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Data report: wavelength-dispersive X-ray fluorescence–based geochemical data, Site U1418, IODP Expedition 341, Gulf of Alaska¹

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Abstract

Integrated Ocean Drilling Program (IODP) Site U1418 was drilled during Expedition 341 in 2013. The site is situated on the Surveyor Fan, one of the largest deep-sea fans in the world. The site was drilled to 972 m below seafloor, and a sediment record spanning ~1.2 My was attained. For this study, 285 sediment samples were analyzed for bulk geochemical composition using wavelength-dispersive X-ray fluorescence (XRF). Records for the major elements Al, Ca, Fe, K, Mg, Mn, Na, P, Si, and Ti and minor elements As, Ba, Co, Cr, Cu, Mo, Ni, Nb, Pb, Rb, Sr, Y, V, U, Zn, and Zr are presented, as well as data for total carbon and total organic carbon analyzed by elemental analyzer.

Introduction

Integrated Ocean Drilling Program (IODP) Site U1418 is one of five sites drilled during Expedition 341 in the Gulf of Alaska and is situated on the proximal Surveyor Fan at a water depth of 3703 m (Figure F1). The 972 m cored interval analyzed here (based on a splice of samples from Holes U1418A, U1418B, U1418D, and U1418F) represents a depositional history of ~1.2 My according to the shipboard age model (Jaeger et al., 2014a). Site U1418 was primarily drilled to obtain a paleoclimate record in the Gulf of Alaska.

The chemical composition of sediment core samples can be used to investigate a broad variety of environmental or chemical processes: changes in bulk sediment composition over depth/time can reflect a change in the source area of the detrital material. Enrichment of specific elements such as Si or Ba can be associated

with organic material and caused by higher bioproductivity (Goldberg and Arrhenius, 1958; DeMaster, 1981; Von Breymann et al., 1992). Elements such as Si, Ti, and Zr can be associated with larger grain sizes (quartz) or heavy minerals (Wedepohl, 1971). Enrichments of specific diagenetically active elements (Ca, Ba, and Fe) and trace metals (Co, Cr, Cu, Mo, Ni, V, and U) in specific horizons can indicate authigenic mineral formation and thus suggest past or present diagenetic reactions (e.g., Riedinger et al., 2006; Torres et al., 1996; Wehrmann et al., 2016).

For provenance studies, general composition of multiple elements can be compared to the composition of specific lithologies on land (Haughton et al., 1991). In the Gulf of Alaska, the main lithologies delivering detrital material to the ocean are situated in the Chugach-St. Elias Coastal range, as determined for the more coast-proximal Site U1419 in geologically recent times (Barker et al., 1992; Penkrot et al., 2018). To reveal if an unusual enrichment or depletion of a specific element exists, comparison to Average Shale (Wedepohl, 1991, 1971) as a first assessment is useful.

Sedimentary carbon content can provide information on changes in carbon deposition and preservation. Changes in total organic carbon can be an indicator of variations in past bioproductivity or preservation/degradation of deposited organic material (Hedges and Keil, 1995). Inorganic carbon can indicate changes in carbonate shell deposition (e.g., from foraminifers) or formation of authigenic carbonates in diagenetically active zones (Hathaway and Degens, 1969).

Here, we present bulk inorganic geochemical data alongside total and organic carbon from Site U1418 in the Gulf of Alaska.

¹ Zindorf, M., März, C., and Schnetger, B., 2020. Data report: wavelength-dispersive X-ray fluorescence–based geochemical data, Site U1418, IODP Expedition 341, Gulf of Alaska. In Jaeger, J.M., Gulick, S.P.S., LeVay, L.J., and the Expedition 341 Scientists, *Proceedings of the Integrated Ocean Drilling Program*, 341: College Station, TX (Integrated Ocean Drilling Program). <https://doi.org/10.2204/iodp.proc.341.206.2020>

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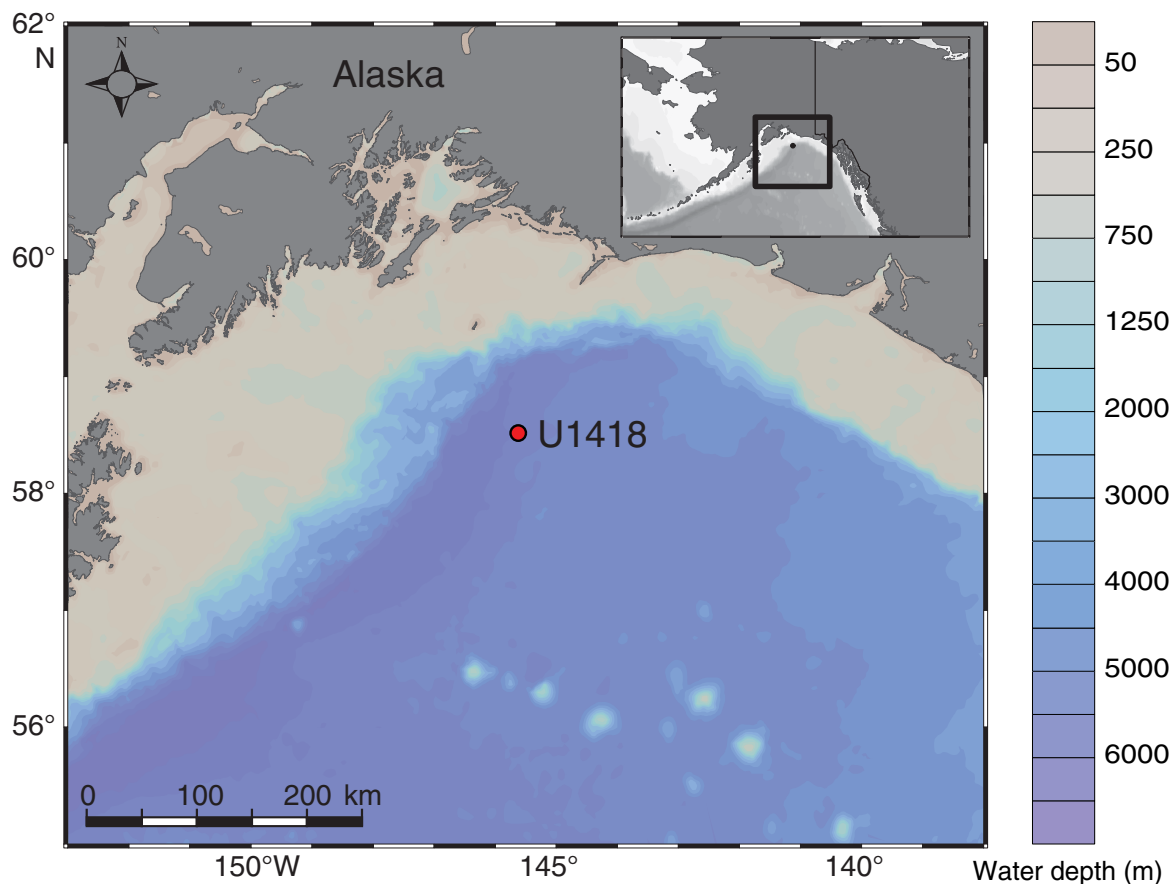
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Figure F1. Position of Site U1418 in the Gulf of Alaska. (Map created with Ocean Data View [Schlitzer, 2015]).



Methods and materials

A total of 285 sediment samples from Holes U1418A, U1418B, U1418D, and U1418F were taken on board the R/V *JOIDES Resolution* to provide a continuous sediment record over the entire cored interval. Samples are either cubes previously used for paleomagnetic analyses (179 samples) or squeeze cakes used for pore water extraction (105 samples). Thus, the individual samples integrate over different sediment intervals: a paleomagnetic cube has an edge length of 2 cm, whereas a squeeze cake covers 5–30 cm of a whole-round core. Sample type for each individual sample as well as sample length is indicated in the data set (see XRF in [Supplementary material](#)). Samples were freeze-dried and homogenized with an agate mortar and pestle. From each sample, 700 mg was mixed with 4200 mg dilithiumtetraborate, preoxidized with 1 g ammonium nitrate at 500°C and then fused to homogeneous glass beads. The glass beads were analyzed by wavelength-dispersive X-ray fluorescence (XRF) (Panalytical Axios Max, 3 kW) for major and minor elements (Si, Ti, Al, Fe, Mn, Mg, Ca, Na, K, P, As, Ba, Co, Cr, Cu, Mo, Ni, Nb, Pb, Rb, Sr, Y, V, U, Zn, and Zr). The XRF was calibrated with 52 standard reference materials (SRMs) and in-house standards. Average absolute errors are listed in Table [T1](#) along with average concentrations of each element. Major elements are reported as oxides and converted to elemental values using a conversion factor reported in Table [T1](#) (e.g., $[\text{Si}] = [\text{SiO}_2] \times 0.4674$).

Total carbon (TC) and total organic carbon (TOC) were analyzed using a Leco combustion analyzer. Total inorganic carbon

Table T1. XRF results for major and minor elements, Site U1418. [Download table in CSV format.](#)

Table T2. Carbon fraction results, Site U1418. [Download table in CSV format.](#)

(TIC) was calculated as the difference between TC and TOC. Reproducibility was better than 5% for TC and 10% for TOC, as determined by analyzing duplicates of every tenth sample. Average results can be found in Table [T2](#).

All results are presented in weight percent or parts per million of dry sediment weight. Sample depth indications are given in meters below seafloor (mbsf) on the CCSF-A (core composite depth below seafloor, as described in the [Methods](#) chapter [Jaeger et al., 2014b]) depth scale. This represents a continuous composite depth scale combining all drilled holes into a splice.

Results

Inorganic elemental geochemistry

Consistent across all geochemical data is that there are no abrupt changes or breaks observed that could be linked to distinct paleoclimatic or diagenetic events. All elements show consistently small variations throughout the core except P and Ni. In the P record, major narrow peaks exist that exceed the background signal 2- to 5-fold. These peaks could represent past diagenetically active

zones where P minerals precipitated. Nickel has a peak at 430 mbsf. This peak could represent a volcanic ash layer. However, no such layer was detected in this interval during sedimentological core description (Jaeger et al., 2014c). Most elements do not exhibit obvious upcore or downcore trends except Fe, Mg, Co, Cr, Cu, and V, which increase downcore, and Al and Zr, which show a mild downcore decrease. The minor elements Mo and Nb are close to the quantification limit and thus only take discrete values in 1 ppm steps.

Strong correlations (correlation coefficient $[r] > 0.8$) exist between elements Fe and Mg ($r = 0.85$), Fe and V ($r = 0.88$), Mg and V ($r = 0.82$), Ba and Ce ($r = 0.88$), and K and Rb ($r = 0.95$).

The general chemical composition of sediment material from Site U1418 shows no stronger similarity to Average Shale (AS);

Wedepohl, 1971) than to the composition of the Chugach Formation (CT; Barker et al., 1992). Elements such as Si, Ti, Fe, Mn, Mg, Ca, Co, and Cr are closer to AS than to CT. The elements K, Al, Nb, Rb, Sr, and U are closer to CT than to AS. For several elements, authigenic enrichments (Fe, Mn, Ca, Co, Cr, U) or a biogenic component (Si, Ca) can obscure a signal of the terrigenous source area. Except for Si and U, these elements are also more strongly enriched relative to both comparison materials, making such an interpretation plausible.

Average contents, standard deviations, minima and maxima, and quantification limits for all elements can be found in Table T1. Plots for each element are shown in Figures F2 (major elements) and F3 (minor elements).

Figure F2. Major element composition of Site U1418 sediment samples: Ti, Si, Al, Fe, Mn, Mg, Ca, Na, K, and P. Blue dashed vertical line = Average Shale content except for Mg, Na, and K (out of range) (Wedepohl, 1971, 1991), red dashed vertical line = Chugach Terrane average content except for Si, Ti, Fe, and Mg (out of range). Blue and red arrows = direction and magnitude of out of range reference values (Barker et al., 1992). See Table T1 for comparison.

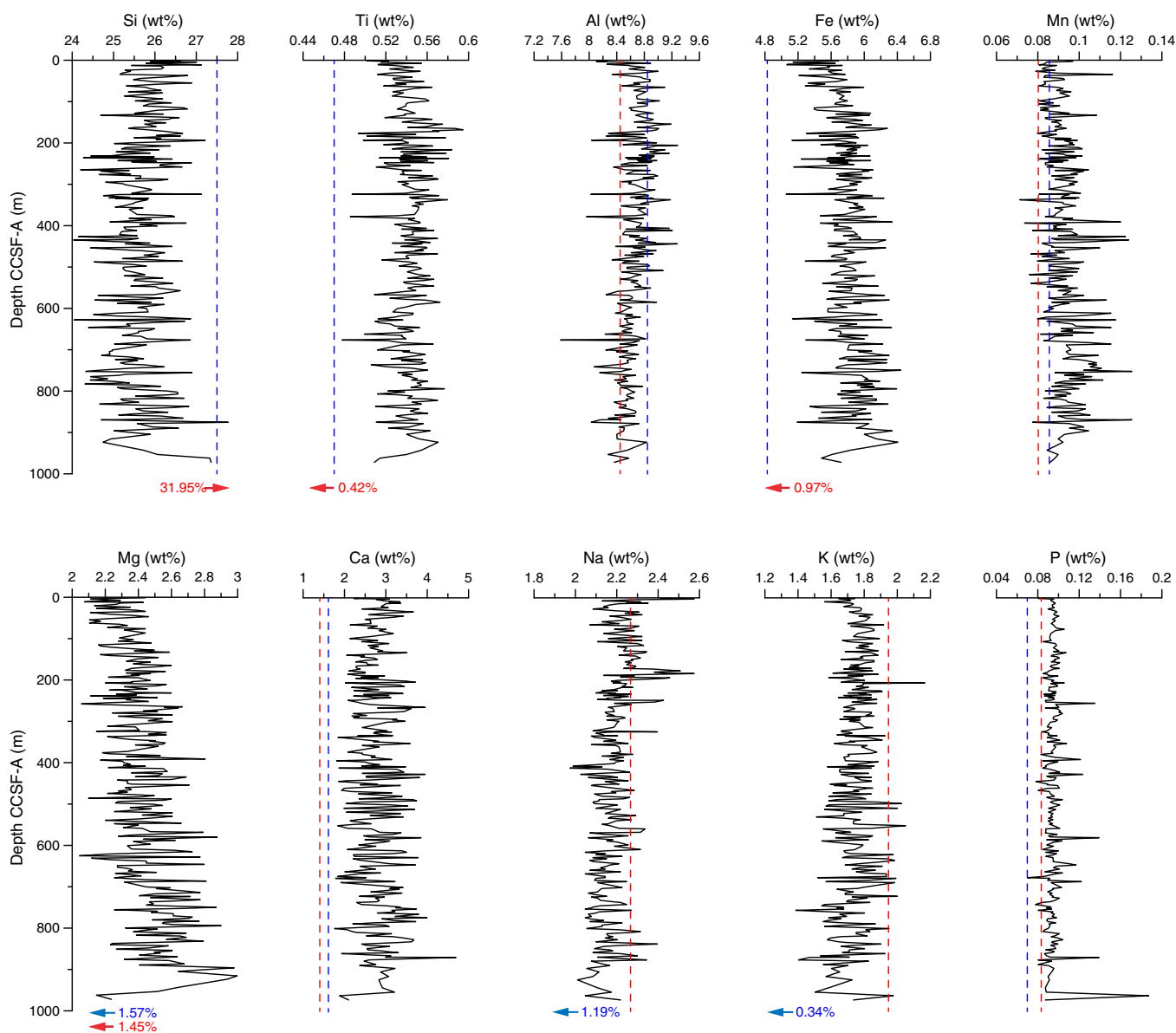


Figure F3. Minor element composition of Site U1418 sediment samples: As, Ba, Co, Cr, Cu, Mo, Ni, Nb, Pb, Rb, Sr, Y, U, V, Zn, and Zr. Blue dashed vertical line = Average Shale content except for Nb, Pb, Rb, V, and Zr (out of range) (Wedepohl, 1971, 1991), red dashed vertical line = Chugach Terrane average content except for Cr, Ni, and Zr (out of range) and As, Mo, Pb, and V (not reported). Blue and red arrows = direction and magnitude of out of range reference values (Barker et al., 1992). Sum of concentration indicates the proportion of total sediment by here analyzed elements. Difference from 100% is loss on ignition (LOI). See Table T1 for comparison.

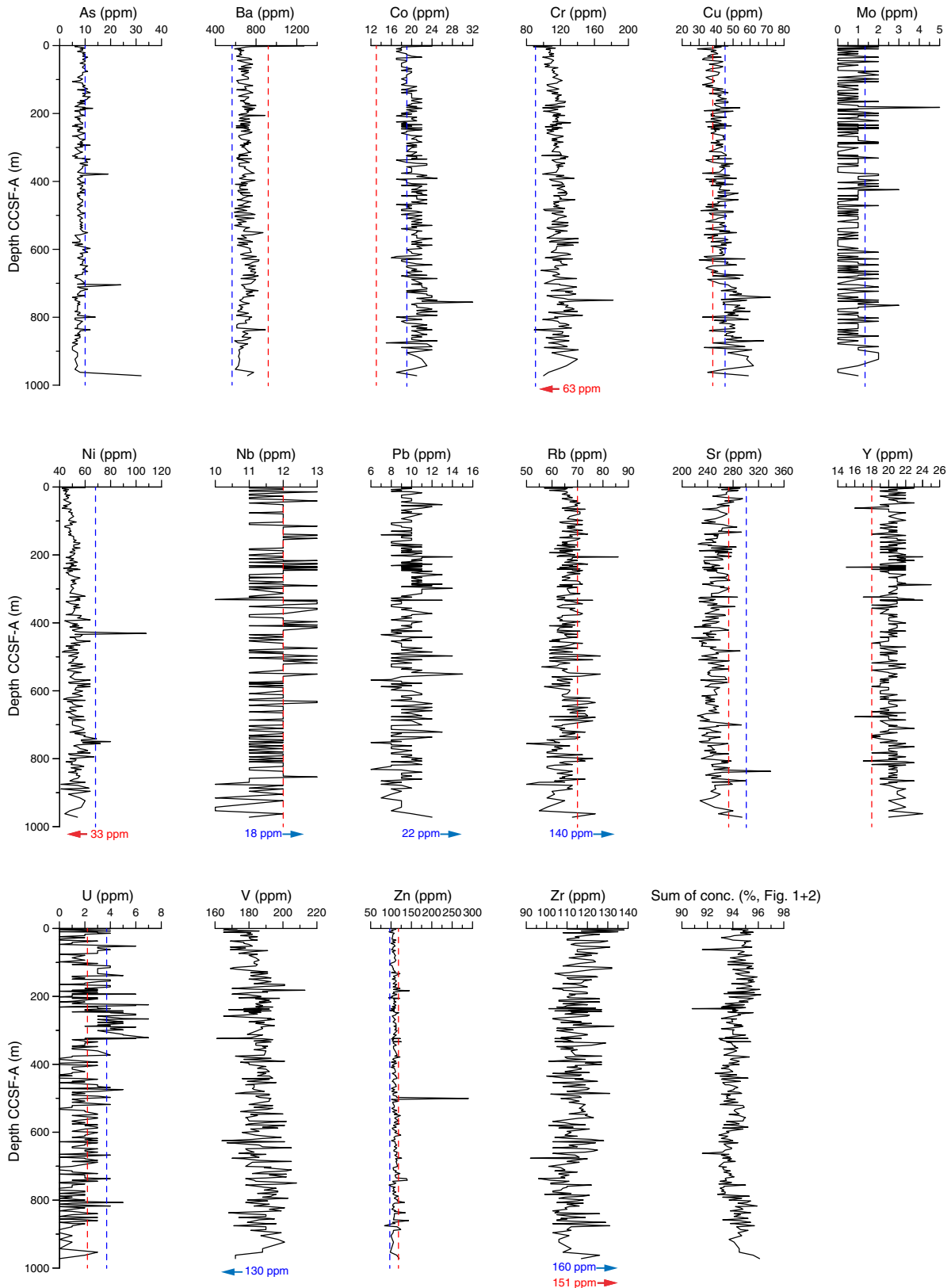
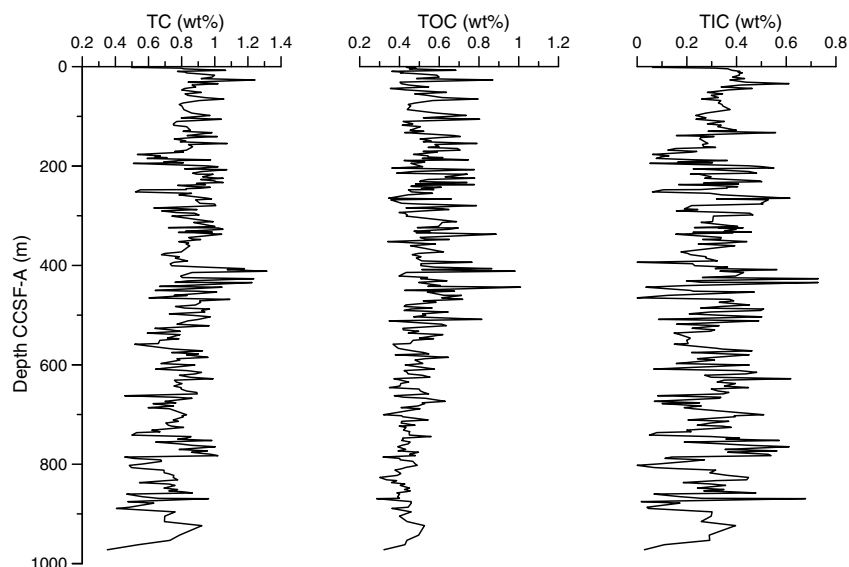


Figure F4. Carbonate composition in Site U1418 sediment samples: total carbon (TC), total organic carbon (TOC), and total inorganic carbon (TIC). See Table T2 for comparison.



Inorganic and organic carbon

Total carbon generally decreases from ~1 wt% at the top of the core to ~0.8 wt% at the bottom (Figure F4). Intersample variability is generally higher than the overall trend. TOC decreases from core top to bottom from ~0.5 to ~0.3 wt%. The variability decreases below 500 mbsf. TIC, which is the difference between TC and TOC, has values ~0.4 wt% and varies between 0 and 0.7 wt%. TIC does not exhibit a downcore trend or an observable change in variability. Thus, it can be assumed that the downcore decrease in TC is dominantly caused by decreasing TOC contents. This could be caused either by variations in organic matter deposition or by the slow microbial conversion of refractory organic matter to natural gas (see methane profile in Jaeger et al., 2014c).

Average contents, minima, and maxima for each carbon fraction can be found in Table T2.

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