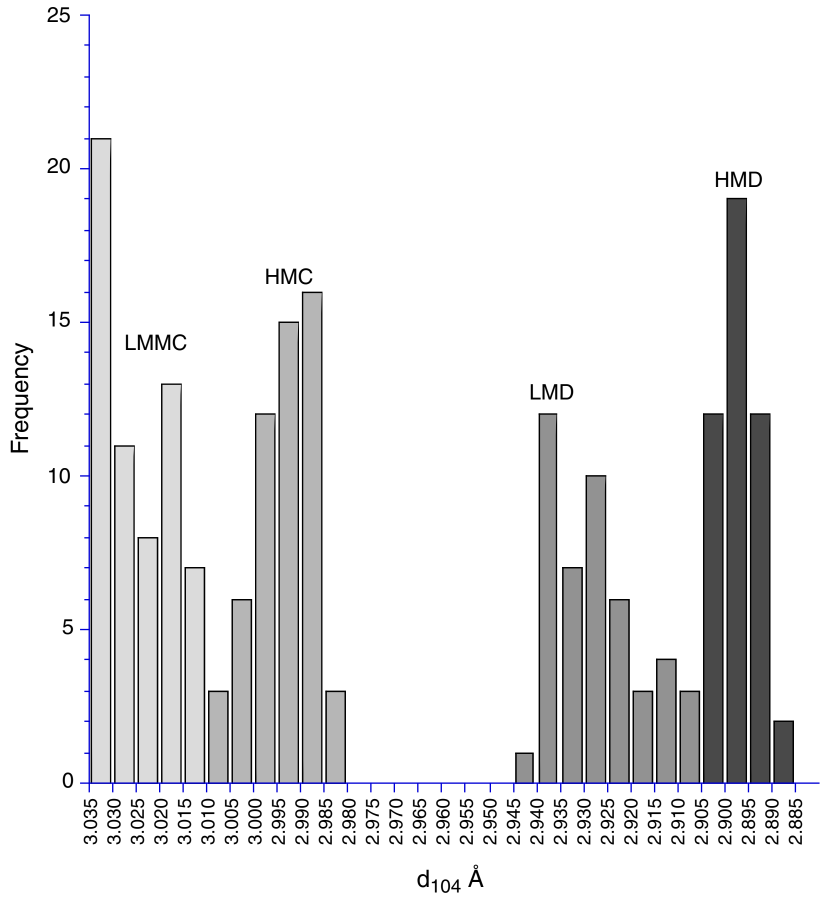

Figure F3. Downhole variations of carbonates in sediment and authigenic carbonate samples, Site U1326. Lith. = lithologic, SED = standard sediment, CARB = semi-indurated to indurated authigenic carbonate sediment, BGHSZ = bottom gas hydrate stability zone. The carbonate weight percent shipboard value of Sample 311-U1326C-1H-2, 65–80 cm (2.15 mbsf), was plotted with authigenic carbonate samples because unlithified to partly lithified carbonates were observed onboard between 0.97 and 2.15 mbsf.

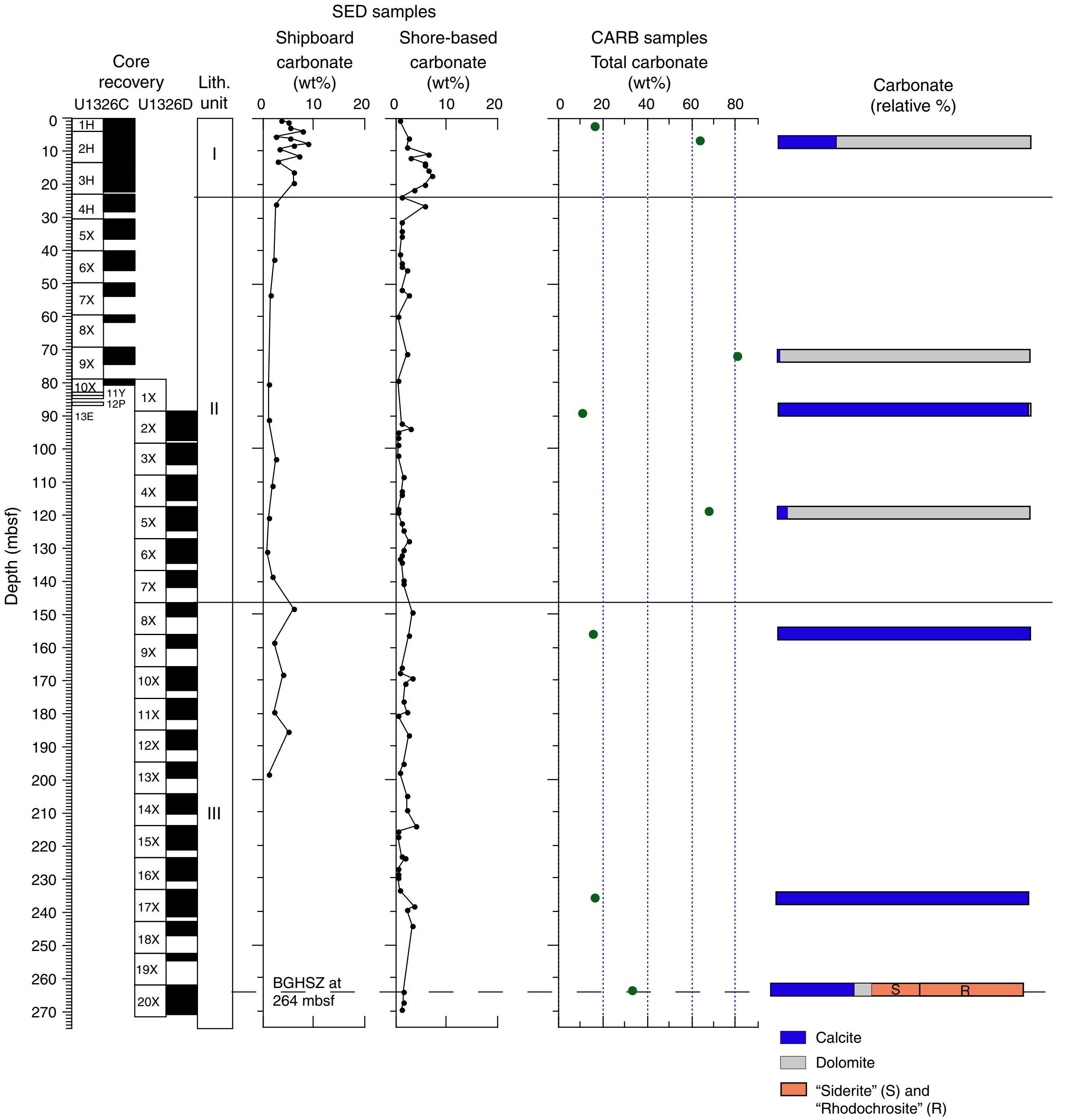

Figure F4. Downhole variations of carbonates in sediment and authigenic carbonate samples, Site U1325. Lith. = lithologic, SED = standard sediment, CARB = semi-indurated to indurated authigenic carbonate sediment, BGHSZ = bottom gas hydrate stability zone.

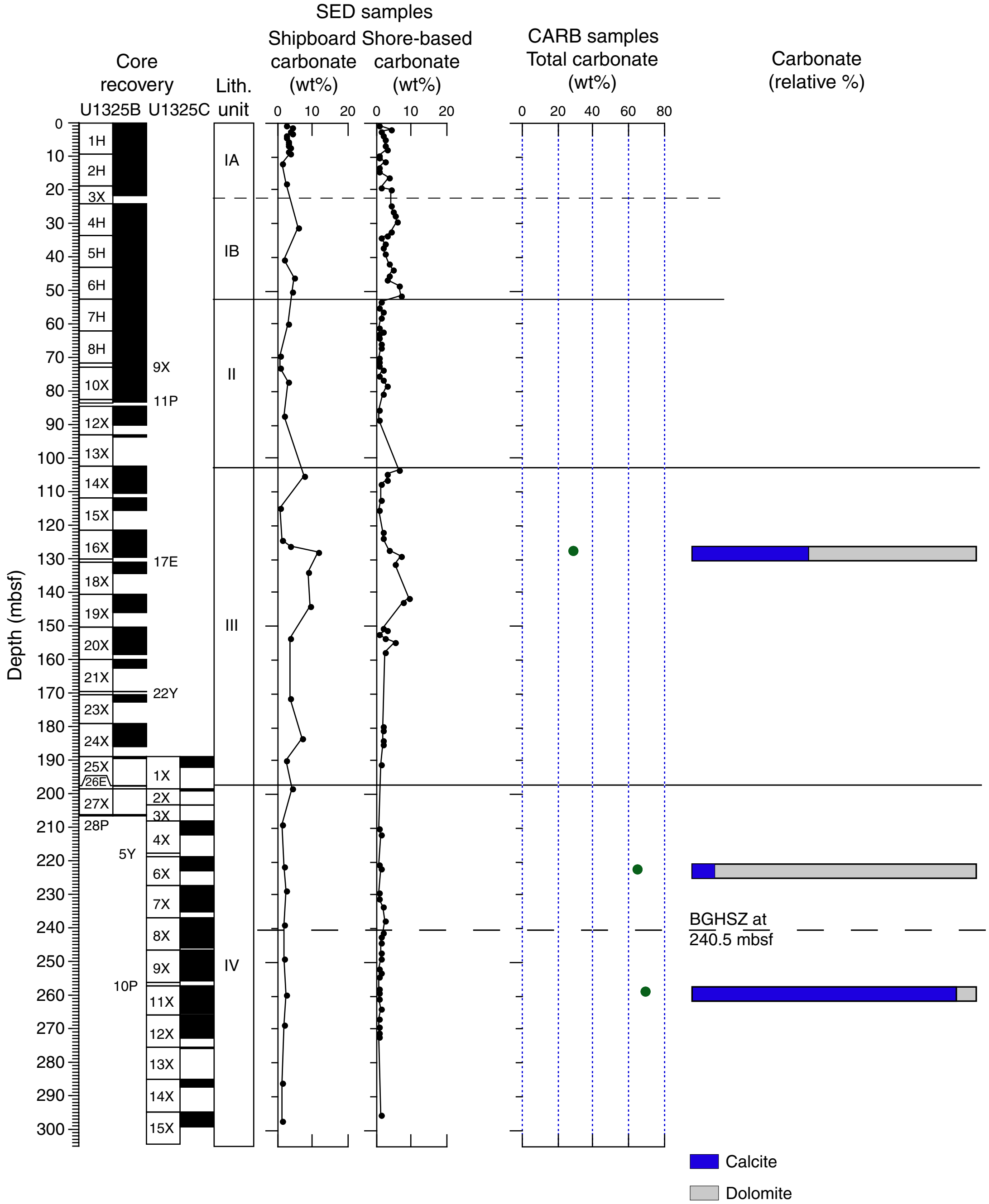

Figure F5. Downhole variations of carbonates in sediment and authigenic carbonate samples, Site U1327. Lith. = lithologic, SED = standard sediment, CARB = semi-indurated to indurated authigenic carbonate sediment, BGHSZ = bottom gas hydrate stability zone. XRD shipboard data were added for Cores 311-U1327C-24P, 29X, and 30X.

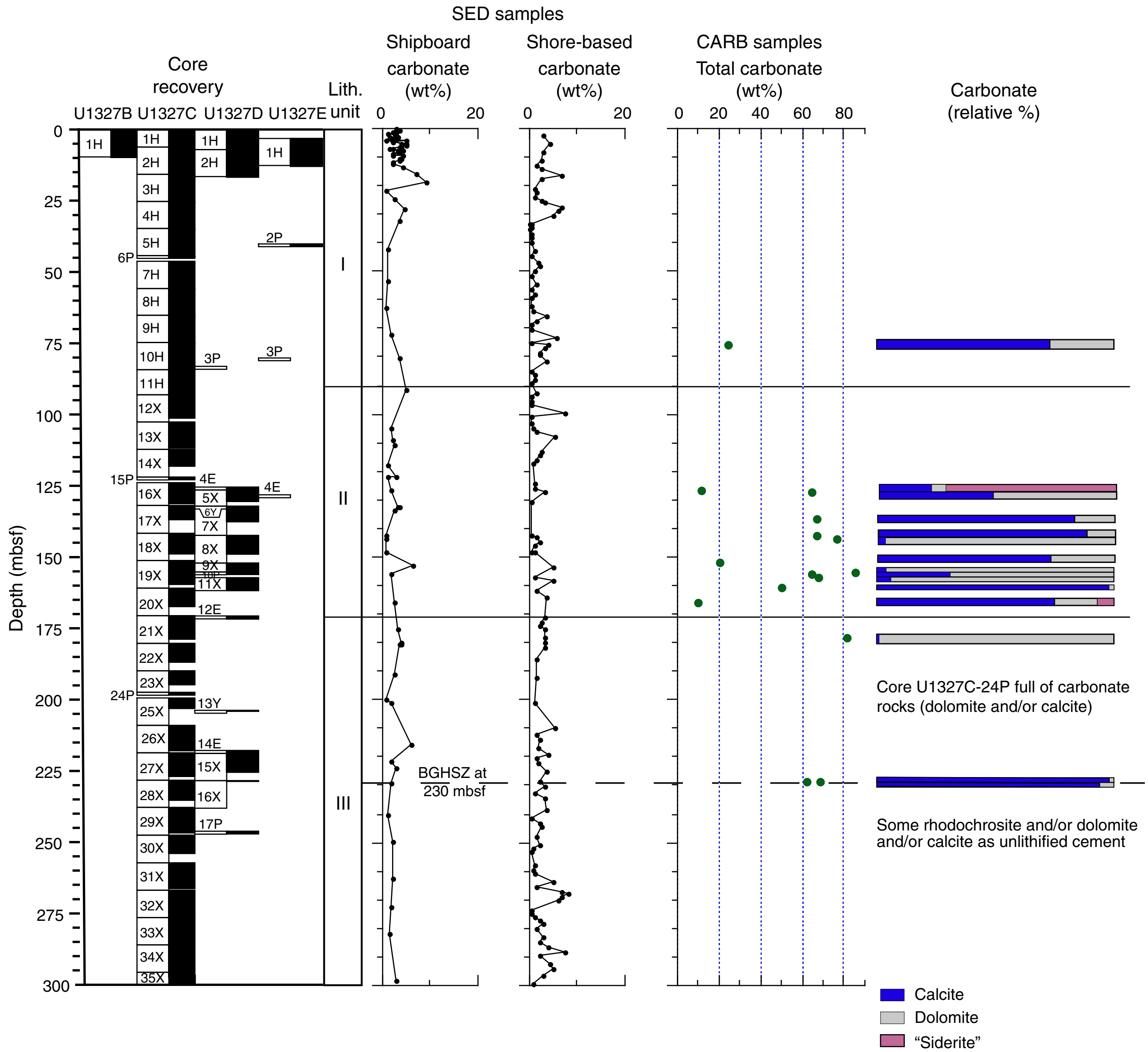

Figure F6. Downhole variations of carbonates in sediment and authigenic carbonate samples, Site U1329. Lith. = lithologic, SED = standard sediment, CARB = semi-indurated to indurated authigenic carbonate sediment, BGHSZ = bottom gas hydrate stability zone.

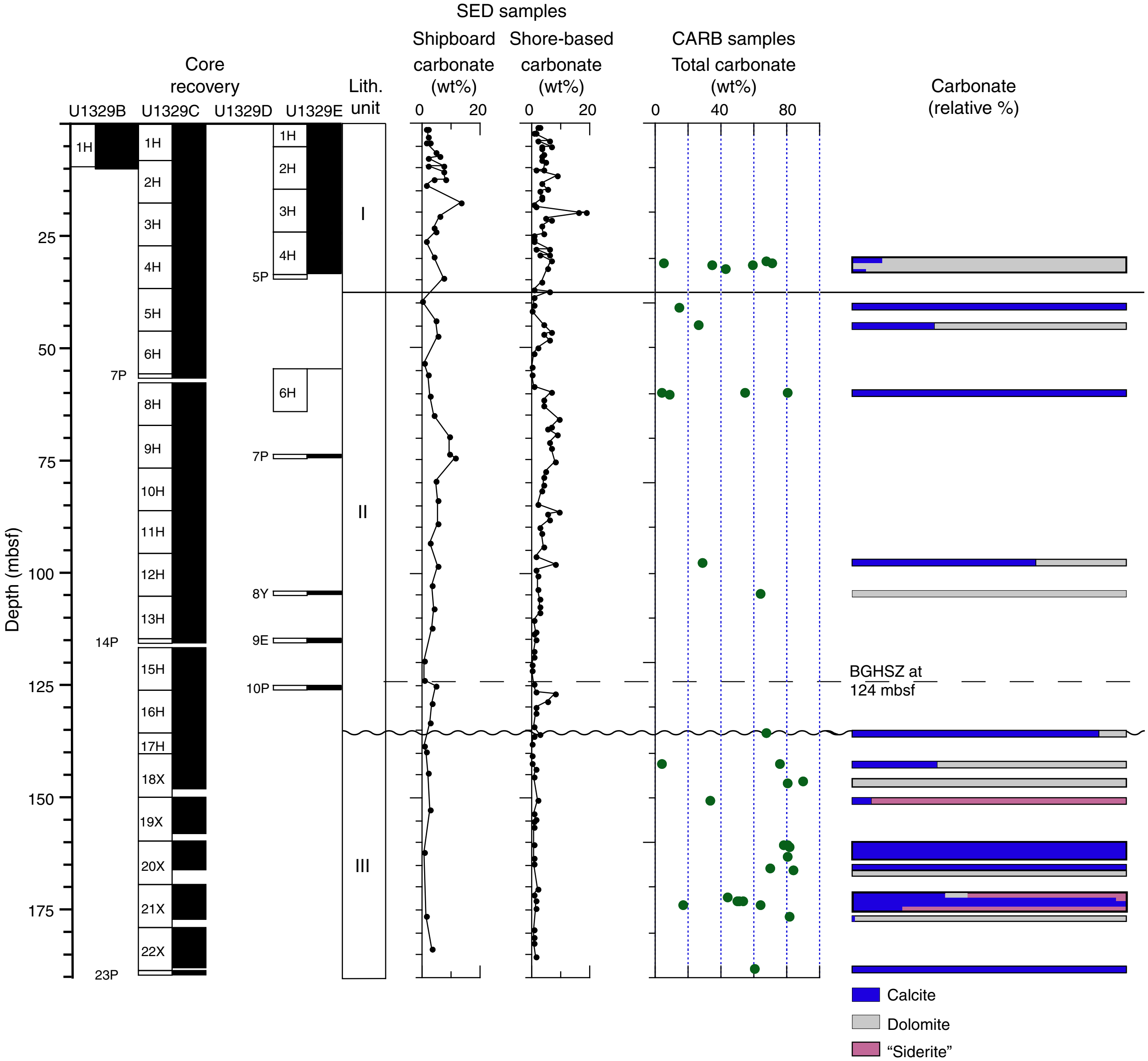

Figure F7. Downhole variations of carbonates in sediment and authigenic carbonate samples, Site U1328. ManoCalcimeter Mélières values and carbonate relative percent not plotted for Sample 311-U1328C-5P-1, 0–2 cm, and Hole U1328D samples with uncertain depths. Lith. = lithologic, SED = standard sediment, CARB = semi-indurated to indurated authigenic carbonate sediment, BGHSZ = bottom gas hydrate stability zone.

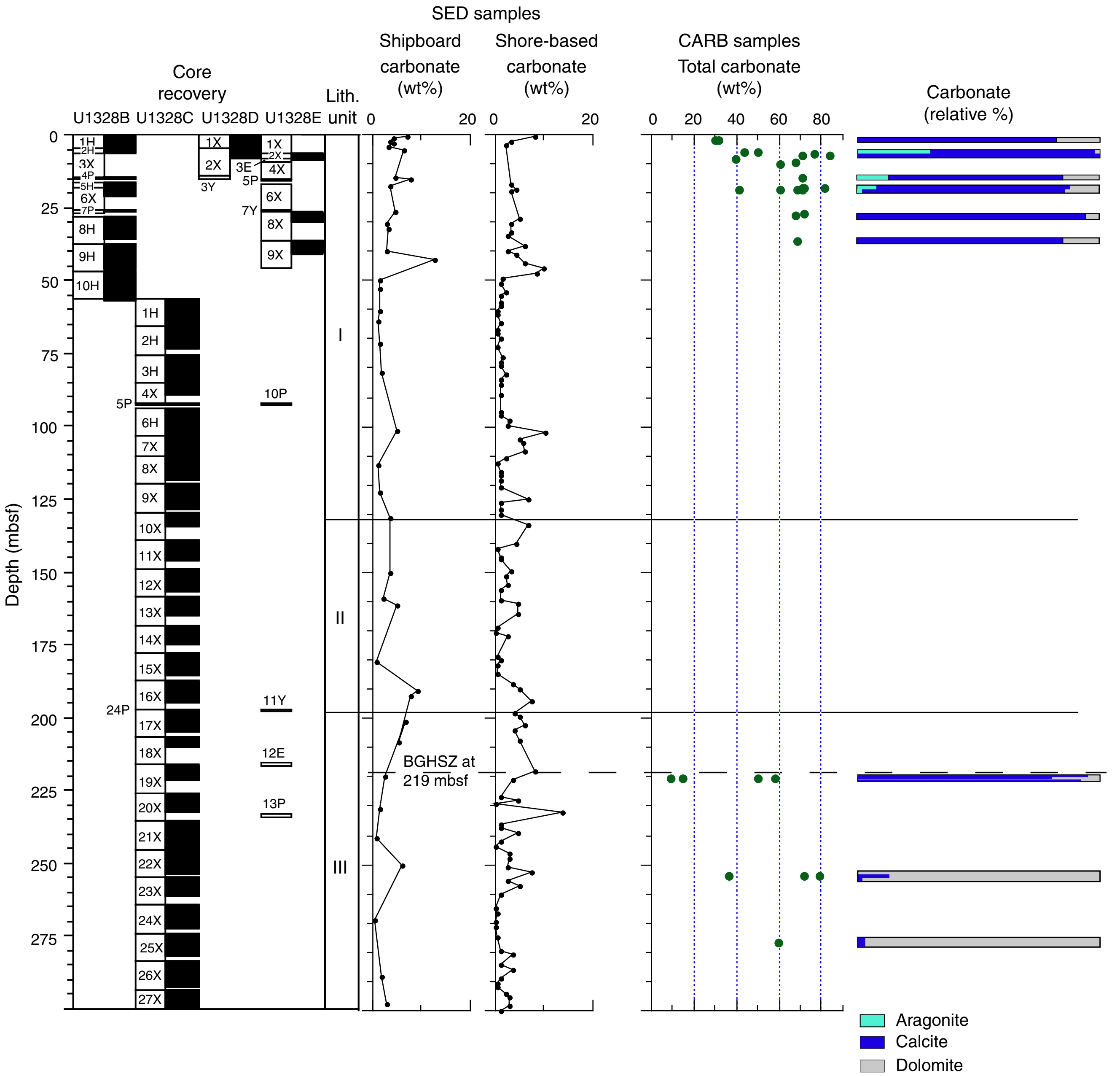

Figure F8. Scanning electron microscopy photographs of Site U1328 cold seep carbonate facies. **A.** General view (backscattered electron) showing the association of aragonite needles and small high-magnesium calcite (HMC) crystals (~13 mol% $MgCO_3$) with knobbly surface (Sample 311-U1328B-6X-1, 0–20 cm). **B.** Secondary electron detail of A. **C.** Energy dispersive spectrometer (EDS) spectrum of HMC crystal (arrow in B). **D.** Small HMC crystals (~16 mol% $MgCO_3$) with knobbly surface (Sample 311-U1328B-6X-1, 47-50 cm). **E.** Clusters of rounded dolomite grains with knobbly surface (Sample 311-U1328D-2X-2, 30-31 cm). **F.** EDS spectrum for sample in E.

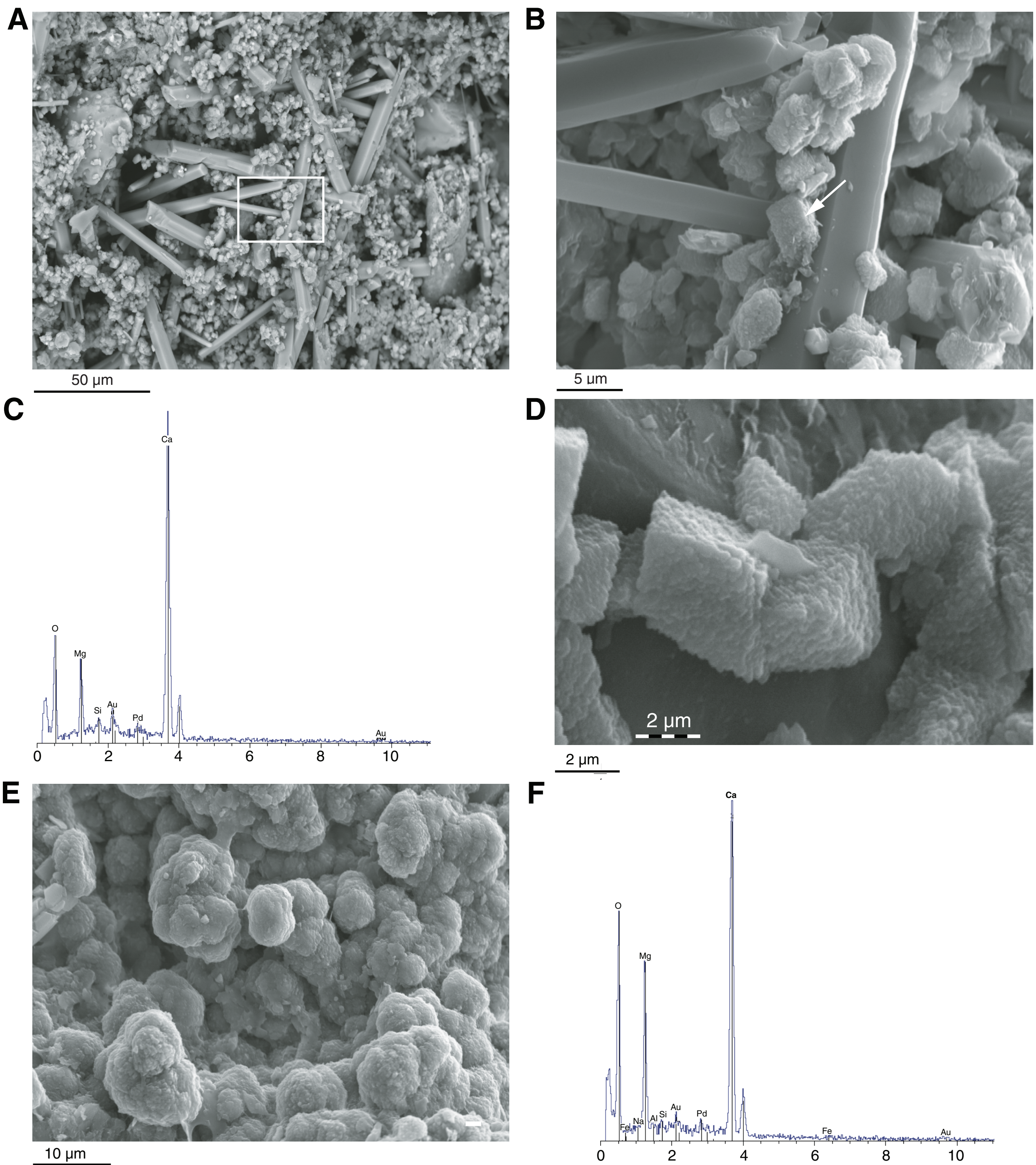

Figure F9. Scanning electron microscopy photographs of siderite and rhodochrosite authigenic facies. **A.** General view (backscattered electron [BSE]) of rhombohedra (1–4 µm) (Sample 311-U1329C-21X-3, 129–131 cm). **B.** Secondary electron (SE) detail view of A. **C.** Energy dispersive spectrometer (EDS) spectrum corresponding to an intermediate phase between magnesite, siderite, and calcite (see Mg, Fe, and Ca in EDS spectra). Corresponding XRD diagram appears indicate siderite with all peaks translated toward higher values (e.g., $d_{104} \approx$ 2.809 Å instead of 2.796 Å). **D.** SE photograph showing carbonates corresponding to thin areas (<1 µm; arrows) scattered in the detrital matrix (Sample 311-U1326D-20X-3, 0–1 cm). **E.** Dispersed fragments of sample in D observed on a glass slide (BSE). **F.** EDS spectrum of sample in E with Ca, Fe, Mg, and some Mn in the carbonates. **G.** Higher magnification of E showing aligned bladelike particles. **H.** Higher magnification of E showing rhombic crystals.

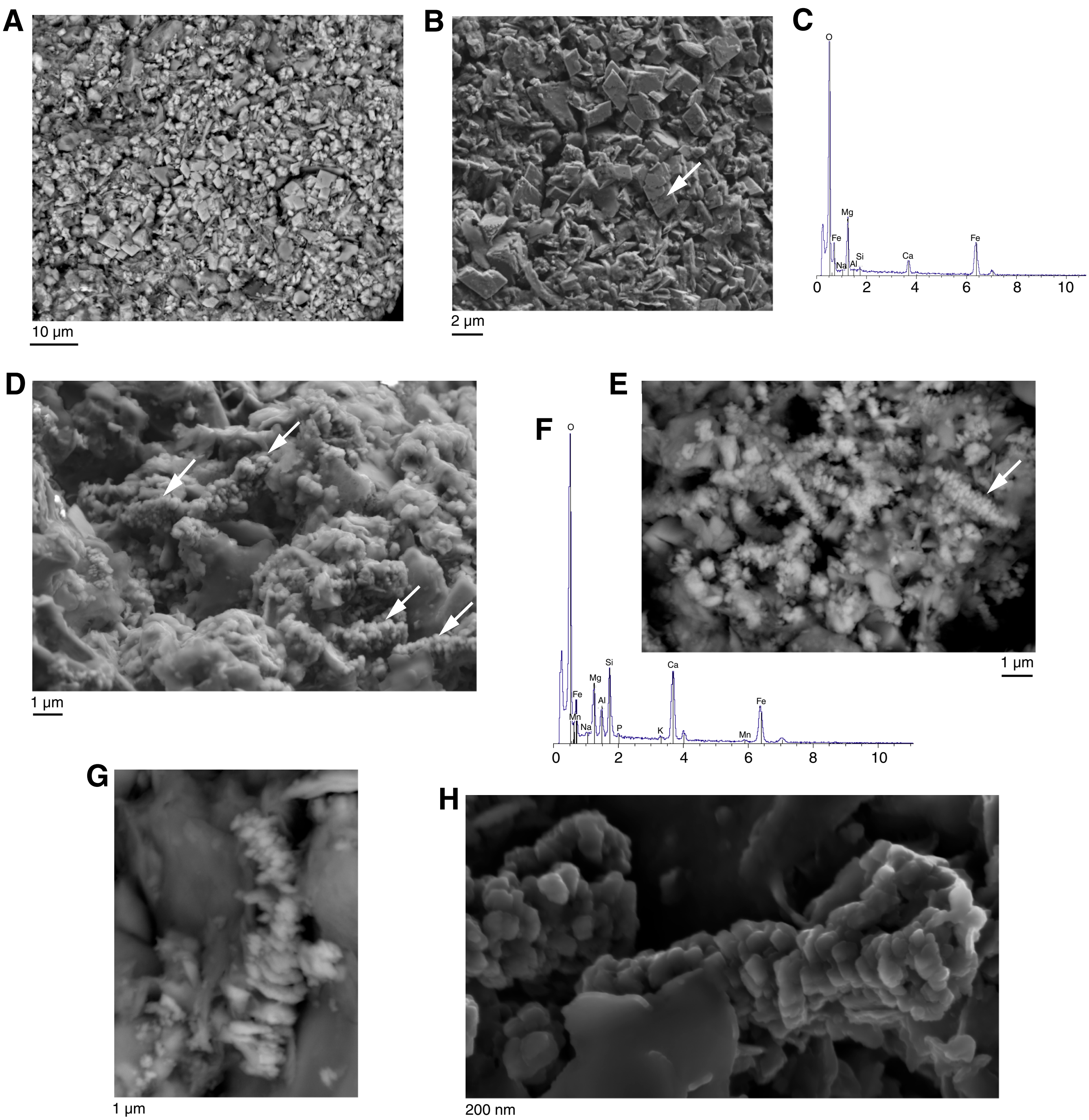

Table T1. Sediment carbonate content. (**See table note.**)

Site	Depth (mbsf)	MCM values (wt%)		MCM + shipboard values (wt%)	
		Range	Average	Range	Average
U1326	1828	0.3–7	1.9	0.3–8.7	2.4
U1325	2195	0.5–9.3	2.1	0.5–11.4	2.4
U1327	1304	0–8.1	2.2	0–9.2	2.5
U1329	946	0.3–18.6	3.2	0.3–18.6	3.4
U1328	1268	0.3–13.6	2.6	0.3–13.6	2.9

Note: MCM = ManoCalcimeter Mélières apparatus.

Table T2. Total carbonate content and mineralogical calcite composition. (See table notes.) (Continued on the next eight pages.)

Core, section, interval (cm)	Depth (mbsf)	MCM (wt%)	Calcite (d_{104} Å)	$MgCO_3$ (mol%)	Remarks
311-U1325B-					
1H-2, 43–45	1.93	3.8	3.034	0.3	
1H-4, 48–50	4.98	2.5	3.032	1.0	
1H-5, 49–51	6.49	2.5	3.029	2.0	
1H-6, 44–46	7.94	3.0	3.032	1.0	
1H-7, 31–33	9.31	0.8	3.028	2.3	
2H-1, 75–77	10.05	0.5	—		
2H-2, 75–77	11.55	2.5	3.029	2.0	
2H-3, 75–77	13.05	0.5	ND	ND	
2H-4, 75–77	14.55	0.8	ND	ND	
2H-5, 75–77	16.05	3.5	3.032	1.0	
2H-7, 75–77	19.05	1.3	3.030	1.7	
3X-1, 75–77	19.55	3.8	3.033	0.7	
4H-1, 75–77	24.75	4.3	3.034	0.3	
4H-2, 75–77	26.07	4.8	3.035	0.0	
4H-3, 75–77	27.57	5.3	3.034	0.3	
4H-4, 75–77	29.07	5.6	3.035	0.0	
4H-6, 75–77	32.07	4.0	3.035	0.0	
4H-7, 62–64	33.44	3.0	3.035	0.0	
5H-1, 75–77	34.25	1.0	3.035	0.0	
5H-2, 75–77	35.75	2.3	3.034	0.3	
5H-3, 75–77	37.17	1.8	3.033	0.7	
5H-4, 75–77	38.67	2.5	3.034	0.3	
5H-6, 75–77	41.67	3.3	3.031	1.3	
6H-1, 75–77	43.75	4.5	3.035	0.0	
6H-2, 75–77	45.25	3.8	3.034	0.3	
6H-3, 75–77	46.75	2.8	3.035	0.0	
6H-4, 75–77	48.25	6.3	3.034	0.3	
6H-6, 78–80	51.28	6.8	3.034	0.3	
7H-1, 58–60	53.08	1.0	3.035	0.0	
7H-2, 75–77	54.75	0.5	ND	ND	
7H-3, 75–77	56.25	1.5	3.026	3.0	
7H-4, 78–80	57.78	1.0	3.034	0.3	
7H-6, 75–77	60.75	0.5	ND	ND	
7H-7, 71–73	61.97	1.5	3.030	1.7	
8H-1, 75–77	62.75	0.5	ND	ND	
8H-2, 75–77	64.01	0.8	ND	ND	
8H-3, 75–77	65.51	1.0	3.031	1.3	
8H-4, 75–77	67.01	1.0	3.032	1.0	
8H-6, 75–77	70.01	0.5	—		
8H-7, 75–77	71.01	0.5	ND	ND	
9X-1, 75–77	72.25	0.5	—		
10X-1, 75–77	73.55	1.5	3.012	7.7	
10X-2, 75–77	75.05	0.8	ND	ND	
10X-3, 75–77	76.55	2.0	3.028	2.3	
10X-4, 75–77	78.05	2.8	3.030	1.7	
10X-6, 75–77	80.85	1.5	3.032	1.0	
12X-1, 75–77	85.15	0.5	—		
12X-3, 75–77	88.15	0.8	ND	ND	
14X-1, 75–77	103.05	6.3	3.034	0.3	
14X-2, 75–77	104.55	3.0	3.035	0.0	
14X-3, 75–77	106.05	3.0	3.034	0.3	
14X-4, 75–77	107.55	1.3	3.034	0.3	
15X-1, 75–77	112.45	1.0	3.028	2.3	
15X-3, 64–66	115.34	0.5	ND	ND	
16X-1, 75–77	122.05	2.0	3.034	0.3	
16X-2, 75–77	123.55	2.0	3.035	0.0	
16X-6, 75–77	127.40	3.5	3.035	0.0	
16X-7, 75–77	128.90	7.0	3.035	0.0	
18X-1, 75–77	131.65	5.3	3.035	0.0	
19X-1, 75–77	141.25	**9.3**	3.033	0.7	Abundant foraminifers and calcareous nannoplankton
19X-2, 75–77	142.75	7.5	3.034	0.3	
20X-1, 5–7	150.25	2.0	3.034	0.3	
20X-1, 75–77	150.95	3.0	3.03	1.7	
20X-2, 75–77	152.45	0.5	3.032	1.0	
20X-3, 7–9	153.27	2.5	3.035	0.0	
20X-4, 75–77	154.59	5.0	3.033	0.7	

Table T2 (continued). (Continued on next page.)

Core, section, interval (cm)	Depth (mbsf)	MCM (wt%)	Calcite (d_{104} Å)	$MgCO_3$ (mol%)	Remarks
20X-6, 77–79	157.61	2.3	3.034	0.3	
24X-1, 75–77	179.75	2.0	3.033	0.7	
24X-2, 75–77	181.14	1.8	3.032	1.0	
24X-4, 75–77	184.02	2.0	3.034	0.3	
24X-5, 75–77	185.02	1.5	3.035	0.0	
311-U1325C-					
1X-2, 75–77	191.05	1.0	ND	ND	
4X-2, 75–77	209.99	0.5	ND	ND	
4X-4, 75–77	211.67	1.0	3.027	2.7	
6X-3, 75–77	221.14	0.5	ND	ND	
6X-4, 75–77	222.26	1.0	3.035	0.0	
7X-2, 75–77	229.45	0.5	ND	ND	
7X-3, 77–79	230.97	0.5	3.029	2.0	
7X-6, 75–77	233.42	1.8	3.020	5.0	
8X-1, 75–77	237.55	2.3	3.031	1.3	
8X-4, 75–77	241.40	1.8	3.022	4.4	
8X-5, 75–77	242.55	1.0	3.031	1.3	
8X-6, 75–77	244.05	1.3	3.028	2.3	
9X-1, 75–77	247.25	1.0	ND	ND	
9X-2, 75–77	248.75	1.0	ND	ND	
9X-4, 75–77	251.75	0.8	ND	ND	
9X-5, 75–77	253.03	1.0	ND	ND	
9X-6, 71–73	254.49	0.8	—		
11X-1, 75–77	257.85	0.5	ND	ND	
11X-2, 75–77	259.35	0.5	—		
11X-3, 73–75	260.83	0.5	—		
11X-5, 75–77	263.85	1.3	3.031	1.3	
12X-1, 75–77	266.55	0.5	ND	ND	
12X-3, 75–77	269.42	0.8	ND	ND	
12X-4, 75–77	270.92	0.8	ND	ND	
12X-5, 75–77	272.42	0.5	—		
15X-1, 75–77	295.45	1.0	ND	ND	
311-U1325D-					
1H-1, 76–78	0.76	0.5	3.032	1.0	
1H-2, 75–77	2.25	1.0	3.035	0.0	
1H-3, 76–78	3.76	2.0	3.028	2.3	
311-U1326B-					
1H-1, 75–77	0.75	0.8	ND	ND	
311-U1326C-					
2H-2, 51–53	5.91	2.5	3.035	0.0	
2H-4, 51–53	8.91	2.0	3.034	0.3	
2H-5, 75–77	10.65	6.3	3.034	0.3	
2H-6, 72–74	12.12	3.0	3.029	2.0	
2H-7, 47–49	13.37	5.8	3.029	2.0	
3H-1, 75–77	14.15	5.5	3.034	0.3	
3H-2, 75–77	15.65	6.5	3.032	1.0	
3H-3, 75–77	17.15	**7.0**	3.030	1.7	Small foraminifers in sieved fraction; coccoliths and detrital carbonates in smearslide
3H-5, 80–82	20.2	5.5	3.034	0.3	
3H-6, 75–77	21.65	3.5	3.029	2.0	
4H-1, 75–77	23.65	1.0	3.031	1.3	
4H-3, 75–77	26.65	5.5	3.012	7.7	
5X-1, 75–77	31.15	1.3	3.03	1.7	
5X-3, 75–77	34.07	1.3	3.026	3.0	
5X-4, 75–77	35.40	1.3	3.032	1.0	
6X-1, 75–77	40.75	0.8	3.028	2.3	
6X-3, 75–77	43.75	1.0	3.025	3.4	
6X-4, 75–77	44.77	1.3	3.035	0.0	
6X-5, 75–77	45.73	2.0	ND	ND	
7X-2, 75–77	51.78	1.3	3.034	0.3	
7X-3, 71–73	53.24	2.5	3.032	1.0	
8X-1, 75–77	60.15	0.5	ND	ND	
9X-2, 75–77	71.35	2.0	3.021?	4.7?	
10X-1, 75–77	79.45	0.3	—		
311-U1326D-					
2X-3, 75–77	92.15	1.0	3.022?	4.4	
2X-4, 75–77	93.65	2.8	3.020?	5.0?	
2X-5, 75–77	95.15	0.5	ND	ND	

Table T2 (continued). (Continued on next page.)

Core, section, interval (cm)	Depth (mbsf)	MCM (wt%)	Calcite (d_{104} Å)	$MgCO_3$ (mol%)	Remarks
2X-6, 75–77	96.59	0.5	ND	ND	
3X-1, 75–77	98.85	0.5	—		
3X-3, 75–77	101.85	0.5	ND	ND	
4X-1, 75–77	108.45	1.3	ND	ND	
4X-4, 75–77	112.51	1.0	3.026	3.0	
4X-5, 75–77	113.86	1.0	3.034	0.3	
5X-1, 75–77	118.05	0.3	—		
5X-2, 75–77	119.45	0.5	—		
5X-4, 75–77	122.29	1.0	3.034	0.3	
5X-6, 75–77	124.35	1.3	3.030	1.7	
6X-1, 75–77	127.75	2.3	3.034	0.3	
6X-3, 75–77	130.75	1.5	3.028	2.3	
6X-4, 75–77	131.88	1.0	3.028	2.3	
6X-5, 75–77	133.20	0.8	ND	ND	
6X-6, 75–77	134.20	1.0	—		
7X-3, 75–77	139.49	1.3	3.034	0.3	
7X-4, 75–77	140.94	1.5	3.030	1.7	
8X-3, 75–77	149.51	3.1	3.035	0.0	
9X-1, 75–77	156.65	2.6	3.029	2.0	
10X-1, 75–77	166.35	1.0	ND	ND	
10X-2, 75–77	167.85	0.8	ND	ND	
10X-3, 75–77	169.27	3.1	3.033	0.7	
10X-4, 75–77	170.77	1.8	3.031	1.3	
11X-2, 75–77	176.44	1.3	3.024	3.7	
11X-4, 75–77	179.44	2.0	3.034	0.3	
11X-5, 75–77	180.94	0.5	ND	ND	
12X-2, 75–77	186.80	2.6	3.031	1.3	
13X-1, 75–77	195.15	1.5	3.033	0.7	
13X-3, 75–77	197.75	0.8	ND	ND	
14X-1, 75–77	204.75	2.0	3.032	1.0	
14X-5, 75–77	209.25	2.0	3.032	1.0	
15X-1, 73–75	214.33	3.8	3.013	7.4	
15X-2, 75–77	215.77	0.5	ND	ND	
15X-3, 75–77	217.11	0.5	ND	ND	
16X-1, 24–26	223.54	1.0	3.035	0.0	
16X-1, 75–77	224.05	1.8	3.034	0.3	
16X-3, 75–77	227.05	0.3	—		
16X-4, 75–77	228.55	0.5	—		
16X-5, 75–77	229.65	0.5	—		
17X-1, 75–77	233.65	0.8	—		
17X-4, 75–77	238.15	3.6	3.033	0.7	
17X-5, 75–77	239.65	2.0	3.032	1.0	
18X-2, 75–77	244.40	3.1	3.034	0.3	
20X-3, 75–77	264.50	1.5	3.030	1.7	
20X-5, 75–77	267.29	1.3	3.032	1.0	
20X-7, 74–76	269.78	1.0	3.030	1.7	
311-U1327C-					
1H-2, 75–77	2.25	2.8	3.033, 3.017	0.7, 6.0	
1H-4, 75–77	5.25	4.3	3.032	1.0	
2H-2, 75–77	8.35	2.8	3.035	0.0	
2H-4, 75–77	11.35	2.5	3.029	2.0	
2H-5, 75–77	12.85	1.5	3.030	1.7	
2H-6, 72–74	14.32	2.5	3.031	1.3	
3H-1, 75–77	16.35	6.6	3.035	0.0	
3H-2, 75–77	17.85	2.5	3.035	0.0	
3H-4, 81–83	20.91	1.3	3.030	1.7	
3H-5, 75–77	22.35	1.5	3.035	0.0	
3H-6, 75–77	23.85	1.3	3.033	0.7	
3H-7, 75–77	25.35	2.5	3.032	1.0	
4H-1, 75–77	25.85	3.1	3.028	2.2	
4H-2, 75–77	27.35	6.6	3.035	0.0	
4H-3, 75–77	28.85	6.1	3.033	0.7	
4H-4, 75–77	30.35	4.8	3.033	0.7	
4H-6, 75–77	33.35	0.5	3.027	2.7	
4H-6, 83–85	33.43	0.0	—		Dropstone
4H-7, 75–77	34.85	0.3	3.028	2.3	
5H-1, 75–77	35.35	0.0	—		
5H-2, 75–77	36.85	0.5	—		

Table T2 (continued). (Continued on next page.)

Core, section, interval (cm)	Depth (mbsf)	MCM (wt%)	Calcite (d_{104} Å)	$MgCO_3$ (mol%)	Remarks
5H-3, 75–77	38.35	0.5	ND	ND	
5H-4, 75–77	39.85	0.5	—		
5H-6, 75–77	42.85	1.0	3.026	3.0	
5H-7, 75–77	44.35	0.3	—		
7H-1, 75–77	46.85	1.8	3.033	0.7	
7H-2, 75–77	48.35	2.0	3.035	0.0	
7H-3, 75–77	49.85	1.3	3.030	1.7	
7H-4, 75–77	51.35	0.5	ND	ND	
7H-6, 75–77	54.35	1.5	3.030	1.7	
8H-1, 75–77	56.35	0.5	ND	ND	
8H-2, 75–77	57.85	1.0	3.028	2.3	
8H-3, 75–77	59.35	0.5	ND	ND	
8H-5, 75–77	62.35	0.5	—		
8H-6, 75–77	63.85	0.8	ND	ND	
9H-1, 75–77	65.85	3.5	3.033	0.7	
9H-2, 75–77	67.35	1.5	3.032	1.0	
9H-3, 77–79	68.87	0.5	—		
9H-4, 75–77	70.35	0.3	—		
9H-6, 75–77	73.35	5.8	3.034	0.3	
9H-7, 75–77	74.85	0.5	—		
10H-1, 75–77	75.35	3.8	3.035	0.0	
10H-2, 75–77	76.85	3.3	3.034	0.3	
10H-3, 75–77	78.35	2.0	3.034	0.3	
10H-4, 0–15	79.10	2.1	3.032	1.0	
10H-6, 75–77	81.50	3.5	3.033	0.7	
11H-1, 75–77	84.85	0.5	ND	ND	
11H-2, 75–77	86.35	1.0	ND	ND	
11H-3, 75–77	87.85	1.0	ND	ND	
11H-4, 75–77	89.35	0.5	—		
11H-6, 75–77	92.35	1.5	3.036		
12X-2, 75–77	94.01	0.5	—		
12X-3, 75–77	95.51	0.5	—		
12X-4, 75–77	97.01	0.5	—		
12X-6, 75–77	99.87	7.5	3.028, ND	2.3, ?	
12X-7, 65–67	100.77	0.5	—		
13X-1, 75–77	103.25	0.5	—		
13X-2, 75–77	104.75	0.8	—		
13X-3, 75–77	106.25	1.5	3.033	0.7	
13X-4, 75–77	107.75	5.3	3.033	0.7	
14X-1, 75–77	112.85	2.5	3.034	0.3	
14X-2, 75–77	114.35	2.0	3.033	0.7	
14X-3, 75–77	115.85	1.5	3.034	0.3	
14X-4, 75–77	117.35	0.8	ND	ND	
16X-1, 75–77	124.55	1.3	3.028	2.3	
16X-2, 75–77	125.95	1.0	ND	ND	
16X-3, 75–77	127.45	3.1	3.027	2.7	
16X-5, 75–77	130.45	0.5	ND	ND	
18X-1, 72–74	142.22	0.5	ND	ND	
18X-2, 75–77	143.10	1.5	ND	ND	
18X-3, 75–77	144.60	2.0	3.017	6.0	
18X-4, 75–77	146.10	1.3	ND	ND	
18X-5, 120–150	148.05	0.5	ND	ND	
19X-3, 75–77	153.85	5.1	3.035	0.0	
19X-5, 79–81	156.89	1.0	ND	ND	
19X-6, 75–77	158.35	4.8	3.030	1.7	
20X-1, 75–77	161.55	1.5	3.034	0.3	
20X-3, 75–77	163.83	3.6	3.035	0.0	
21X-1, 75–77	171.15	3.1	3.029	2.0	
21X-2, 72–74	172.62	2.6	3.029	2.0	
21X-3, 78–80	174.11	2.0	3.026	3.0	
21X-4, 76–78	175.28	3.1	3.034	0.3	
21X-6, 75–77	178.17	3.1	3.033	0.7	
22X-1, 74–76	180.00	3.1	3.034	0.3	
22X-2, 74–76	181.50	3.1	3.033	0.7	
22X-5, 75–77	186.00	1.5	3.031	1.3	
23X-2, 72–74	192.03	1.5	3.035	0.0	
25X-2, 77–79	200.88	1.0	ND	ND	
26X-1, 75–77	209.65	5.3	3.034	0.3	
26X-3, 75–77	212.29	1.5	ND	ND	

Table T2 (continued). (**Continued on next page.**)

Core, section, interval (cm)	Depth (mbsf)	MCM (wt%)	Calcite (d_{104} Å)	$MgCO_3$ (mol%)	Remarks
26X-4, 75–77	213.79	2.3	3.035	0.0	
26X-6, 75–77	216.79	1.8	3.035	0.0	
27X-1, 75–77	219.25	3.8	3.034	0.3	
27X-2, 75–77	220.63	1.5	ND	ND	
27X-3, 75–77	222.04	1.8	ND	ND	
27X-5, 75–77	224.88	3.6	ND	ND	
28X-1, 74–76	228.84	2.3	ND	ND	
28X-2, 74–76	230.34	3.1	3.031	1.3	
28X-4, 73–75	232.93	1.3	3.032	1.0	
28X-5, 68–70	234.38	3.1	3.032	1.0	
29X-1, 75–77	238.45	3.5	3.032	1.0	
29X-3, 75–77	241.45	0.5	ND	ND	
29X-4, 80–82	243.00	2.0	3.028	2.3	
29X-5, 75–77	244.30	2.5	ND		
30X-1, 75–77	248.15	1.5	3.032	1.0	
30X-3, 73–75	250.81	2.0	ND		
30X-4, 75–77	251.86	0.8	ND	ND	
30X-5, 70–72	253.31	0.5	ND	ND	
31X-1, 75–77	257.85	1.0	ND	ND	
31X-2, 72–74	259.32	0.8	ND	ND	
31X-3, 75–77	260.85	1.0	ND	ND	
31X-5, 75–77	263.81	5.1	3.034, 3.016	0.3, 6.4	
31X-6, 75–77	265.31	1.5	ND	ND	
32X-1, 72–74	267.42	6.6	3.033	0.7	
32X-1, 90–91	267.60	**8.1**	3.032	1.0	Abundant foraminifers in sieved fractions
32X-2, 75–77	268.95	6.8	3.033	0.7	
32X-3, 75–77	270.45	6.1	3.035, ?	0.0, ?	
32X-5, 75–77	273.45	0.5	ND	ND	
32X-6, 75–77	274.95	0.5	—		
32X-7, 75–77	275.86	1.0	—		
33X-1, 75–77	277.05	2.0	3.032	1.0	
33X-2, 75–77	278.55	3.0	3.032	1.0	
33X-3, 75–77	280.05	1.5	ND	ND	
33X-5, 75–77	283.05	2.8	3.028	2.3	
33X-6, 75–77	284.55	2.0	3.033	0.7	
34X-1, 73–75	286.63	4.0	3.034	0.3	
34X-2, 77–79	288.17	**7.3**	3.032	1.0	Foraminifers in sieved fractions; detrital carbonates in smearslide
34X-3, 77–79	289.67	2.3	3.034	0.3	
34X-5, 76–78	292.66	4.3	3.033	0.7	
34X-6, 75–77	294.11	4.8	3.035	0.0	
35X-1, 75–77	296.25	3.0	3.033	0.7	
35X-3, 75–77	299.25	0.8	ND	ND	
311-U1328B-					
1H-1, 71–73	0.71	8.2	3.034, 3.005	0.3, 0.1	
1H-2, 69–71	2.19	3.1	3.034, 3.002	0.3, 1.1	
1H-3, 60–62	3.60	2.0	3.027, ?	2.7, ?	
5H-1, 68–70	17.18	3.1	3.035, ?	0.0, ?	
6X-1, 36–38	18.76	4.1	3.030, ?	1.7, ?	
6X-1, 75–77	19.15	3.1	3.034, ?	0.3, ?	
8H-1, 75–77	28.75	5.1	3.034, ?	0.3, ?	
8H-2, 75–77	30.25	3.1	3.031, ?	1.3, ?	
8H-4, 75–77	33.25	3.1	3.029	2.0	
8H-5, 75–77	34.75	2.6	3.029, ?	2.0, ?	
9H-1, 75–77	38.25	6.1	3.033, ?	0.7, ?	
9H-2, 75–77	39.72	2.6	3.034	0.3	
9H-3, 75–77	41.06	4.1	3.033	0.7	
9H-5, 75–77	44.06	6.1	3.035	0.0	
9H-6, 75–77	45.56	**9.7**	3.034	0.3	Foraminifer bloom (sieved fractions)
10H-1, 75–77	47.75	8.5	3.034	0.3	
10H-2, 75–77	49.25	1.5	ND	ND	
10H-3, 75–77	50.75	1.0	3.035	0.0	
10H-5, 75–77	53.75	2.0	3.033	0.7	
10H-6, 75–77	55.22	1.0	3.028	2.3	
311-U1328C-					
1H-1, 75–77	57.25	1.0	3.030	1.7	
1H-2, 75–77	58.71	1.0	—		
1H-3, 75–77	60.18	0.5	3.032	1.0	
1H-4, 75–77	61.68	0.5	3.033	0.7	

Table T2 (continued). (Continued on next page.)

Core, section, interval (cm)	Depth (mbsf)	MCM (wt%)	Calcite (d_{104} Å)	$MgCO_3$ (mol%)	Remarks
1H-6, 75–77	64.68	1.0	3.031	1.3	
2H-1, 75–77	66.75	0.5	—		
2H-2, 75–77	68.25	0.5	—		
2H-3, 75–77	69.75	1.0	—		
2H-5, 75–77	72.75	0.5	—		
3H-1, 75–77	76.25	1.5	3.027	2.7	
3H-2, 75–77	77.75	1.0	3.032	1.0	
3H-3, 75–77	79.25	1.0	ND		
3H-5, 77–79	82.27	2.0	3.029	2.0	
3H-6, 76–78	83.76	1.0	3.035	0.0	
4X-1, 75–77	85.75	1.0	ND	ND	
4X-3, 84–86	88.84	1.0	—		
6H-1, 75–77	94.75	1.0	ND	ND	
6H-2, 75–77	96.25	1.0	3.028	2.3	
6H-3, 75–77	97.65	3.0	3.033, ?	0.7, ?	
6H-6, 75–77	99.75	2.5	3.029	2.0	
6H-8, 75–77	102.14	**10.1**	3.035	0.0	Foraminifer bloom (sieved fractions)
7X-1, 73–75	104.23	5.0	3.035	0.0	
7X-2, 75–77	105.75	5.6	3.034	0.3	
7X-4, 75–77	108.65	6.1	3.026	3.0	
8X-1, 74–76	111.04	2.0	3.030	1.7	
8X-2, 74–76	112.54	0.5	—		
8X-4, 75–77	115.23	1.0	3.028	2.3	
8X-5, 74–76	116.72	1.0	ND	ND	
8X-6, 77–79	118.25	1.0	ND	ND	
9X-1, 78–80	120.68	1.0	3.027	2.7	
9X-4, 72–74	124.62	6.6	3.023	4.1	No foraminifers; almost no nannoplankton but irregular carbonate grains
9X-5, 78–80	126.18	1.0	ND	ND	
9X-7, 75–77	128.23	1.0	—		
10X-1, 75–77	130.35	1.0	ND	ND	
10X-3, 75–77	133.35	6.6	3.034, ?	0.3, ?	
11X-1, 75–77	140.05	4.1	3.033, ?	0.7, ?	
11X-2, 75–77	141.55	0.5	3.035	0.0	
11X-4, 75–77	144.55	1.0	3.034	0.3	
11X-5, 73–75	145.53	1.0	3.035	0.0	
12X-1, 75–77	149.65	3.1	3.035	0.0	
12X-2, 75–77	151.15	2.0	3.034	0.3	
12X-4, 75–77	154.15	2.5	3.034	0.3	
12X-5, 75–77	155.65	1.0	3.034	0.3	
13X-1, 75–77	159.35	1.0	3.032	1.0	
13X-2, 75–77	160.82	4.5	3.032	1.0	
13X-4, 75–77	163.82	4.5	3.033	0.7	
14X-1, 75–77	168.95	0.5	—		
14X-2, 75–77	170.28	0.0	—		
14X-3, 75–77	171.78	2.5	3.035	0.0	
15X-1, 75–77	178.65	0.5	ND	ND	
15X-2, 75–77	180.15	1.0	—		
15X-3, 75–77	181.62	0.5	—		
15X-5, 75–77	184.62	0.5	—		
16X-1, 75–77	188.25	3.5	3.034	0.3	
16X-2, 75–77	189.75	5.0	3.035	0.0	
16X-5, 75–77	194.25	7.5	3.033	0.7	
17X-1, 75–77	197.85	4.0	3.035	0.0	
17X-2, 75–77	199.35	5.0	3.035	0.0	
17X-4, 75–77	202.35	6.0	3.035	0.0	
17X-5, 75–77	203.85	4.0	3.034	0.3	
18X-1, 62–64	207.32	5.0	3.034	0.3	
19X-2, 75–77	217.78	8.0	3.035	0.0	
19X-4, 77–79	220.80	3.5	3.035	0.0	
20X-1, 75–77	226.75	1.0	3.035	0.0	
20X-2, 75–77	228.25	4.5	3.034	0.3	
20X-3, 75–77	229.10	0.0	—		
20X-5, 75–77	231.82	**13.6**	3.035	0.0	Foraminifer bloom (sieved fractions)
21X-1, 75–77	236.35	1.0	ND	ND	
21X-2, 75–77	237.63	1.0	3.033	0.7	
21X-3, 75–77	239.13	4.5	3.035	0.0	
21X-5, 75–77	242.13	1.0	ND	ND	
21X-6, 75–77	243.52	0.0	—		
22X-1, 75–77	245.95	3.0	3.032	1.0	

Table T2 (continued). (**Continued on next page.**)

Core, section, interval (cm)	Depth (mbsf)	MCM (wt%)	Calcite (d_{104} Å)	$MgCO_3$ (mol%)	Remarks
22X-3, 75–77	248.06	3.0	3.035	0.0	
22X-5, 75–77	251.06	2.5	3.035	0.0	
22X-6, 75–77	252.56	7.5	3.034	0.3	
23X-1, 75–77	255.55	2.5	3.032	1.0	
23X-2, 75–77	257.05	5.0	3.035	0.0	
23X-4, 75–77	260.05	1.0	3.032	1.0	
24X-1, 72–74	265.12	0.0	—		
24X-2, 75–77	266.61	0.5	3.035	0.0	
24X-4, 75–77	269.47	0.0	—		
24X-6, 75–77	271.55	0.0	—		
25X-1, 78–80	274.88	0.5	—		
25X-4, 75–77	279.35	1.0	ND	ND	
25X-5, 71–73	280.81	3.5	3.032	1.0	
26X-1, 73–75	284.43	1.0	3.033	0.7	
26X-2, 73–75	285.93	3.5	3.034	0.3	
26X-4, 71–73	288.91	1.0	3.031	1.3	
26X-5, 75–77	290.45	0.5	3.032	1.0	
26X-6, 74–76	291.94	0.5	—		
27X-1, 75–77	294.05	2.0	3.035	0.0	
27X-2, 75–77	295.55	3.0	3.035	0.0	
27X-4, 75–77	298.47	3.0	3.033	0.7	
27X-5, 75–77	299.86	1.0	3.032	1.0	
311-U1329B-					
1H-1, 74–76	0.74	2.8	3.035	0.0	
1H-2, 74–76	2.24	1.5	3.035	0.0	
1H-3, 74–76	3.74	5.8	3.035	0.0	
1H-4, 74–76	5.24	7.0	3.035	0.0	
1H-5, 74–76	6.74	3.8	3.033	0.7	
1H-6, 74–76	8.24	3.3	3.031	1.3	
311-U1329C-					
1H-2, 75–77	2.25	1.0	3.031	1.3	
1H-4, 75–77	5.25	3.3	3.035	0.0	
1H-5, 75–77	6.75	3.8	3.030	1.7	
2H-2, 75–77	10.35	1.5	3.034	0.3	
2H-4, 75–77	13.35	3.3	3.032	1.0	
2H-5, 75–77	14.85	5.5	3.035	0.0	
2H-6, 77–79	16.37	3.5	3.029	2.0	
3H-1, 77–79	18.37	1.5	3.032	1.0	
3H-2, 75–77	19.85	**18.6**	3.035	0.0	Foraminifer bloom (sieved fractions)
3H-3, 75–77	21.35	6.8	3.033	0.7	
3H-5, 75–77	24.35	4.3	3.032	1.0	
3H-6, 75–77	25.85	0.5	3.029	2.0	
4H-1, 75–77	27.85	1.3	3.033	0.7	
4H-2, 75–77	29.35	3.0	3.031	1.3	
4H-4, 75–77	32.35	5.5	3.032	1.0	
4H-6, 75–77	35.35	3.5	3.032	1.0	
4H-7, 75–77	36.85	1.0	3.033	0.7	
5H-1, 75–77	37.35	5.8	3.024	3.7	
5H-2, 79–81	38.89	0.8	3.029	2.0	
5H-3, 75–77	40.35	0.5	ND	ND	
5H-4, 74–76	41.84	0.0	—		
5H-6, 74–76	44.84	4.0	3.030	1.7	
5H-7, 73–75	46.33	7.0	3.032	1.0	
6H-1, 75–77	46.85	3.8	3.03	1.7	
6H-2, 75–77	48.35	5.8	3.034	0.3	
6H-3, 75–77	49.85	2.0	3.032	1.0	
6H-4, 75–77	51.35	0.5	ND	ND	
6H-6, 75–77	54.35	0.3	—		
6H-7, 75–77	55.85	0.3	—		
8H-1, 75–77	58.35	0.5	—		
8H-2, 75–77	59.85	6.8	3.033	0.7	
8H-3, 75–77	61.35	4.0	3.033	0.7	
8H-4, 75–77	62.85	4.0	3.035	0.0	
8H-6, 75–77	65.85	**9.6**	3.035	0.0	Foraminifer bloom (sieved fractions)
8H-7, 71–73	67.31	6.6	3.034	0.3	
9H-1, 75–77	67.85	5.6	3.035	0.0	
9H-2, 75–77	69.35	8.8	3.034	0.3	
9H-3, 75–77	70.85	6.1	3.035	0.0	

Table T2 (continued). (Continued on next page.)

Core, section, interval (cm)	Depth (mbsf)	MCM (wt%)	Calcite (d_{104} Å)	$MgCO_3$ (mol%)	Remarks
9H-4, 75–77	72.35	6.5	3.035	0.0	
9H-6, 75–77	75.35	7.8	3.034	0.3	
10H-1, 75–77	77.35	5.0	3.035	0.0	
10H-2, 75–77	78.85	3.8	3.035	0.0	
10H-3, 75–77	80.35	4.0	3.035	0.0	
10H-4, 75–77	81.85	3.5	3.035	0.0	
10H-6, 75–77	84.85	1.8	3.035	0.0	
10H-7, 75–77	86.35	9.5	3.033	0.7	
11H-1, 69–71	86.79	5.5	3.035	0.0	
11H-2, 75–77	88.35	5.8	3.035	0.0	
11H-3, 75–77	89.85	3.0	3.033	0.7	
11H-4, 75–77	91.35	3.3	3.034	0.3	
11H-6, 75–77	94.35	4.0	3.035	0.0	
12H-1, 75–77	96.35	1.5	3.034	0.3	
12H-2, 75–77	97.83	8.0	3.034	0.3	
12H-3, 75–77	99.33	1.3	3.035	0.0	
12H-4, 75–77	100.83	2.3	3.034	0.3	
12H-6, 75–77	103.83	2.0	3.035	0.0	
13H-1, 75–77	105.85	2.5	3.034	0.3	
13H-2, 91–93	107.51	3.0	3.034	0.3	
13H-3, 75–77	108.85	2.5	3.034	0.3	
13H-4, 75–77	110.35	0.8	ND	ND	
13H-6, 37–40	112.97	1.6	—		Dropstone; pyroxene-rich
13H-6, 75–77	113.35	0.8	3.035	0.0	
13H-7, 72–74	114.82	1.3	3.032	1.0	
15H-1, 75–77	117.35	0.5	ND	ND	
15H-2, 73–75	118.83	0.5	ND	ND	
15H-3, 75–77	120.35	0.3	ND	ND	
15H-4, 75–77	121.85	0.3	ND	ND	
15H-6, 75–77	124.85	1.0	3.032	1.0	
15H-7, 70–72	126.30	1.3	3.029	2.0	
16H-1, 75–77	126.85	8.1	3.035	0.0	
16H-2, 75–77	128.35	5.1	3.034	0.3	
16H-3, 77–79	129.87	1.5	—		
16H-4, 75–77	131.35	1.5	3.032	1.0	
16H-6, 75–77	134.35	0.5	—		
16H-7, 75–77	135.85	3.0	3.015	6.7	
17H-1, 78–80	136.38	0.5	ND	ND	
17H-2, 75–77	137.85	0.3	—		
18X-1, 57–59	140.77	0.0	—		
18X-2, 79–80	142.49	0.0	—		
18X-3, 57–59	143.77	1.5	ND	ND	
18X-4, 57–59	145.27	0.5	ND	ND	
19X-1, 75–77	150.65	1.8	3.029	2.0	
19X-3, 75–77	153.65	0.8	ND	ND	
19X-4, 46–48	154.86	1.6	3.032		
19X-4, 75–77	155.15	1.0	ND	ND	
19X-5, 75–77	156.65	1.0	ND	ND	
20X-1, 75–77	160.35	0.5	—		
20X-3, 75–77	163.35	1.0	ND	ND	
20X-4, 75–77	164.85	0.5	—		
21X-1, 75–77	170.05	2.0	3.019	5.4	Plus traces of siderite
21X-2, 75–77	171.55	1.0	3.030	1.7	
21X-3, 75–77	173.05	1.3	ND	ND	
21X-4, 75–77	174.55	1.5	3.033	0.7	
22X-1, 55–57	179.45	0.6	—		
22X-2, 55–57	180.95	0.7	ND	ND	
22X-3, 55–57	182.45	0.6	—		
22X-5, 55–57	185.42	1.5	3.032	1.0	
311-U1329E-					
1H-1, 75–77	0.75	2.0	3.035	0.0	
1H-2, 79–81	2.29	1.0	3.030	1.7	
1H-3, 75–77	3.75	2.0	3.034	0.3	
2H-1, 75–77	5.75	3.7	3.035	0.0	
2H-2, 75–77	7.25	3.5	3.035	0.0	
2H-3, 75–77	8.75	4.5	3.034	0.3	
2H-4, 75–77	10.25	4.0	3.034	0.3	
2H-5, 75–77	11.75	8.5	3.035	0.0	

Table T2 (continued).

Core, section, interval (cm)	Depth (mbsf)	MCM (wt%)	Calcite (d_{104} Å)	$MgCO_3$ (mol%)	Remarks
2H-6, 75–77	13.25	3.5	3.032	1.0	
3H-1, 75–77	15.25	3.0	3.034	0.3	
3H-2, 75–77	16.75	3.2	3.032	1.0	
3H-3, 75–77	18.25	0.5	3.029	2.0	
3H-4, 75–77	19.75	**15.9**	3.034	0.3	Foraminifer bloom (sieved fractions)
3H-5, 75–77	21.25	4.7	3.035	0.0	
3H-6, 75–77	22.75	3.7	3.035	0.0	
4H-1, 75–77	24.75	1.0	3.028	2.3	
4H-2, 75–77	26.25	1.0	3.033	0.7	
4H-3, 78–80	27.78	6.0	3.030	1.7	
4H-4, 74–76	29.24	6.0	3.033	0.7	
4H-5, 75–77	30.75	6.5	3.035	0.0	

Notes: Dolomite present but not reported. MCM = ManoCalcimeter Mélières apparatus. ND = present but not determined, — = absent or below detection level, bold = higher carbonate values (nature of carbonate observed in smear slide or sieved fractions and reported in Remarks column).

Table T3. Carbonate content semiquantitative mineralogical composition of carbonate samples. (**See table notes.**) (**Continued on next two pages.**)

Core, section, interval (cm)	Depth (mbsf)	MCM (wt%)	Carbonate (wt%) Relative A	Relative Cc	Relative Dol	Relative (Rh) Si	Absolute A	Absolute Cc	Absolute Dol	Absolute (Rh) Si	Absolute Σ Cbt	LMMC (d_{104} Å)	LMMC (wt%)	LMMC $MgCO_3$ (mol%)	HMC (d_{104} Å)	HMC (wt%)	HMC $MgCO_3$ (mol%)	LMD (d_{104} Å)	LMD (wt%)	HMD (d_{104} Å)	HMD (wt%)
311-U1325B-																					
16X-6, 28–30	126.93	28.6		41	59			11	16		27	3.031	4		**3.003**	**7**	**10.7**	2.918	4	**2.902**	**12**
311-U1325C-																					
6X-4, 47–48	221.98	64.6		8	92			5	55		60	3.029	2		2.995	2		2.924	8	**2.895**	**47**
11X-1, 119–122	258.29	68.8		93	7			63	5		68				**3.004**	**63**	**10.4**	2.928	5		
311-U1326C-																					
2H-2, 92–93	6.32	63.5		23	77			13	46		60	**3.014**	**13**	**7.0**				**2.914**	**46**		
9X-2, 92–93	71.52	80.2		1	99			1	73		74	3.031	1							**2.900**	**73**
311-U1326D-																					
2X-1, 72–74 SED	89.12	10.2		99	1			10	tr		10	**3.016**	**6**	**6.4**	2.990	4				2.897	tr
5X-2, 5–6	118.75	67.2		4	96			2	60		62	3.035	1		2.993	1		**2.905**	**60**		
9X-1, 0–1	155.90	15.6		100				16			16				**3.009**	**16**	**8.7**				
17X-3, 0–100	235.90	16.1		100				16			16	**3.012**	**16**	**7.7**							
20X-3, 0–1	263.75	33.3		33	7	(41) 18		12	3	(15) 6	36	3.024	3		**2.994**	**9**	**13.8**	2.935	1	2.894	1
311-U1327C-																					
10H-1, 96–98	75.56	24.0		73	27			17	6		23	**3.015**	**17**	**6.7**						**2.902**	**6**
16X-2, 120–150	126.4	11.5		22	6	72		3	1	9	13	3.034	3							2.898	1
17X-CC, 13–18	136.77	66.7		83	17			54	11		66	**3.015**	**54**	**6.7**				**2.920**	**11**		
18X-2, 0–5	142.35	66.7		88	12			58	8		66				**3.003**	**58**	**10.7**	**2.920**	**8**		
18X-2, 130–150	143.65	76.0		3	97			2	68		70	3.024	1		2.986	1				**2.893**	**68**
19X-1, 75–77 SED	151.85	20.2		73	27			14	5		20	3.030	5	1.7	**3.000**	**9**	**11.7**	2.930	4	2.890	1
20X-1, 0–2	160.80	49.5		98	2			48	1		49	3.016	5		**2.988**	**44**	**15.8**	2.923	1		
20X-5, 6–7	166.14	9.4		75	17	7		7	2	1	9				**3.008**	**7**	**9.1**			2.893	2
21X-7, 0–1	178.43	81.6		1	99			1	75		76	3.028	1							**2.897**	**75**
311-U1327D-																					
5X-1, 65–75	126.95	64.2		48	52			30	32		61	**3.016**	**30**	**6.4**						**2.903**	**32**
10P-1, 0–92	155.10	85.3		4	96			3	76		79	3.031	1		2.995	2				**2.896**	**76**
10P-1, 78–80	155.88	64.2		31	69			19	42		61	**3.014**	**19**	**7.0**						**2.900**	**42**
11X-1, 0–8	157.10	67.4		6	94			4	58		62				2.989	4		**2.929**	**11**	**2.897**	**48**
16X-CC, 10–11	228.40	62.1		98	2			60	2		62	**3.019**	**60**	**5.4**				2.937	1	2.897	tr
16X-CC, 18–19	228.48	68.4		94	6			64	4		68	**3.019**	**64**	**5.4**				2.937	4	2.897	tr
311-U1328B-																					
1H-2, 8–9	1.58	29.6		82	18			24	5		29				**3.009**	**24**	**8.7**	2.936	4	2.907	1
3X-CC, 0–1	6.20	76.5	30	68	2		23	52	1		76	3.030	1		**2.986**	**51**	**16.4**	2.911	1		
4P-1, 0–11	14.50	70.4	13	72	16		9	50	11		69	3.027	3		**2.993**	**46**	**14.1**	**2.936**	**11**		
6X-1, 0–20 (A)	18.40	70.9	8	82	10		6	58	7		70	3.030	1		**2.996**	**57**	**13.1**	**2.939**	**7**		
6X-1, 0–20 (B)	18.40	71.9	8	77	14		6	55	10		71	3.020	4		**2.989**	**51**	**15.4**	**2.935**	**10**		
6X-1, 25–26	18.65	70.4		87	13			61	9		70	3.019	8	5.4	**2.984**	**53**	**17.1**	**2.936**	**9**		
6X-1, 30–31	18.70	60.2		88	12			52	7		60	3.026	4		**2.984**	**49**	**17.1**	**2.935**	**7**		
6X-1, 35–36	18.75	41.3		96	4			40	2		41	3.035	5		**2.990**	**35**	**15.1**			2.902	2
6X-1, 36–38 >250 µm	18.76	68.5	11	62	27		8	41	18		67	3.025	8	3.4	**2.993**	**33**	**14.1**	**2.935**	**18**		
6X-1, 47–50	18.87	70.9		87	13			61	9		70	3.026	4		**2.986**	**57**	**16.4**	**2.932**	**9**		
311-U1328C-																					
5P-1, 0–2	92.0?	83.7	46	48	5		39	40	5		83	3.025	1		**2.985**	**39**	**16.8**	**2.929**	**5**		
19X-4, 18–19	220.21	9.2		96	4			9	tr		9	3.035	2		**2.988**	**7**	**15.8**			2.894	tr
19X-4, 24–26	220.27	14.3		94	6			13	1		14	3.034	4		**2.998**	**9**	**12.4**			2.899	1

Table T3 (continued). (Continued on next page.)

Core, section, interval (cm)	Depth (mbsf)	MCM (wt%)	Carbonate (wt%) Relative A	Relative Cc	Relative Dol	Relative (Rh) Si	Absolute A	Absolute Cc	Absolute Dol	Absolute (Rh) Si	Absolute Σ Cbt	LMMC (d_{104} Å)	LMMC (wt%)	LMMC $MgCO_3$ (mol%)	HMC (d_{104} Å)	HMC (wt%)	HMC $MgCO_3$ (mol%)	LMD (d_{104} Å)	LMD (wt%)	HMD (d_{104} Å)	HMD (wt%)
19X-4, 26–28	220.29	50.0		80	20			39	10		49	3.023	8	4.0	**2.987**	**31**	**16.1**	**2.935**	**10**		
19X-4, 32–36	220.35	58.2		92	8			53	5		58	3.016	2		**2.998**	**51**	**12.4**	**2.935**	**5**		
22X-CC, 12–14	253.70	78.6			100				72		72									**2.887**	**72**
22X-CC, 20–21	253.78	36.2		13	87			4	29		34	3.034	4		2.990	1				**2.888**	**29**
22X-CC, 20–22	253.78	71.4		2	98			2	64		66	3.032	2							**2.890**	**64**
25X-2, 77–79	276.37	59.2		3	97			2	53		55	3.034	tr		2.992	1				**2.895**	**53**
311-U1328D-																					
1X-2, 40–42	1.90?	31.1		91	9			28	3		31	3.030	3		**2.994**	**25**	**13.8**	2.937	2	2.904	1
1X-5, 9–11	6.09?	43.4		97	3			42	1		43	3.025	3		**2.992**	**39**	**14.4**	2.925	1	2.901	1
1X-5, 10–11	6.10?	50.0		97	3			48	1		50	3.030	4		**2.993**	**45**	**14.1**	2.911	1		
1X-5, 135–150	7.35?	83.7		81	19			66	16		82				**2.989**	**66**	**15.4**			**2.902**	**16**
1X-CC, 0–5	8.10?	39.8		27	73			10	27		37	3.032	4		**2.993**	**7**	**14.1**			**2.895**	**27**
2X-2, 30–31	5.80?	67.9		30	70			19	45		64				**2.988**	**19**	**15.8**	**2.916**	**23**	**2.894**	**22**
2X-CC, 0–5	6.29?	60.7		8	92			4	52		56	3.032	2		2.999	2				**2.904**	**52**
311-U1328E-																					
2X-1, 52–54	7.02	70.4		100				70			70				**3.001**	**70**	**11.4**				
8X-1, 57–58	27.27	71.4		93	7			66	5		71	3.030	1		**2.989**	**65**	**15.4**	**2.935**	**5**		
8X-1, 97–98	27.67	67.3		96	4			64	3		67				**2.990**	**64**	**15.1**	2.931	2	2.897	tr
9X-1, 16–17	36.46	68.4		85	15			57	10		67				**2.989**	**57**	**15.4**	**2.927**	**10**		
311-U1329C-																					
4H-3, 138–140	31.48	34.6			100				32		32							**2.922**	**13**	**2.898**	**19**
4H-3, 140–142	31.50	58.6			100				54		54							**2.923**	**22**	**2.897**	**32**
5H-3, 129–131	40.89	14.7		100				15			15	**3.018**	**12**	**5.7**	2.991	3					
5H-6, 61–62	44.71	26.2		30	70			7	17		25	3.035	4		2.999	3		2.931	2	**2.905**	**15**
8H-2, 58–60	59.68	79.6		100				80			80				**2.993**	**80**	**14.1**				
8H-2, 62–64	59.72	53.9		100				54			54				**2.995**	**54**	**13.4**				
8H-2, 91–93	60.01	7.9		95	5			7	tr		8	3.035	3		**2.996**	**5**	**13.1**			2.893	tr
12H-2, 36–37	97.44	27.7		67	33			18	9		27	3.024	2		**2.995**	**16**	**13.4**	**2.933**	**7**	2.907	2
17H-1, 0–2	135.60	67.6		90	10			60	7		67	**3.031**	**23**	**1.3**	**3.004**	**37**	**10.4**	**2.944**	**5**	2.913	1
18X-2, 65–66	142.35	75.9		45	55			33	40		72	**3.016**	**33**	**6.4**				2.928	6	**2.900**	**40**
18X-2, 69–71	142.39	3.7		10	90			tr	3		3	3.028?	tr							2.900	3
18X-5, 18–20	146.38	89.0			100				82		82									**2.897**	**82**
18X-5, 27–29	146.47	80.6			100				74		74									**2.895**	**74**
19X-1, 64–66	150.54	33.0		7		93		3		35	38	3.027	3								
20X-1, 70–71	160.30	78.0		100				78			78				**3.000**	**78**	**11.7**				
20X-1, 89–90	160.49	79.6		100				80			80				**3.000**	**80**	**11.7**				
20X-1, 125–126	160.85	81.7		100				82			82				**2.997**	**82**	**12.8**				
20X-3, 34–36	162.94	80.6		100				81			81				**2.995**	**81**	**13.4**				
20X-5, 34–35	165.44	69.6		100				70			70				**2.996**	**70**	**13.1**				
20X-CC, 19–20	166.00	83.2			100				77		77									**2.896**	**77**
21X-2, 118–120	171.98	44.0		36	8	56		17	4	26	47	**3.013**	**17**	**7.4**						2.929	4
21X-3, 61–63A	172.91	49.2		96		4		48		2	49	**3.019**	**48**	**5.4**							
21X-3, 61–63B	172.91	52.9		100				53			53	**3.017**	**53**	**6.0**							
21X-3, 61–63 SED	172.91	51.0		100				51			51	**3.017**	**51**	**6.0**							
21X-3, 129–131	173.59	16.2		38		62		7		11	18	**3.011**	**7**	**8.1**							
21X-3, 129–131 Bis	173.59	63.5		18		82		13		58	71	**3.014**	**13**	**7.0**							
21X-6, 0–30	176.30	81.7		1	99			1	74		75	3.033	1							**2.894**	**74**
22X-CC, 72–74	187.75	60.3		100				60			60	**3.028**	**60**	**2.3**							

Table T3 (continued).

Core, section, interval (cm)	Depth (mbsf)	MCM (wt%)	Carbonate (wt%)									LMMC			HMC			LMD		HMD	
			Relative				Absolute														
			A	Cc	Dol	(Rh) Si	A	Cc	Dol	(Rh) Si	Σ Cbt	(d_{104} Å)	(wt%)	$MgCO_3$ (mol%)	(d_{104} Å)	(wt%)	$MgCO_3$ (mol%)	(d_{104} Å)	(wt%)	(d_{104} Å)	(wt%)
311-U1329E-																					
4H-5, 48–50	30.48	67.5		11	89			7	56		63	**3.031**	**7**	**1.3**				2.926	4	**2.902**	**52**
4H-5, 93–95	30.93	35.6		10	90			3	30		33	3.033	3					2.923	5	**2.899**	**25**
4H-5, 113–118	31.13	70.1		1	99			1	64		65	3.033	1					2.929	7	**2.901**	**57**
4H-6, 72–74 SED	32.22	42.5		5	95			2	37		39				2.988	2		2.926	4	**2.898**	**33**
8Y-1, 35–37	104.35	63.9			100				59		59									**2.894**	**59**

Notes: MCM = ManoCalcimeter Mélières apparatus, A = aragonite, Cc = calcite, Dol = dolomite, Rh = "rhodochrosite" ($d_{104} \approx$ 2.85 Å), Si = "siderite" ($d_{104} \approx$ 2.796 Å), LMMC = low- to medium-magnesium calcite, HMC = high-magnesium calcite, LMD = low-magnesium dolomite, HMD = high-magnesium dolomite. SED = standard sediment sample, Bis = more carbonated part of the sample. ? = dubious depth value, bold = most significant values, tr = traces. For distinction between LMMC, HMC, LMD, and HMC from frequency distribution of d_{104}, see Figure **F1.** $MgCO_3$ mol% not reported when calcite weight percent was too low.