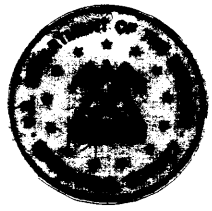
U.S. DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY



# ANALYSIS OF TRACE METALS IN BOTTOM SEDIMENTS IN SUPPORT OF DEEPWATER BIOLOGICAL PROCESSES STUDIES ON THE U.S. MID-ATLANTIC CONTINENTAL SLOPE AND RISE

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U.S. Minerals Management Service under
Interagency Agreement No. 14-12-0001-30197

[1]Woods Hole, MA
[2]Reston, VA

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# ANALYSIS OF TRACE METALS IN BOTTOM SEDIMENTS IN SUPPORT OF DEEPWATER BIOLOGICAL PROCESSES STUDIES ON THE U.S. MID-ATLANTIC CONTINENTAL SLOPE AND RISE

FINAL REPORT

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## ABSTRACT

This study is part of a multidisciplinary program conducted on the continental slope and rise off the North, Middle, and South Atlantic states to characterize the biology, chemistry, and geology of the sea floor. The specific objectives are to measure and evaluate the extent of environmental changes which relate to exploratory drilling activities. In this report we use trace-metal concentrations to assess both the depositional pattern and fate of discharged drilling mud.

Sediment samples collected during six cruises to the continental slope and rise off the Mid-Atlantic states have been analyzed for 12 metals [aluminum (Al), barium (Ba), cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), lead (Pb), manganese (Mn), mercury (Hg), nickel (Ni), vanadium (V), and zinc (Zn)]. We found that Ba was the only metal that showed an increase as a result of drilling, and the magnitude of the Ba increase was small (<32%). In one core collected during Cruise 3 at Station 1, adjacent to the drilling site

in Block 372, the Ba concentration in the surface sediment was 13 percent higher than measured deeper in the core. Concentrations of Ba in one of the three replicate surface sediments from Cruise 6, Station 1, were 20 percent higher than concentrations in deeper sediments. Neither samples from other replicate box cores from Cruise 3 or from Cruise 6, Station 1, nor replicate sub-cores from the same box core, show the same increase, indicating a patchy distribution of drilling-related Ba. There is no consistent trend of increasing Ba concentration in blended surface sediment from Station 1, Cruises 1 to 6. The average concentrations of Ba at Station 1 are similar to concentrations at stations away from drilling rigs and in sediments having similar grain size.

At stations 13 and 14, located within 1.4 km of the drilling in Block 93, no significant changes in the average Ba concentration of bottom sediments were measured between predrilling and postdrilling samples.

The barium increases are probably not harmful to benthic organisms on the basis of the low enrichments, the patchy distribution, and the low toxicity of $BaSO_4$ (based on its use in medicine).

The strongest Ba signal from drilling mud was measured in sediments collected in sediment traps positioned in the upper 850 m of the water column at a mooring located 2.4 km southwest of the drilling rig in Block 372. Discrete particles of barite were identified in the sample using a scanning electron microscope equipped with an energy dispersive X-ray detector. The larger particles have dimensions of 60 x 90 μm. Their transport from the drilling rig to the sediment trap mooring is predictable given a calculated settling velocity and the measured currents.

For samples collected from the study area during Cruise 1, the distribution of metals in surface sediments appears to vary with the changes in the concentrations of fine sediment and organic carbon. The concentrations of the metals analyzed in these sediments are the same or lower than they are in average shales from around the world, and are characteristic of uncontaminated sediments. The highest concentration (555 ppm) of Ba measured in sediments at Station 1 is less than the concentration in average shales (580 ppm).

Pb concentrations are consistently higher in the upper 5-10 cm of sediment than in deeper sections of sediment cores, but the average values in surface sediments do not exceed those measured in average shales. Pb enrichment in surface sediments has been observed at other locations off the U.S. East Coast and is thought to be related to the onshore burning of gasoline containing Pb additives. The inventories of anthropogenic lead in the sediments of this study area are higher than are predicted from long-term atmospheric fluxes. This suggests enhanced deposition of lead in these sediments.

## INTRODUCTION

This U.S. Geological Survey (USGS) study was designed to establish the concentrations of trace metals in sediments prior to petroleum exploration drilling on the continental slope and rise off the U.S. Middle Atlantic States, and to quantify changes in trace-metal concentrations that are related to exploration activities. Some of the specific questions addressed during this three-year sampling and analysis program are: (1) Where do discharged drilling muds accumulate on the continental slope and rise? and (2) How much do trace metals increase as a result of accumulating drilling mud?

This study is part of a cooperative, multidisciplinary program that is managed and funded by the U.S. Minerals Management Service. The overall goal is to evaluate potential adverse effects of drilling effluents on bottom-dwelling organisms. Other major components of the program include studies of infaunal and epifaunal communities, hydrocarbon concentrations in sediments and organisms, trace-metal concentrations in organisms, sediment texture, and hydrography. These studies will be accomplished under separate contracts awarded to Battelle New England Marine Research Laboratory, Woods Hole Oceanographic Institution (WHOI), and Lamont-Doherty Geological Observatory. Study areas on the continental slope and rise off both the South and North Atlantic states are included in the overall program.

Fourteen station locations were selected on the Mid-Atlantic continental slope and rise (Fig. 1). This station array was established on the premise that drilling mud will be transported by currents over long distances before being deposited. The mean current flow on the continental slope (about 5 cm/s to the southwest) and currents generated by winds and Gulf Stream rings are generally parallel to isobaths (Beardsley and others, 1985; Butman, 1985) and can be in the direction opposite to the mean flow. Tidal currents induce periodic flows across isobaths. In response to this current regime, ten of the stations are arranged along the 2,100-m isobath centered around the drilling site at Station 1. Stations 11, 1, and 12 represent a transect across the slope. Station 13 is located 1.3 km southwest of the drill site in Block 93. Station 14 was located on the drilling site in Block 93 and was not sampled during cruises 2 and 3 while the drill rig was on location.

These stations were sampled three times per year for a two-year period. The first cruise was conducted in March 1984 (Leg 1) and May 1984 (Leg 2). Other cruises were conducted in August 1984, November 1984, May 1985, August 1985 and November 1985.

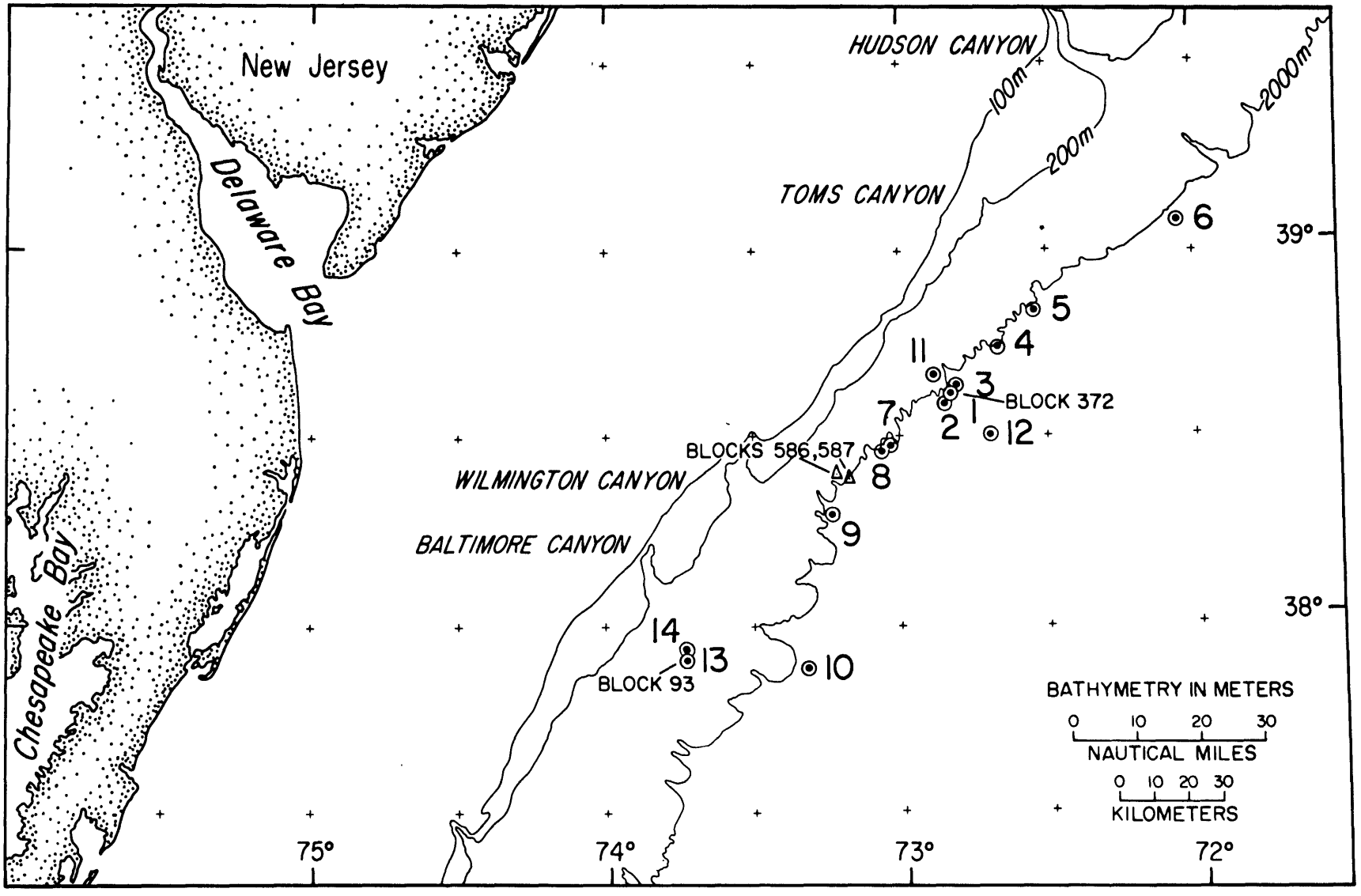


Figure 1. Station locations on the continental slope and rise off the Middle Atlantic states.

Cruise 1 predated the drilling activity in Lease Blocks 372 and 93. However, exploratory drilling had already taken place in this general area at the time of Cruise 1. Two wells had been completed approximately 60 km southwest of Station 1 (Blocks 586 and 587), and 28 wells were drilled on the continental shelf off the Mid-Atlantic states between April 1978 and October 1981.

## FIELD SAMPLING AND SAMPLE PREPARATION

Positioning of the ship at each sampling location was based on time delays within the Loran-C navigation network read by a Northstar 6000 receiver (Digital Marine Equipment Corp., Bedford, Mass.). Latitude and longitude values listed in Appendix Table 1 were calculated using updated additional secondary factor corrections (McCullough and others, 1982, 1983). The accuracy of collecting a sample at a given location is more dependent upon wind and current conditions than on the navigation system. Replicate samples collected at a given station typically fall within a circle having a diameter of 400 m.

A 0.25-$m^2$ box core, manufactured by Ocean Instruments, Inc., San Diego, Calif., was used to collect sediment samples for this study. The box was divided into 25 subcores of 0.01 $m^2$ each. Three box cores were collected at each station. Two and occasionally three of the subcores from each box core were allocated for trace-metal studies. Surfaces of the aluminum subcores were precoated with teflon as a precaution against metal contamination. At sea, an acid-cleaned round plastic tube, 8.2 cm internal diameter (ID), was pushed into the center of the sediments collected in the teflon subcores, thereby sampling material not in contact with the coring apparatus. These tubes were capped at both ends and frozen. The length of the core samples averaged 24 cm and typically ranged from 19 to 32 cm.

Surficial sediment was sampled by partially extruding the frozen sediment from the core barrel and cutting off the top 2 cm of the sediment with a plastic utensil. To generate a blend from a single station, the material from the upper 2 cm of each of three replicates was thawed, homogenized by stirring and shaking in a closed container, and then subsampled with a syringe constructed of glass and teflon.

On selected samples, sand and coarser material were removed by washing the wet sample through a 60-μm nylon sieve using filtered distilled water. The resultant slurry was dried at <70°C in an oven having teflon-coated surfaces and a filtered nitrogen atmosphere.

Cores from selected stations were subsampled in sequential 2-cm depth intervals so that the concentration profile of metals could be measured over increasing sediment depth. The frozen cores were extruded into a holding tray, thawed overnight, and cut into 2-cm depth intervals using plastic utensils. These samples, from which some of the interstitial water had drained while thawing, were subsequently oven dried. On the basis of trace metal concentrations in interstitial water reported by Lyons and Fitzgerald (1983), less than 0.05 percent of the metal in bulk sediment is lost with the drained interstitial water.

All samples prepared for trace-metal analysis were ground using an agate grinding mill.

The field numbers (for example, C10123 and C21300) that identify samples in each data table have the following code: The first two characters define the cruise as occurring in the Mid-Atlantic region; the second two characters are the station number; the fifth character is the replicate box core number; and the sixth character is the core number within the box core. The use of "00" for the fifth and sixth characters indicates that the sample is a

homogenized mixture of subsamples from each of three replicate box cores. Digits in the seventh and eighth space indicate the bottom of a 2-cm-thick depth interval; where these are missing, the 0 to 2-cm interval is implied. The letter "X" at the end of the field number indicates that the fraction of sediment coarser than 60 μm has been removed from the sample.

The USGS prepared thirteen sediment traps for deployment by Science Applications International Corporation (SAIC) near the drilling site in Block 372. Two sizes of traps were used. Ten of the traps were constructed from clear polybuterate tubing 6.6 cm ID and 60 cm length. The other traps were constructed from molded fiberglass. They were cone shaped, and had a mouth diameter of 50 cm, tapering to a 2-cm-ID sample collection tube. All the trap openings were fitted with baffles to prevent occupation by fish and other large organisms and to reduce turbulence in the traps. The baffles, which had a cell diameter of 1 cm and a length of 7.5 cm, were constructed of an aramid fiber/phenolic resin (HEXCELL). Details of the trap design and relative collection efficiencies are described in Bothner and others, 1987.

## TRACE-METAL ANALYSES PROCEDURES

The analyses of trace metals in these marine sediments were carried out by the U.S. Geological Survey laboratories in Reston, Va. Concentrations of the following elements were determined: Al, Ba, Cd, Cr, Cu, Fe, Hg, Mn, Ni, Pb, V, and Zn. The various procedures employed in each of the analyses are detailed below and summarized in Table 1.

### Preparation of stock solution A

Exactly 0.5 g of ground bulk sediment or 0.2 g of the fine fraction was added to a covered teflon beaker and digested overnight in 5 mL of $HClO_4$, 5 mL

Table 1. Summary of analytical conditions.

| Element | Instrument | Instrument conditions | Extraction procedure | Procedure determination limit in sample, µg/g | Average blanks, as measured in µg/g in solution |
|---|---|---|---|---|---|
| Al | ICP (argon) | 308.2 nm<br>FP (Forward power)=1.1 kw<br>Fixed cross flow nebulizer<br>Spectral band width 0.036 nm<br>Observation height 16 mm. | None | 50 | 0.02 |
| Ba | ICP (argon) | 455.4 nm<br>FP=1.1 kw<br>Fixed cross flow nebulizer<br>Spectral band width 0.036 nm<br>Observation height 16 mm. | None | 20 | .01 |
| Cd | Graphite furnace AA. | 110°C dry temperature<br>250°C char temperature<br>2100°C atom temperature<br>Regular graphite tube<br>Interrupt gas flow<br>W.l.=228.8 nm<br>Slit=0.7 nm. | Butyl acetate and DDTC. | 0.02 | .0002 |
| Cr | Graphite furnace AA. | 110°C dry temperature<br>850°C char temperature<br>2700°C atom temperature<br>Pyrolytic tube<br>Normal gas flow (low)<br>W.l.=357.9 nm<br>Slit=0.7 nm. | None | 2 | .003 |
| Cu | Graphite furnace AA. | 110°C dry temperature<br>850°C char temperature<br>2700°C atom temperature<br>Regular graphite tube<br>Interrupt gas flow<br>W.l.=324.7 nm<br>Slit=0.7 nm. | Butyl acetate and DDTC. | 1 | .005 |
| Fe | ICP (argon) | 259.9 nm<br>FP=1.1 kw<br>Fixed cross flow nebulizer<br>Spectral band width 0.036 nm<br>Observation height 16 mm. | None | 50 | .02 |
| Hg | Induction furnace AA. | Wavelength=254 nm<br>Cold vapor AA. | None | .005 | .005 |
| Mn | ICP (argon) | 257.6 nm<br>FP=1.1 kw<br>Fixed cross flow nebulizer<br>Spectral band width 0.036 nm<br>Observation height 16 mm. | Butyl acetate (removal of iron). | 10 | .006 |
| Ni | Graphite furnace AA. | 110°C dry temperature<br>900°C char temperature<br>2700°C atom temperature<br>Pyrolytic tube<br>Normal gas flow (low)<br>W.l.=232.0 nm<br>Slit=0.2 nm. | None | 2 | .02 |
| Pb | Graphite furnace AA. | 110°C dry temperature<br>500°C char temperature<br>2700°C atom temperature<br>Regular graphite tube<br>Interrupt gas flow<br>W.l.=283.3<br>Slit=0.7 nm. | Butyl acetate and DDTC. | 1 | .02 |
| V | Graphite furnace AA. | 110°C dry temperature<br>1000°C char temperature<br>2800°C atom temperature<br>Pyrolytic curtained tube<br>Normal gas flow (high)<br>W.l.=318.4 nm<br>Slit=0.7 nm. | None | 2 | .002 |
| Zn | Flame AA. | Oxidizing; air-acetylene flame<br>W.l.=213.9<br>Slit=0.7 nm. | Butyl acetate | 1 | .01 |

of $HNO_3$, and 13 mL of HF at approximately 140°C. The covers were removed and the temperature was increased to between 180° and 190°C, first producing fumes of $HClO_4$ and then evaporating the solution to dryness. The residue was dissolved and diluted to exactly 25 mL using 8 N HCl. This solution is referred to as stock solution A.

Two blanks containing all reagents were analyzed along with samples. All reagents were analyzed for contaminants prior to use, as is always necessary. The Canadian reference sediment standard MESS-1 was analyzed in each set of samples. A series of solutions was prepared that approximated the concentration levels expected in the samples; this series was used as the standard in calibrating the inductively coupled plasma (ICP) spectrometer and atomic absorption (AA) spectrophotometer.

Preparation of stock solution B

Stock solution B was made by adding 10 mL of butyl acetate (distilled to remove impurities such as copper) to 15 mL of stock solution A in a 60-mL separatory funnel. This solution was vigorously agitated by an automatic shaker for six minutes to extract iron. The layers were separated, and the extraction step was repeated with an additional 10 mL of butyl acetate. The aqueous layer was evaporated to dryness at 150°C in a 50-mL beaker. The residue was dissolved and diluted to 25 mL by adding 1 N HCl.

Barium

The measurements for Ba were made by ICP spectrometry using 2 mL of stock solution A diluted with distilled $H_2O$ to 4 mL.

Aluminum, iron, chromium, nickel, and vanadium

Concentrations of Al and Fe were determined by ICP spectrometry by using 1 mL of stock solution A diluted to 10 mL with distilled $H_2O$. The measurements for Cr, Ni, and V were made by injecting 20 µL of diluted (1:10) stock solution A into a graphite-furnace AA spectrophotometer.

Lead, copper, and cadmium

Fifteen mL of 0.5-percent (weight:volume) diethyldithiocarbamic acid diethylammonium salt (DDTC) in chloroform were added to 10 mL of solution B in a 60-mL separatory funnel and mixed for 10 minutes by an automatic shaker. The chloroform layer was drained into a 30-mL beaker and the aqueous layer washed with 10 mL of chloroform. The second chloroform layer was combined with the first, and the total volume of chloroform was evaporated to dryness at 90°C. The organic matter was destroyed by adding 0.1 mL of concentrated $HNO_3$ and the solution was evaporated to dryness. This residue then was dissolved in 2 mL of warm 1 N HCl. The beaker was rinsed four times with 2 mL portions of distilled $H_2O$, and the solution was transferred to a small polyethylene container. The measurements for Pb, Cu, and Cd were made by injecting 20 µL of the final solution into a graphite-furnace AA spectrophotometer.

Manganese and zinc

The measurements for Mn were made by ICP spectrometry with a solution made by diluting 2 mL of stock solution B to 4 mL by adding distilled $H_2O$. Zinc was measured by flame AA directly from stock solution B.

Mercury

Mercury concentration was determined on a separate portion of the sample. Two hundred milligrams of sediment were decomposed in a 1-oz teflon screw-top vial using 2 mL of concentrated $HNO_3$ (J. T. Baker Chemical Co.) and 2 mL of $HClO_4$ (G. Frederick Smith Chemical Co. -- double distilled from Vycor, a pure silica glass). The mixture was heated in a capped vial until the solution reached 200° C. The solution was then heated with the cap off for about 45 minutes, after which the samples were removed from the heat source. Immediately, 1 mL of concentrated $HNO_3$ was added; the vial was filled with distilled $H_2O$ and capped tightly until used. This sample solution was added to a flask containing 125 mL of $H_2O$ and 4 mL of 10 percent (weight:volume) $SnCl_2$ in 20 percent HCl. Nitrogen was passed through the solution to remove elemental Hg, which was collected on gold foil located in the center of the coils of an induction furnace. Activation of the furnace released the Hg, which was measured by a cold-vapor AA technique. Blanks, standard rocks, and internal sediment standards were analyzed for each set of samples. A series of solutions was prepared that had the same Hg concentration range expected in the samples.

## TEXTURAL ANALYSIS PROCEDURES

Sediment samples selected from different depth horizons within the box cores were analyzed for texture by the standard pipette method (Folk, 1974). The specific procedures were essentially identical to those used by other contractors within this program (Maciolek and others, 1987). The textural results are reported in phi units ($-\log_2 D$) where D is the grain diameter in millimeters.

## ANALYTICAL ACCURACY AND PRECISION

Analytical accuracy was determined by analyzing rock standard MESS-1. The metals are within one or, at most, two standard deviations of the "best value" determined for this sediment standard (Table 2A). A new fine-grained sediment standard, established for the Georges Bank Monitoring Program by Bothner and others (1983), also has been used during this program (B series, Table 2A).

In our second interim report we discussed a systematic increase in the Cr data generated on standards and samples after a pyrolitically coated graphite tube was installed in the graphite furnace. Chromium values for the standard MESS using the original non-coated graphite tube averaged 47.7 ±0.5 ppm; values obtained with the pyrolitically coated tube averaged 63.1 ±4.3 ppm. The latter value is within the published acceptable range for Cr (71 ±11 ppm).

Using a new graphics display, we were able to observe the Cr peak shapes of sediment standards and liquid standards. With the graphite tube, which is more porous than the pyrolytically coated tube, sediment standards had a broader peak than pure liquid standards. The interpretation is that some of the analyzed solution evaporated within the fabric of the graphite tube and that the residual salts slightly retarded the release of Cr during the heating cycle. The liquid standards having less salt were not affected. Both liquid and sediment standards give the same shape with the pyrolytically coated tube, which is glazed and nonporous.

We corrected the Cr data generated using the graphite-tube furnace by basing the Cr signal on the sediment standards that were run with each batch of samples rather than on the liquid standards. To confirm the calculation, we reanalyzed 11 samples using a furnace equipped with the pyrolytically coated tube. In all but one sample, the calculated correction agreed with the new data at the 99 percent level of confidence (t test).

Table 2A. Analysis of sediment standard.

| Sediment Standard | Al (%) | Ba (ppm) | Cd (ppm) | Cr (ppm) | Cu (ppm) | Fe (%) | Hg (ppm) | Mn (ppm) | Ni (ppm) | Pb (ppm) | V (ppm) | Zn (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MESS-1----- | 5.30 | 280 | 0.46 | 64[1] | 27 | 2.9 | - | 470 | 35 | 28 | 70 | 170 |
| | 5.70 | 260 | .43 | 65[1] | 21 | 2.9 | - | 470 | 31 | 31 | 71 | 180 |
| | 5.40 | 260 | .45 | 65[1] | 23 | 2.8 | - | 480 | 37 | 29 | 73 | 200 |
| | 5.30 | 280 | .46 | 64[1] | 27 | 2.9 | - | 470 | 35 | 28 | 70 | 170 |
| | 5.70 | 260 | .43 | 65[1] | 21 | 2.9 | - | 470 | 31 | 31 | 71 | 180 |
| | 5.40 | 260 | .45 | 65[1] | 23 | 2.8 | - | 480 | 37 | 29 | 73 | 200 |
| | 5.41 | 258 | .48 | 65 | 23 | 2.78 | - | 469 | 35 | 31 | 85 | 174 |
| | 4.89 | 259 | .42 | 61 | 25 | 2.80 | - | 483 | 31 | 25 | 80 | 178 |
| | 5.06 | 259 | .41 | 61 | 28 | 2.85 | - | 489 | 34 | 27 | 74 | 186 |
| | 5.38 | 257 | .50 | 59 | 25 | 2.81 | - | 481 | 31 | 32 | 85 | 187 |
| | 5.21 | 256 | .40 | 62 | 24 | 2.79 | - | 476 | 34 | 32 | 85 | 184 |
| | 5.61 | 277 | .46 | 66 | 22 | 2.97 | - | 485 | 32 | 31 | 80 | 200 |
| | 5.27 | 278 | .40 | 65 | 23 | 2.86 | - | 476 | 34 | 33 | 80 | 173 |
| | 4.83 | 259 | .39 | 73 | 23 | 2.84 | .14 | 458 | 35 | 26 | 74 | 178 |
| | 5.41 | 258 | .44 | 69 | 25 | 2.86 | .20 | 474 | 34 | 26 | 76 | 179 |
| | 5.65 | 263 | .43 | 57 | 25 | 2.87 | .20 | 469 | 37 | 23 | 73 | 176 |
| | 5.73 | 265 | .44 | 57 | 24 | 2.87 | .20 | 480 | 38 | 27 | 70 | 174 |
| | 5.28 | 259 | .44 | 62 | 24 | 2.87 | .20 | 471 | 36 | 26 | 85 | 174 |
| | 5.05 | 263 | .43 | 62 | 24 | 2.84 | - | 472 | 37 | 25 | 88 | 174 |
| | 4.94 | 276 | .45 | 62 | 23 | 2.83 | - | 476 | 37 | 25 | 86 | 176 |
| | 5.43 | 264 | .44 | 65 | 24 | 2.86 | - | 494 | 40 | 27 | 88 | 173 |
| $\bar{x}$---- | 5.32 | 263 | .44 | 63.1 | 24.2 | 2.85 | .19 | 475 | 35 | 27.8 | 77.7 | 180 |
| σ----- | .27 | 7 | .03 | 4.3 | 1.8 | .04 | .03 | 8 | 2.6 | 2.7 | 6.9 | 9 |
| CV(%)[2]- | 5.1 | 2.8 | 5.9 | 6.8 | 7.6 | 1.4 | 14 | 1.7 | 7.4 | 9.6 | 8.9 | 4.8 |
| Best value[3] | 5.8 | 270 | .59 | 71 | 25 | 3.0 | - | 513 | 30 | 34 | 72 | 191 |
| σ--------- | .2 | - | .1 | 11 | 4 | .2 | - | 25 | 3 | 6 | 5 | 17 |
| B-10[4] | 3.4 | 280 | .066 | 43[1] | 6.3 | 1.6 | .015 | 290 | 12 | 17 | 40 | 40 |
| B-12 | 3.5 | 270 | .063 | 44[1] | 6.0 | 1.6 | - | 290 | 20 | 15 | 38 | 40 |
| B-11 | 3.7 | 270 | .060 | 46[1] | 5.8 | 1.7 | .015 | 300 | 10 | 15 | 38 | 42 |
| | 3.4 | 269 | .066 | 50 | 6.1 | 1.65 | .015 | 289 | 11 | 17 | 41 | 44 |
| | 3.11 | 268 | .071 | 46 | 6.0 | 1.60 | .015 | 281 | 10 | 17 | 43 | 37 |
| | 3.11 | 260 | .088 | 47 | 5.0 | 1.62 | .015 | 286 | 12 | 14 | 40 | 38 |
| | 3.62 | 269 | .073 | 42 | 6.1 | 1.64 | .015 | 282 | 14 | 14 | 44 | 35 |
| | 3.22 | 264 | .083 | 47 | 5.5 | 1.62 | .015 | 278 | 11 | 13 | 46 | 40 |
| | 3.12 | 270 | .075 | 43 | 6.6 | 1.60 | .015 | 287 | 14 | 13 | 41 | 43 |
| | 3.46 | 260 | .058 | 40 | 6.0 | 1.65 | .015 | 299 | 14 | 13 | 46 | 40 |
| $\bar{x}$---- | 3.39 | 268 | .071 | 45 | 5.9 | 1.63 | .015 | 289 | 13.4 | 14.2 | 41.6 | 39.8 |
| σ----- | .22 | 7 | .011 | 3.5 | .5 | .03 | 0 | 8 | 3.1 | 1.4 | 3.3 | 2.4 |
| CV(%)[2]- | 6.6 | 2.4 | 15 | 7.7 | 8.3 | 2.1 | 0 | 2.6 | 23 | 9.7 | 7.9 | 6.1 |

1 Corrected Cr values
2 Coefficent of variation
3 Values reported by the Marine Analytical Chemistry Program, National Research Council, Canada.
4 A fine-grained sediment standard collected from station 13 of the Georges Bank Monitoring Program (Bothner and others, 1983).

Table 2B. Analysis of replicate sediment samples.

| Sample Replicate | Al (%) | Ba (ppm) | Cd (ppm) | Cr (ppm) | Cu (ppm) | Fe (%) | Hg (ppm) | Mn (ppm) | Ni (ppm) | Pb (ppm) | V (ppm) | Zn (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C11311 | 5.7 | 420 | .095 | 83[1] | 27 | 3.2 | - | 810 | 50 | 24 | 87 | 76 |
| W-228624 | 5.7 | 430 | .075 | 79 | 27 | 3.2 | - | 800 | 50 | 22 | 87 | 76 |
| | 5.7 | 420 | .083 | 83 | 26 | 3.2 | - | 800 | 48 | 22 | 90 | 76 |
| | 5.7 | 410 | .095 | 82 | 26 | 3.2 | - | 780 | 49 | 22 | 90 | 76 |
| | 5.7 | 420 | .091 | 84 | 27 | 3.2 | - | 790 | 49 | 22 | 87 | 78 |
| $\bar{x}$--- | 5.7 | 420 | .09 | 82.2 | 26.6 | 3.2 | - | 796 | 49.2 | 22.4 | 88.2 | 76.4 |
| σ---- | 0 | 7 | .01 | 1.9 | .5 | 0 | - | 11 | .8 | .9 | 1.6 | .9 |
| CV(%)[2]-- | 0 | 1.7 | 11.1 | 2.3 | 7.9 | 0 | - | 1.2 | 1.6 | 4.0 | 1.8 | 1.2 |

| Sample Replicate | Al (%) | Ba (ppm) | Cd (ppm) | Cr (ppm) | Cu (ppm) | Fe (%) | Hg (ppm) | Mn (ppm) | Ni (ppm) | Pb (ppm) | V (ppm) | Zn (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C1142202 | 5.98 | 414 | .066 | 73 | 24 | 3.25 | .070 | 576 | 53 | 15 | 95 | 83 |
| W-233733 | 5.99 | 413 | .063 | 72 | 23 | 3.25 | .070 | 575 | 53 | 14 | 98 | 83 |
| | 5.96 | 413 | .063 | 73 | 23 | 3.23 | .070 | 574 | 53 | 14 | 85 | 83 |
| | 6.00 | 418 | .063 | 72 | 24 | 3.24 | .060 | 576 | 50 | 14 | 85 | 83 |
| | 5.96 | 426 | .063 | 73 | 24 | 3.21 | .070 | 578 | 53 | 15 | 85 | 83 |
| $\bar{x}$--- | 5.98 | 417 | .064 | 72.6 | 23.6 | 3.24 | .068 | 576 | 52.4 | 14.4 | 89.6 | 83 |
| σ---- | .02 | 5 | .001 | .5 | .5 | .02 | .004 | 1 | 1.3 | .5 | 6.4 | 0 |
| CV(%)[2] | .3 | 1.3 | 2.1 | .8 | 2.3 | .5 | 6.6 | .3 | 2.6 | 3.8 | 7.1 | 0 |

| Sample Replicate | Al (%) | Ba (ppm) | Cd (ppm) | Cr (ppm) | Cu (ppm) | Fe (%) | Hg (ppm) | Mn (ppm) | Ni (ppm) | Pb (ppm) | V (ppm) | Zn (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C20131 | 5.0 | 390 | .042 | 68[1] | 16 | 3.0 | - | 670 | 40 | 14 | 90 | 75 |
| W-228517 | 4.9 | 390 | .048 | 68 | 16 | 2.9 | - | 670 | 42 | 12 | 83 | 73 |
| | 5.0 | 380 | .048 | 69 | 16 | 3.0 | - | 640 | 42 | 12 | 90 | 73 |
| | 5.0 | 380 | .050 | 68 | 16 | 3.0 | - | 610 | 40 | 12 | 83 | 73 |
| | 5.0 | 410 | .042 | 68 | 16 | 3.0 | - | 650 | 41 | 13 | 87 | 75 |
| $\bar{x}$--- | 4.98 | 390 | .046 | 68.2 | 16 | 2.98 | - | 648 | 41 | 12.6 | 86.6 | 73.8 |
| σ---- | .05 | 12 | .004 | .4 | 0 | .05 | - | 25 | 1 | .9 | 3.5 | 1.1 |
| CV(%)[2] | 1.0 | 3.1 | 8.7 | .6 | 0 | 1.7 | - | 3.9 | 2.4 | 7.1 | 4.0 | 1.5 |

1 Corrected Cr values
2 Coefficient of variation

Table 2B. Analysis of replicate sediment samples.- Continued

| Sample Replicate | Al (%) | Ba (ppm) | Cd (ppm) | Cr (ppm) | Cu (ppm) | Fe (%) | Hg (ppm) | Mn (ppm) | Ni (ppm) | Pb (ppm) | V (ppm) | Zn (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C21300 | 6.3 | 430 | .075 | 79[1] | 24 | 3.4 | - | 790 | 34 | 18 | 120 | 91 |
| W-228542 | 6.3 | 420 | .075 | 82 | 23 | 3.4 | - | 780 | 36 | 16 | 120 | 90 |
| | 6.4 | 420 | .071 | 82 | 24 | 3.4 | - | 800 | 38 | 16 | 110 | 90 |
| | 6.4 | 430 | .063 | 82 | 23 | 3.4 | - | 810 | 36 | 16 | 120 | 90 |
| | 6.3 | 430 | .066 | 82 | 23 | 3.3 | - | 790 | 34 | 16 | 120 | 90 |
| $\bar{x}$--- | 6.34 | 426 | .07 | 81.4 | 23.4 | 3.4 | - | 794 | 35.6 | 16.4 | 116 | 90.4 |
| σ | .06 | 5 | .01 | 1.3 | .5 | 0 | - | 11 | 1.7 | .9 | 5.5 | .5 |
| CV(%)[2]- | .9 | 1.2 | 14.3 | 1.6 | 2.1 | 0 | - | 1.4 | 4.8 | 5.5 | 4.7 | .5 |

| Sample Replicate | Al (%) | Ba (ppm) | Cd (ppm) | Cr (ppm) | Cu (ppm) | Fe (%) | Hg (ppm) | Mn (ppm) | Ni (ppm) | Pb (ppm) | V (ppm) | Zn (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C-3011114 | 5.70 | 461 | .058 | 82[1] | 22 | 3.25 | .04 | 360 | 48 | 8.7 | 102 | 90 |
| W-229793 | 5.71 | 442 | .073 | 83 | 23 | 3.26 | .035 | 353 | 48 | 9.8 | 98 | 90 |
| | 5.69 | 444 | .065 | 80 | 20 | 3.24 | .036 | 352 | 44 | 8.7 | 98 | 88 |
| | 5.67 | 450 | .065 | 80 | 24 | 3.23 | .035 | 349 | 44 | 9.8 | 98 | 90 |
| | 5.73 | 452 | .065 | 84 | 24 | 3.25 | .035 | 353 | 46 | 10 | 102 | 89 |
| $\bar{x}$--- | 5.7 | 450 | .065 | 81.8 | 22.6 | 3.25 | .036 | 353 | 46 | 9.4 | 99.6 | 89.4 |
| σ---- | .02 | 7 | .005 | 1.8 | 1.7 | .01 | .002 | 4 | 2 | .6 | 2.2 | .9 |
| CV(%)[2]- | .4 | 1.7 | 8.1 | 2.2 | 7.4 | .4 | 6 | 1.1 | 4.3 | 6.8 | 2.2 | 1 |

| Sample Replicate | Al (%) | Ba (ppm) | Cd (ppm) | Cr (ppm) | Cu (ppm) | Fe (%) | Hg (ppm) | Mn (ppm) | Ni (ppm) | Pb (ppm) | V (ppm) | Zn (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C3020002X | 5.40 | 418 | .041 | 86[1] | 22 | 3.03 | .030 | 686 | 50 | 12 | 94 | 76 |
| W-229825 | 5.43 | 418 | .050 | 83 | 22 | 3.06 | .030 | 686 | 50 | 12 | 98 | 76 |
| | 5.41 | 420 | .041 | 82 | 23 | 3.04 | .027 | 712 | 45 | 13 | 90 | 76 |
| | 5.50 | 416 | .050 | 82 | 22 | 3.10 | .030 | 702 | 45 | 12 | 98 | 76 |
| | 5.43 | 413 | .058 | 86 | 23 | 3.05 | .030 | 704 | 50 | 12 | 98 | 75 |
| $\bar{x}$--- | 5.43 | 417 | .048 | 83.8 | 22.4 | 3.06 | .029 | 698 | 47.4 | 12.4 | 95.6 | 75.8 |
| σ----- | .04 | 3 | .007 | 2 | .5 | .03 | .001 | 12 | 2.5 | .5 | 3.6 | .4 |
| CV(%)[2] | .7 | .6 | 15 | 2.4 | 2.4 | .9 | 4.6 | 1.7 | 5.3 | 4.4 | 3.7 | .6 |

1 Corrected Cr values
2 Coefficient of variation

Table 2B. Analysis of replicate sediment samples.- Continued

| Sample Replicate | Al (%) | Ba (ppm) | Cd (ppm) | Cr (ppm) | Cu (ppm) | Fe (%) | Hg (ppm) | Mn (ppm) | Ni (ppm) | Pb (ppm) | V (ppm) | Zn (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C4012122 | 5.52 | 423 | .071 | 80 | 23 | 3.03 | .040 | 360 | 36 | 9.6 | 109 | 75 |
| W-232029 | 5.41 | 420 | .080 | 82 | 23 | 3.00 | .040 | 360 | 36 | 10 | 104 | 75 |
| | 5.39 | 418 | .071 | 80 | 22 | 2.98 | .040 | 354 | 36 | 10 | 109 | 75 |
| | 5.39 | 416 | 080 | 80 | 23 | 2.99 | .040 | 362 | 39 | 9.6 | 104 | 76 |
| | 5.42 | 416 | .075 | 80 | 23 | 3.00 | .040 | 361 | 39 | 9.6 | 109 | 75 |
| $\bar{x}$--- | 5.43 | 419 | .075 | 80.4 | 22.8 | 3.00 | .04 | 359 | 37.2 | 9.8 | 107 | 75.2 |
| σ---- | .05 | 3 | .004 | .9 | .4 | .02 | 0 | 3 | 1.6 | .2 | 3 | .4 |
| CV(%)[2] | 1 | .7 | 6 | 1.1 | 2 | .6 | 0 | .9 | 4.4 | 2.2 | 2.6 | .6 |

| Sample Replicate | Al (%) | Ba (ppm) | Cd (ppm) | Cr (ppm) | Cu (ppm) | Fe (%) | Hg (ppm) | Mn (ppm) | Ni (ppm) | Pb (ppm) | V (ppm) | Zn (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C5141112 | 5.99 | 418 | .083 | 84 | 23 | 3.29 | .015 | 357 | 51 | 6.8 | 96 | 85 |
| W-233040 | 5.96 | 426 | .083 | 84 | 23 | 3.27 | .015 | 358 | 52 | 6.8 | 103 | 88 |
| | 5.96 | 409 | .091 | 86 | 23 | 3.26 | .015 | 356 | 53 | 7.3 | 94 | 85 |
| | 5.97 | 421 | .091 | 84 | 23 | 3.27 | .015 | 354 | 51 | 6.8 | 101 | 88 |
| | 5.96 | 416 | .091 | 85 | 23 | 3.27 | .015 | 362 | 52 | 7.3 | 94 | 88 |
| $\bar{x}$--- | 5.97 | 418 | .088 | 84.6 | 23 | 3.27 | .015 | 357 | 51.8 | 7 | 97.6 | 86.8 |
| σ---- | .01 | 6 | .004 | .9 | 0 | .01 | 0 | 3 | .8 | .3 | 4.2 | 1.6 |
| CV(%)[2] | .2 | 1.5 | 5 | 1.1 | 0 | .3 | 0 | .8 | 1.6 | 3.9 | 4.3 | 1.9 |

| Sample Replicate | Al (%) | Ba (ppm) | Cd (ppm) | Cr (ppm) | Cu (ppm) | Fe (%) | Hg (ppm) | Mn (ppm) | Ni (ppm) | Pb (ppm) | V (ppm) | Zn (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C6020002X | 5.42 | 429 | .042 | 67 | 21 | 3.02 | .030 | 626 | 45 | 10 | 98 | 73 |
| W-234543 | 5.49 | 427 | .042 | 67 | 21 | 3.07 | .020 | 625 | 45 | 9.0 | 96 | 73 |
| | 5.46 | 432 | .050 | 65 | 20 | 3.06 | .020 | 625 | 46 | 8.3 | 102 | 71 |
| | 5.48 | 427 | .050 | 66 | 21 | 3.04 | .020 | 622 | 45 | 10 | 98 | 71 |
| | 5.49 | 431 | .050 | 67 | 20 | 3.05 | .030 | 632 | 45 | 10 | 98 | 73 |
| $\bar{x}$--- | 5.47 | 429 | .047 | 66.4 | 20.6 | 3.05 | .024 | 626 | 45.2 | 9.5 | 98.4 | 72.2 |
| σ---- | .03 | 2 | .004 | .9 | .5 | .02 | .005 | 4 | .4 | .8 | 2.2 | 1.1 |
| CV(%)[2] | .5 | .5 | 9.4 | 1.3 | 2.7 | .6 | 23 | .6 | 1 | 8.2 | 2.2 | 1.5 |

[2] Coefficient of variation

Table 2C. - Chemical analysis of blind duplicates.

| Field no. | Top (cm) | Btm (cm) | Lab no. | Al (%) | Ba (ppm) | Cd (ppm) | Cr (ppm) | Cu (ppm) | Fe (%) | Hg (ppm) | Mn (ppm) | Ni (ppm) | Pb (ppm) | V (ppm) | Zn (ppm) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C11411 | 0 | 2 | W-233730 | 5.79 | 408 | .055 | 70 | 23 | 3.16 | .002L | 592 | 50 | 15.0 | 85 | 81 | |
| C11411 | 0 | 2 | W-233736 | 5.79 | 418 | .091 | 73 | 23 | 3.09 | .070 | 593 | 53 | 14.0 | 90 | 83 | BLIND # |
| C40121 | 2 | 4 | W-232024 | 5.37 | 412 | .050 | 80 | 20 | 2.98 | .040 | 603 | 36 | 10.0 | 94 | 61 | |
| C40121 | 2 | 4 | W-232039 | 5.39 | 418 | .058 | 80 | 23 | 2.97 | .040 | 599 | 37 | 12.0 | 109 | 70 | BLIND # |
| C51411 | 16 | 18 | W-233041 | 5.94 | 423 | .120 | 84 | 22 | 3.22 | .020 | 352 | 52 | 19.0 | 99 | 90 | |
| C51411 | 16 | 18 | W-233043 | 5.91 | 420 | .120 | 82 | 22 | 3.20 | .025 | 347 | 53 | 11.0 | 99 | 85 | BLIND # |
| C60112 | 0 | 2 | W-234525 | 4.58 | 343 | .033 | 59 | 14 | 2.83 | .010 | 490 | 30 | 14.0 | 72 | 55 | |
| C60112 | 0 | 2 | W-234547 | 4.54 | 367 | .033 | 57 | 15 | 2.70 | .020 | 498 | 36 | 18.0 | 74 | 57 | BLIND # |
| C40100S0 | 0 | 2 | W-235344 | 5.23 | 404 | .082 | 57 | 22.0 | 2.95 | .040 | 358 | 39 | 15.0 | 100 | 73 | |
| C40100S0 | 0 | 2 | W-235358 | 5.43 | 403 | .077 | 68 | 23.0 | 3.16 | .090 | 664 | 44 | 22.0 | 100 | 81 | BLIND # |

The concentration of V in the sediment standard MESS (Table 2A) showed a slight increase corresponding to the change in procedure, but there was no consistent change in results on samples reanalyzed using the pyrolytically coated tube and so no correction to V results was applied.

The concentratons of Pb in the last three batches of samples analyzed were systematically lower than values measured at comparable stations collected earlier in the program. Reanalysis of these three sets of samples were consistent with earlier results and the new data are reported in the data tables (lab numbers W-233008 - W-233043; W-234511 - W-234587).

Analytical precision was determined by periodically analyzing replicate aliquots taken from a single sample. Coefficients of variation shown in Table 2B indicate that the standard deviations are typically less than 10 percent of the mean value, except for concentrations at or near the detection limit of the method. Analytical precision for Ba averages 1.4 percent (range 0.5 - 3.1 percent) for five replicates from each of nine samples.

An additional precision check was conducted by submitting unidentified (blind) duplicates to all stages in the analytical procedure. The agreement between duplicates was generally excellent (Table 2C).

During the early phases of this program, we evaluated the metal concentrations in surface sediment that had been in contact with different materials used in the box of the box corer. Mr. George Hampson, WHOI, suggested this experiment and provided the carefully collected samples.

To assess contamination effects from the box core sampler, we compared the metal concentrations in sediments from the center of a teflon-coated subcore (i.e., material that had not been in contact with the sampler) with sediments in direct contact with either the teflon-coated or the uncoated aluminum corer (Table 3). Bulk sediments and the fraction <60 μm were

Table 3. - Chemical analyses of replicate samples collected from different areas of a single box core.

[Samples A, B, and C from center of a teflon-coated subcore (assumed to be the least contaminated); D, E, and F in contact with the side of teflon-coated subcore; G, H, and I in contact with the side of aluminum subcore. Field no. ending in X means size fraction finer than 60 μm analyzed.]

| Field no. Lab no. | Al (%) | Ba (ppm) | Cd (ppm) | Cr (ppm) | Cu (ppm) | Fe (%) | Hg (ppm) | Mn (ppm) | Ni (ppm) | Pb (ppm) | V (ppm) | Zn (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SA21A-----W-226341 | 1.8 | 120 | 0.068 | 26 | 8.4 | 1.1 | 0.02 | 120 | 11 | 5 | 12 | 30 |
| SA21B-----W-226342 | 1.8 | 130 | .140 | 26 | 8.6 | 1.0 | .02 | 120 | 11 | 5 | 17 | 32 |
| SA21C-----W-226343 | 1.9 | 130 | .180 | 28 | 12 | 1.1 | -- | 120 | 13 | 6 | 16 | 32 |
| $\bar{x}$-------- | 1.83 | 127 | .13 | 26.7 | 9.7 | 1.07 | .02 | 120 | 11.7 | 5.3 | 15 | 31 |
| σ--------- | .06 | 5.8 | .06 | 1.2 | 2.0 | .06 | 0 | 0 | 1.2 | .6 | 2.6 | 1.2 |
| CV(%)[1]---- | 3.2 | 4.6 | 44 | 4.3 | 21 | 5.4 | 0 | 0 | 9.9 | 10.8 | 17.6 | 3.7 |
| SA21D-----W-226344 | 1.9 | 130 | .150 | 26 | 10 | 1.1 | .02 | 130 | 12 | 7 | 20 | 33 |
| SA21E-----W-226345 | 1.9 | 130 | .130 | 26 | 8.6 | 1.1 | .02 | 130 | 11 | 5 | 21 | 32 |
| SA21F-----W-226346 | 1.9 | 130 | .088 | 29 | 7.8 | 1.1 | .02 | 150 | 12 | 6 | 23 | 32 |
| $\bar{x}$-------- | 1.9 | 130 | .12 | 27.0 | 8.8 | 1.1 | .02 | 137 | 11.7 | 6.0 | 21 | 32 |
| σ--------- | 0 | 0 | .03 | 1.7 | 1.1 | 0 | 0 | 12 | .6 | 1.0 | 1.5 | .6 |
| CV(%)[1]---- | 0 | 0 | 26 | 6.4 | 13 | 0 | 0 | 8.4 | 4.9 | 16.7 | 7.2 | 1.8 |
| SA21G-----W-226347 | 1.8 | 120 | .083 | 26 | 10 | 1.1 | .02 | 160 | 11 | 6 | 10 | 30 |
| SA21H-----W-226348 | 1.8 | 130 | .110 | 25 | 7.5 | 1.0 | .02 | 130 | 11 | 5 | 12 | 30 |
| SA21I-----W-226349 | 1.8 | 130 | .130 | 26 | 8.0 | 1.0 | .02 | 120 | 11 | 4 | 10 | 30 |
| $\bar{x}$-------- | 1.80 | 127 | .11 | 25.7 | 8.5 | 1.03 | .02 | 137 | 11 | 5.0 | 11 | 30 |
| σ--------- | 0 | 5.8 | .02 | .6 | 1.3 | .06 | 0 | 21 | 0 | 1.0 | 1.2 | 0 |
| CV(%)[1]---- | 0 | 4.6 | 22 | 2.2 | 16 | 5.6 | 0 | 15 | 0 | 20 | 10.8 | 0 |
| SA21AX----W-226350 | 2.8 | 160 | .085 | 35 | 13 | 1.28 | .04 | 149.5 | 20 | 8 | 36 | 48.0 |
| SA21BX----W-226351 | 2.8 | 158 | .105 | 35 | 14 | 1.26 | .04 | 147.5 | 20 | 7 | 33 | 44.2 |
| SA21CX----W-226352 | 2.7 | 158 | .148 | 35 | 14 | 1.27 | -- | 147.7 | 20 | 6 | 33 | 44.3 |
| $\bar{x}$-------- | 2.79 | 159 | .11 | 35 | 14 | 1.27 | .04 | 149 | 20 | 7.0 | 34 | 45.3 |
| σ--------- | .05 | 1.2 | .03 | 0 | .6 | .01 | 0 | 1.2 | 0 | 1.0 | 1.7 | 2.3 |
| CV(%)[1]---- | 1.8 | 0.7 | 28 | 0 | 4.2 | .8 | 0 | .8 | 0 | 14.3 | 5.1 | 5.1 |
| SA21DX----W-226353 | 2.8 | 161 | .098 | 35 | 9.8 | 1.29 | .05 | 150.3 | 19 | 11 | 33 | 48.3 |
| SA21GX----W-226354 | 2.8 | 160 | .097 | 35 | 13 | 1.28 | .04 | 192.5 | 20 | 10 | 37 | 48.1 |
| $\bar{x}$-------- | 2.78 | 160 | .10 | 35 | 11 | 1.28 | .04 | 172 | 19.5 | 10.5 | 35 | 48.2 |
| σ--------- | .01 | .7 | 0 | 0 | 2.3 | .01 | .01 | 30 | .7 | .7 | 2.8 | .1 |
| CV(%)[1] | .2 | .4 | .7 | 0 | 20 | .6 | 16 | 18 | 3.6 | 6.7 | 8.1 | .2 |

[1]Coefficient of variation.

compared. We found that the concentrations of Ba and Cr, the metals most likely to indicate the presence of drilling mud in sediments, were not contaminated by contact with the walls of the box corer. In the bulk sediments, vanadium appeared to be slightly higher in the samples collected from the edge of the teflon-coated subcore compared to the other samples. In the fine fraction, the lead values from the edges of the subcores are about 40 percent higher than in the sediment not in contact with the box-core material.

The material that was in contact with the walls of the subcore probably represent the worst case of contamination from the material used to construct the box-core sample chamber. The sediment that is routinely removed from the subcore for trace-metal analysis, however, excludes the material in contact with the wall of the subcore. We therefore conclude that contamination from the walls of the box core is insignificant. Although this test does not rule out the possibility that metal contamination could occur from flakes of material falling onto the sediment surface from the coring apparatus above the sample box, such contamination would be random and severe and should be obvious from the chemical analyses. Within this program we have observed less than five spurious values that might be explained by contamination from field or laboratory operations.

## RESULTS AND DISCUSSION

### Within-station variability

We determined the variability of metal concentrations within an individual box core and between replicate box cores taken at the same station (Table 4A-G). In samples unaffected by drilling muds, the within-box core variability for Ba is typically less than 2 percent, and the within-station

Table 4A. - Comparison of within-station variability to within box core variability at Station 1, Cruise 1.

| Field no. | Top (cm) | Btm (cm) | Lab no. | Al (%) | Ba (ppm) | Cd (ppm) | Cr (ppm) | Cu (ppm) | Fe (%) | Hg (ppm) | Mn (ppm) | Ni (ppm) | Pb (ppm) | V (ppm) | Zn (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C10111 | 0 | 2 | W-228607 | 5.2 | 400 | 0.110 | 54 | 27 | 2.9 | 0.03 | 750 | 39 | 12 | 78 | 63 |
| C10121 | 0 | 2 | W-228608 | 5.5 | 430 | .096 | 56 | 26 | 3.0 | .02 | 770 | 47 | 12 | 78 | 70 |
| C10131 | 0 | 2 | W-228611 | 5.4 | 420 | .071 | 56 | 25 | 2.9 | .02 | 720 | 41 | 15 | 80 | 70 |
| $\bar{x}$ | | | | 5.37 | 416 | .092 | 55.3 | 26 | 2.93 | .02 | 747 | 42.3 | 13 | 79 | 68 |
| σ | | | | .15 | 15 | .020 | 1.1 | 1 | .06 | 0 | 25 | 4.2 | 1.7 | 1.1 | 4.0 |
| CV%[1] | | | | 2.8 | 3.7 | 21 | 2.1 | 3.8 | 2.0 | 6.4 | 3.4 | 9.8 | 13 | 1.5 | 6.0 |
| C10121 | 0 | 2 | W-228608 | 5.5 | 430 | .096 | 56 | 26 | 3.0 | .02 | 770 | 47 | 12 | 78 | 70 |
| C10122 | 0 | 2 | W-228609 | 5.5 | 430 | .046 | 58 | 28 | 3.0 | .02 | 800 | 45 | 14 | 84 | 71 |
| C10123 | 0 | 2 | W-228610 | 5.5 | 430 | .063 | 58 | 28 | 3.0 | .02 | 860 | 46 | 16 | 90 | 73 |
| $\bar{x}$ | | | | 5.5 | 430 | .068 | 57.3 | 27.3 | 3.0 | .02 | 810 | 46.0 | 14 | 84 | 71 |
| σ | | | | 0 | 0 | .025 | 1.0 | 1.0 | 0 | 0 | 46 | 1.0 | 2 | 6 | 1.5 |
| CV% | | | | 0 | 0 | 37 | 1.8 | 3.7 | 0 | 0 | 5.7 | 2.2 | 14 | 7.1 | 2.1 |

Table 4B. - Comparison of within station variability to within box core variability at Station 1, Cruise 2.

| Field no. | Top (cm) | Btm (cm) | Lab no. | Al (%) | Ba (ppm) | Cd (ppm) | Cr (ppm) | Cu (ppm) | Fe (%) | Hg (ppm) | Mn (ppm) | Ni (ppm) | Pb (ppm) | V (ppm) | Zn (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C20111 | 0 | 2 | W-228513 | 5.2 | 420 | 0.055 | 52 | 14 | 2.9 | 0.03 | 710 | 50 | 12 | 90 | 83 |
| C20121 | 0 | 2 | W-228516 | 4.7 | 410 | .042 | 48 | 15 | 2.7 | .04 | 590 | 40 | 13 | 80 | 73 |
| C20131 | 0 | 2 | W-228517 | 5.0 | 390 | .046 | 50 | 16 | 3.0 | .04 | 650 | 41 | 13 | 86 | 74 |
| $\bar{x}$ | | | | 4.97 | 407 | .048 | 50 | 15 | 2.87 | .04 | 650 | 43.7 | 13 | 86 | 77 |
| σ | | | | .25 | 15 | .006 | 2 | 1.0 | .15 | .01 | 60 | 5.5 | .6 | 5.1 | 5.5 |
| CV% | | | | 5.1 | 3.8 | 14 | 4 | 6.7 | 5.3 | 14 | 9.2 | 13 | 4.5 | 5.9 | 7.2 |
| C20111 | 0 | 2 | W-228513 | 5.2 | 420 | .055 | 52 | 14 | 2.9 | .03 | 710 | 50 | 12 | 90 | 83 |
| C20112 | 0 | 2 | W-228514 | 5.2 | 430 | .048 | 54 | 17 | 3.0 | .03 | 790 | 52 | 16 | 87 | 80 |
| C20113 | 0 | 2 | W-228515 | 5.2 | 430 | .042 | 52 | 19 | 2.9 | .05 | 750 | 46 | 14 | 90 | 80 |
| $\bar{x}$ | | | | 5.2 | 427 | .048 | 52.7 | 16.7 | 2.93 | .04 | 750 | 49.3 | 14 | 89 | 81 |
| σ | | | | 0 | 5.8 | .065 | 1.2 | 2.5 | .06 | .01 | 40 | 3.1 | 2 | 1.7 | 1.7 |
| CV% | | | | 0 | 1.4 | 13 | 2.2 | 15 | 2.0 | 31 | 5.3 | 6.2 | 14 | 1.9 | 2.1 |

[1]Coefficient of variation.

Table 4C. - Comparison of within station variability to within box core variability at Station 1, Cruise 3.

| Field no. | Top (cm) | Btm (cm) | Lab no. | Al (%) | Ba (ppm) | Cd (ppm) | Cr (ppm) | Cu (ppm) | Fe (%) | Hg (ppm) | Mn (ppm) | Ni (ppm) | Pb (ppm) | V (ppm) | Zn (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C30111 | 0 | 2 | W-229828 | 5.08 | 493 | 0.041 | 62 | 22 | 2.87 | 0.03 | 565 | 41 | 12 | 90 | 73 |
| C30121 | 0 | 2 | W-229831 | 5.27 | 427 | .041 | 64 | 23 | 2.93 | .03 | 652 | 44 | 12 | 94 | 75 |
| C30131 | 0 | 2 | W-229832 | 5.19 | 401 | .075 | 62 | 22 | 2.87 | .02 | 343 | 40 | 12 | 94 | 70 |
| $\bar{x}$ | | | | 5.18 | 440 | .052 | 62.7 | 22.3 | 2.89 | .03 | 520 | 41.7 | 12.0 | 92.7 | 72.7 |
| $\sigma$ | | | | 0.09 | 47.4 | .020 | 1.2 | .6 | .03 | .01 | 159 | 2.1 | .0 | 2.3 | 2.5 |
| CV%[1] | | | | 1.84 | 10.8 | 38 | 1.8 | 2.6 | 1.2 | 22 | 31 | 5.0 | .0 | 2.6 | 3.5 |
| C30111 | 0 | 2 | W-229828 | 5.08 | 493 | .041 | 62 | 22 | 2.87 | .03 | 565 | 41 | 12 | 90 | 73 |
| C30112 | 0 | 2 | W-229829 | 5.17 | 412 | .055 | 66 | 22 | 2.90 | .02 | 507 | 42 | 10 | 84 | 75 |
| C30113 | 0 | 2 | W-229830 | 5.13 | 400 | .041 | 75 | 22 | 2.88 | .02 | 513 | 43 | 12 | 89 | 73 |
| $\bar{x}$ | | | | 5.13 | 435 | .046 | 67.7 | 22.0 | 2.88 | .02 | 528 | 42.0 | 10.7 | 87.8 | 73.7 |
| $\sigma$ | | | | .04 | 50.6 | .008 | 6.7 | 0.0 | 0.01 | .01 | 31.9 | 1.0 | 1.2 | 3.2 | 1.2 |
| CV%[1] | | | | .88 | 12 | 18 | 9.8 | 0.0 | 0.53 | 25 | 6.0 | 2.4 | 11 | 3.7 | 1.6 |

Table 4D. - Comparison of within station variability to within box core variability at Station 14, Cruise 4.

| Field no. | Top (cm) | Btm (cm) | Lab no. | Al (%) | Ba (ppm) | Cd (ppm) | Cr (ppm) | Cu (ppm) | Fe (%) | Hg (ppm) | Mn (ppm) | Ni (ppm) | Pb (ppm) | V (ppm) | Zn (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C41411 | 0 | 2 | W-231772 | 5.60 | 389 | 0.071 | 81 | 21 | 3.10 | 0.04 | 689 | 36 | 20 | 87 | 86 |
| C41421 | 0 | 2 | W-231773 | 5.59 | 411 | .055 | 79 | 21 | 3.15 | .04 | 832 | 42 | 18 | 82 | 88 |
| C41431 | 0 | 2 | W-231774 | 5.62 | 386 | .071 | 79 | 23 | 3.13 | .04 | 710 | 39 | 26 | 105 | 85 |
| $\bar{x}$ | | | | 5.60 | 395 | .066 | 79.7 | 21.7 | 3.13 | .04 | 744 | 39.0 | 21.3 | 91.3 | 86.3 |
| $\sigma$ | | | | .01 | 13.6 | .009 | 1.2 | 1.3 | .02 | .00 | 77.2 | 3.0 | 4.2 | 12.1 | 1.5 |
| CV%[1] | | | | .27 | 3.5 | 14 | 1.5 | 5.3 | .80 | .00 | 10 | 7.7 | 20 | 13 | 1.8 |
| C41411 | 0 | 2 | W-231772 | 5.60 | 389 | .071 | 81 | 21 | 3.10 | .04 | 689 | 36 | 20 | 87 | 86 |
| C41412 | 0 | 2 | W-231775 | 5.60 | 397 | .055 | 80 | 22 | 3.07 | .04 | 593 | 36 | 18 | 87 | 88 |
| C41413 | 0 | 2 | W-231776 | 5.66 | 386 | .038 | 85 | 21 | 3.11 | .03 | 577 | 39 | 16 | 96 | 88 |
| $\bar{x}$ | | | | 5.62 | 391 | .055 | 82.0 | 21.3 | 3.09 | .04 | 620 | 37.0 | 18.0 | 40.0 | 87.3 |
| $\sigma$ | | | | .03 | 5.7 | .016 | 2.7 | .6 | .02 | .01 | 60.6 | 1.7 | 2.0 | 5.2 | 1.2 |
| CV%[1] | | | | .62 | 1.5 | 30 | 3.2 | 2.7 | .67 | 16 | 9.8 | 4.7 | 11 | 5.8 | 1.3 |

[1]Coefficient of variation.

Table 4E. - Comparison of within - station variability to within box core variability at Station 14, Cruise 5.

| Field no. | Top (cm) | Btm (cm) | Lab no. | Al (%) | Ba (ppm) | Cd (ppm) | Cr (ppm) | Cu (ppm) | Fe (%) | Hg (ppm) | Mn (ppm) | Ni (ppm) | Pb (ppm) | V (ppm) | Zn (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C51411 | 0 | 2 | W-233019 | 5.2 | 381 | .09 | 77 | 20 | 2.89 | .04 | 641 | 44 | 19 | 78 | 85 |
| C51421 | 0 | 2 | W-233020 | 5.23 | 375 | .075 | 73 | 18 | 2.90 | .045 | 578 | 39 | 14 | 88 | 81 |
| C51431 | 0 | 2 | W-233021 | 5.46 | 383 | .075 | 77 | 21 | 3.03 | .05 | 633 | 41 | 23 | 92 | 83 |
| $\bar{x}$—— | | | | 5.3 | 380 | .08 | 75.7 | 19.7 | 2.94 | .045 | 617 | 41.3 | 18.7 | 86 | 83 |
| σ—— | | | | .14 | 4 | .009 | 2.3 | 1.5 | .08 | .005 | 34 | 2.5 | 4.5 | 7.2 | 2 |
| CV(%)[1]— | | | | 2.7 | 1.1 | 11 | 3 | 7.8 | 2.7 | 11 | 5.6 | 6.1 | 24 | 8.4 | 2.4 |
| C51411 | 0 | 2 | W-233019 | 5.2 | 381 | .09 | 77 | 20 | 2.89 | .04 | 641 | 44 | 19 | 78 | 85 |
| C51412 | 0 | 2 | W-233022 | 5.0 | 355 | .075 | 75 | 18 | 2.81 | .04 | 635 | 41 | 21 | 78 | 76 |
| C51413 | 0 | 2 | W-233023 | 5.19 | 381 | .088 | 79 | 20 | 2.89 | .05 | 610 | 43 | 19 | 82 | 76 |
| $\bar{x}$—— | | | | 5.13 | 372 | .084 | 77 | 19.3 | 2.86 | .043 | 629 | 42.7 | 20 | 79.3 | 79 |
| σ—— | | | | .11 | 15 | .008 | 2 | 1.2 | .05 | .006 | 16 | 1.5 | 1.2 | 2.3 | 5.2 |
| CV(%)[1]— | | | | 2.2 | 4 | 9.7 | 2.6 | 6 | 1.6 | 13 | 2.6 | 3.6 | 5.7 | 2.9 | 6.6 |

[1] Coefficient of variation

Table 4F. - Comparison of within - station variability to within box core variability at Station 1, Cruise 6.

| Field no. | Top (cm) | Btm (cm) | Lab no. | Al (%) | Ba (ppm) | Cd (ppm) | Cr (ppm) | Cu (ppm) | Fe (%) | Hg (ppm) | Mn (ppm) | Ni (ppm) | Pb (ppm) | V (ppm) | Zn (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C60111 | 0 | 2 | W-234524 | 5.04 | 362 | .03 | 62 | 16 | 2.94 | ..02 | 421 | 37 | 21 | 88 | 63 |
| C60121 | 0 | 2 | W-234527 | 5.06 | 443 | .02 | 67 | 18 | 2.89 | .02 | 721 | 39 | 11 | 82 | 63 |
| C60131 | 0 | 2 | W-234528 | 5.07 | 555 | .042 | 65 | 17 | 2.87 | .02 | 613 | 42 | 12 | 82 | 70 |
| $\bar{x}$---- | | | | 5.06 | 453 | .031 | 64.7 | 17 | 2.9 | .02 | 585 | 39.3 | 14.7 | 84 | 68 |
| $\sigma$------ | | | | .02 | 97 | .011 | 2.5 | 1 | .04 | - | 152 | 2.5 | 5 | 3.5 | 4.4 |
| CV(%)[1]— | | | | .3 | 21 | 36 | 3.9 | 5.9 | 1.2 | - | 26 | 6.4 | 37 | 4.1 | 6.4 |
| C60111 | 0 | 2 | W-234524 | 5.04 | 362 | .03 | 62 | 16 | 2.94 | .02 | 421 | 37 | 21 | 88 | 63 |
| C60112 | 0 | 2 | W-234525 | 4.58 | 343 | .033 | 59 | 14 | 2.83 | .01 | 490 | 30 | 14 | 72 | 55 |
| C60113 | 0 | 2 | W-234526 | 5.08 | 380 | .03 | 60 | 16 | 3.04 | .01 | 440 | 35 | 17 | 110 | 61 |
| $\bar{x}$---- | | | | 4.9 | 362 | .031 | 60.3 | 15.3 | 2.94 | .013 | 450 | 34 | 17.3 | 90 | 59.7 |
| $\sigma$---- | | | | 0.28 | 18 | .002 | 1.5 | 1.2 | .1 | .006 | 36 | 3.6 | 3.5 | 19 | 4.2 |
| CV(%)[1]— | | | | 5.7 | 5.1 | 5.6 | 2.5 | 7.5 | 3.6 | 43 | 7.9 | 11 | 20 | 21 | 7 |

Table 4G. - Within station variability for Cruise 1, Stations 5 and 13; Cruise 2, Stations 2, 4, 6 and 13; Cruise 3, Stations 6 and 13; Cruise 4, Stations 1 and 13 and Cruise 6, Stations 6, 13, and 14.

| Field no. | Top (cm) | Btm (cm) | Lab no. | Al (%) | Ba (ppm) | Cd (ppm) | Cr (ppm) | Cu (ppm) | Fe (%) | Hg (ppm) | Mn (ppm) | Ni (ppm) | Pb (ppm) | V (ppm) | Zn (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C10511 | 0 | 2 | W-228612 | 5.5 | 440 | .066 | 58 | 28 | 3.0 | .02 | 840 | 45 | 15 | 84 | 73 |
| C10521 | 0 | 2 | W-228613 | 5.5 | 430 | .096 | 60 | 26 | 2.9 | .02 | 830 | 49 | 15 | 87 | 70 |
| C10531 | 0 | 2 | W-228614 | 5.5 | 420 | .075 | 60 | 29 | 3.0 | .02 | 700 | 46 | 17 | 86 | 71 |
| $\bar{x}$ | | | | 5.5 | 430 | .08 | 59.3 | 27.7 | 2.97 | .02 | 790 | 46.7 | 16 | 86 | 71 |
| σ | | | | 0 | 10 | .02 | 1.2 | 1.5 | .06 | 0 | 78 | 2.1 | 1.2 | 1.5 | 1.5 |
| CV%[1] | | | | 0 | 2.3 | 19 | 1.9 | 5.5 | 1.9 | 0 | 9.9 | 4.4 | 7.5 | 1.8 | 2.2 |
| C11311 | 0 | 2 | W-228624 | 5.7 | 420 | .088 | 60 | 27 | 3.2 | .03 | 800 | 49 | 22 | 88 | 76 |
| C11321 | 0 | 2 | W-228625 | 5.7 | 410 | .090 | 58 | 22 | 3.1 | .04 | 590 | 46 | 22 | 84 | 73 |
| C11331 | 0 | 2 | W-228626 | 5.9 | 440 | .095 | 62 | 25 | 3.3 | .03 | 410 | 50 | 24 | 94 | 78 |
| $\bar{x}$ | | | | 5.77 | 423 | .09 | 60 | 24.7 | 3.20 | .03 | 600 | 48.3 | 23 | 89 | 76 |
| σ | | | | .12 | 15 | 0 | 2.0 | 2.5 | .10 | .01 | 200 | 2.1 | 1.2 | 5.0 | 2.5 |
| CV% | | | | 2.0 | 3.6 | 4.0 | 3.3 | 10 | 3.1 | 19 | 32 | 4.3 | 5.1 | 5.6 | 3.3 |
| C20211 | 0 | 2 | W-228615 | 5.0 | 370 | 0.075 | 50 | 18 | 2.7 | 0.01 | 500 | 34 | 8.3 | 74 | 58 |
| C20221 | 0 | 2 | W-228616 | 4.6 | 360 | .058 | 44 | 19 | 2.5 | .01 | 440 | 30 | 15 | 66 | 56 |
| C20231 | 0 | 2 | W-228617 | 4.8 | 380 | .058 | 46 | 24 | 2.6 | .02 | 610 | 34 | 15 | 74 | 60 |
| $\bar{x}$ | | | | 4.8 | 370 | .06 | 46.7 | 20.3 | 2.6 | .01 | 517 | 32.7 | 13 | 71 | 58 |
| σ | | | | .2 | 10 | .01 | 3.1 | 3.2 | .1 | 0 | 86 | 2.3 | 3.9 | 4.6 | 2.0 |
| CV%[1] | | | | 4.2 | 2.7 | 15 | 6.5 | 16 | 3.8 | 14 | 17 | 7.1 | 30 | 6.5 | 3.4 |
| C20411 | 0 | 2 | W-228618 | 4.9 | 380 | .076 | 48 | 20 | 2.6 | .01 | 490 | 33 | 13 | 74 | 60 |
| C20421 | 0 | 2 | W-228619 | 5.2 | 410 | .063 | 52 | 23 | 2.8 | .02 | 430 | 42 | 11 | 84 | 63 |
| C20431 | 0 | 2 | W-228620 | 4.6 | 370 | .061 | 44 | 20 | 2.4 | .01 | 420 | 32 | 12 | 70 | 51 |
| $\bar{x}$ | | | | 4.9 | 387 | .07 | 48 | 21.0 | 2.6 | .01 | 447 | 35.7 | 12 | 76 | 58.0 |
| σ | | | | .3 | 21 | .01 | 4.0 | 1.7 | .2 | 0 | 38 | 5.5 | 1.0 | 7.2 | 6.2 |
| CV% | | | | 6.1 | 5.4 | 12 | 8.3 | 8.2 | 7.7 | 11 | 8.5 | 15 | 8.3 | 9.5 | 11 |
| C20611 | 0 | 2 | W-228621 | 5.1 | 420 | .075 | 50 | 25 | 2.8 | .02 | 840 | 40 | 14 | 80 | 65 |
| C20621 | 0 | 2 | W-228622 | 5.3 | 430 | .091 | 56 | 24 | 2.9 | .02 | 720 | 42 | 13 | 84 | 65 |
| C20631 | 0 | 2 | W-228623 | 5.2 | 400 | .066 | 52 | 27 | 2.8 | .02 | 810 | 44 | 16 | 87 | 61 |
| $\bar{x}$ | | | | 5.2 | 417 | .077 | 52.7 | 25.3 | 2.83 | .02 | 790 | 42 | 14 | 84 | 64 |
| σ | | | | .1 | 15 | .013 | 3.1 | 1.5 | .06 | 0 | 62 | 2.0 | 1.5 | 3.5 | 2.3 |
| CV% | | | | 1.9 | 3.7 | 16 | 5.8 | 6.0 | 2.0 | 6.0 | 7.9 | 4.8 | 11 | 4.2 | 3.6 |
| C21311 | 0 | 2 | W-228510 | 5.8 | 430 | 0.063 | 58 | 22 | 3.4 | 0.05 | 900 | 54 | 21 | 100 | 100 |
| C21321 | 0 | 2 | W-228511 | 5.8 | 430 | .066 | 59 | 22 | 3.3 | .04 | 730 | 54 | 11 | 100 | 95 |
| C21331 | 0 | 2 | W-228512 | 5.5 | 410 | .042 | 60 | 18 | 3.2 | .06 | 720 | 54 | 22 | 95 | 93 |
| $\bar{x}$ | | | | 5.7 | 423 | .06 | 59 | 20.7 | 3.30 | .05 | 780 | 54 | 18 | 98 | 96 |
| σ | | | | .17 | 11 | .01 | 1.0 | 2.3 | .10 | .01 | 100 | 0 | 6.1 | 2.9 | 3.6 |
| CV% | | | | 3.0 | 2.7 | 23 | 1.7 | 11 | 3.0 | 20 | 13 | 0 | 34 | 2.9 | 3.8 |

[1]Coefficient of variation.

Table 4G. - Within station variability for Cruise 1, Stations 5 and 13; Cruise 2, Stations 2, 4, 6 and 13; Cruise 3, Stations 6 and 13; Cruise 4, Stations 1 and 13 and Cruise 6, Stations 6, 13, and 14.- Continued.

| Field no. | Top (cm) | Btm (cm) | Lab no. | Al (%) | Ba (ppm) | Cd (ppm) | Cr (ppm) | Cu (ppm) | Fe (%) | Hg (ppm) | Mn (ppm) | Ni (ppm) | Pb (ppm) | V (ppm) | Zn (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C30611 | 0 | 2 | W-229833 | 4.74 | 368 | .063 | 55 | 18 | 2.57 | .02 | 537 | 33 | 10.0 | 84 | 66 |
| C30621 | 0 | 2 | W-229834 | 5.13 | 406 | .050 | 64 | 23 | 2.82 | .02 | 674 | 41 | 12.0 | 94 | 71 |
| C30631 | 0 | 2 | W-229835 | 5.24 | 409 | .045 | 69 | 22 | 3.01 | .02 | 1,202 | 47 | 13.0 | 94 | 73 |
| $\bar{x}$ | | | | 5.04 | 394 | .053 | 62.7 | 21.0 | 2.80 | .02 | 804 | 40.3 | 11.7 | 90.7 | 70.0 |
| $\sigma$ | | | | .26 | 22.8 | .009 | 7.1 | 2.6 | .22 | .00 | 351 | 7.02 | 1.5 | 5.8 | 3.6 |
| CV%[1] | | | | 5.2 | 5.8 | 18 | 11 | 13 | 7.9 | .00 | 44 | 17 | 13 | 6.4 | 5.2 |
| C31311 | 0 | 2 | W-229836 | 5.45 | 425 | .066 | 69 | 24 | 3.10 | .03 | 611 | 50 | 25.0 | 104 | 80 |
| C31321 | 0 | 2 | W-229837 | 5.55 | 428 | .066 | 67 | 23 | 3.20 | .03 | 665 | 50 | 18.0 | 95 | 85 |
| C31331 | 0 | 2 | W-229838 | 5.65 | 417 | .075 | 68 | 23 | 3.29 | .03 | 1,171 | 49 | 21.0 | 95 | 83 |
| $\bar{x}$ | | | | 5.55 | 423 | .069 | 68.0 | 23.3 | 3.20 | .03 | 816 | 49.7 | 21.3 | 98.0 | 82.7 |
| $\sigma$ | | | | .10 | 5.7 | .005 | 1.0 | .6 | .09 | .00 | 309 | .6 | 3.5 | 5.2 | 2.5 |
| CV%[1] | | | | 1.8 | 1.3 | 7.5 | 1.5 | 2.5 | 3.0 | .00 | 38 | 1.2 | 17 | 5.3 | 3.0 |
| C40111 | 0 | 2 | W-231766 | 5.32 | 424 | .038 | 78 | 24 | 2.97 | .03 | 717 | 34 | 14.0 | 87 | 80 |
| C40121 | 0 | 2 | W-231767 | 5.14 | 400 | .055 | 74 | 21 | 2.81 | .02 | 810 | 32 | 12.0 | 82 | 73 |
| C40131 | 0 | 2 | W-231768 | 5.31 | 418 | .083 | 78 | 24 | 2.94 | .02 | 704 | 34 | 13.0 | 87 | 85 |
| $\bar{x}$ | | | | 5.26 | 414 | .059 | 76.7 | 23.0 | 2.91 | .02 | 744 | 33.3 | 13.0 | 85.3 | 79.3 |
| $\sigma$ | | | | .10 | 12.5 | .023 | 2.3 | 1.7 | .08 | .01 | 57.8 | 1.2 | 1.0 | 2.9 | 6.0 |
| CV%[1] | | | | 1.9 | 3.0 | 39 | 3.0 | 7.5 | 2.9 | 25 | 7.8 | 3.5 | 7.7 | 3.4 | 7.6 |
| C41311 | 0 | 2 | W-231769 | 5.63 | 412 | .066 | 81 | 26 | 3.15 | .03 | 783 | 40 | 20.0 | 92 | 100 |
| C41321 | 0 | 2 | W-231770 | 5.70 | 404 | .075 | 83 | 26 | 3.30 | .04 | 904 | 43 | 22.0 | 110 | 101 |
| C41331 | 0 | 2 | W-231771 | 5.72 | 399 | .310(?) | 83 | 24 | 3.24 | .05 | 655 | 40 | 22.0 | 82 | 95 |
| $\bar{x}$ | | | | 5.68 | 405 | | 82.3 | 25.3 | 3.23 | .04 | 781 | 41.0 | 21.3 | 94.7 | 98.7 |
| $\sigma$ | | | | .05 | 6.6 | | 1.2 | 1.2 | .07 | .01 | 124 | 1.7 | 1.2 | 14.2 | 3.2 |
| CV%[1] | | | | .83 | 1.6 | | 1.4 | 4.6 | 2.3 | 25 | 16 | 4.2 | 5.4 | 15 | 3.3 |

[1]Coefficient of variation.

Table 4G. - Within station variability for Cruise 1, Stations 5 and 13; Cruise 2, Stations 2, 4, 6 and 13; Cruise 3, Stations 6 and 13; Cruise 4, Stations 1 and 13 and Cruise 6, Stations 6, 13, and 14.- Continued.

| Field no. | Top (cm) | Btm (cm) | Lab no. | Al (%) | Ba (ppm) | Cd (ppm) | Cr (ppm) | Cu (ppm) | Fe (%) | Hg (ppm) | Mn (ppm) | Ni (ppm) | Pb (ppm) | V (ppm) | Zn (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C60611 | 0 | 2 | W-234563 | 5.17 | 399 | .03 | 72 | 18 | 2.81 | .02 | 644 | 49 | 12 | 96 | 71 |
| C60621 | 0 | 2 | W-234529 | 5.05 | 409 | .042 | 65 | 17 | 2.83 | 0.03 | 637 | 44 | 14 | 88 | 68 |
| C60631 | 0 | 2 | W-234530 | 4.83 | 397 | .042 | 65 | 18 | 2.73 | .03 | 889 | 44 | 17 | 82 | 65 |
| $\bar{x}$--- | | | | 5.02 | 402 | .038 | 67.3 | 17.7 | 2.79 | .027 | 723 | 45.7 | 14.3 | 88.7 | 68 |
| σ---- | | | | .17 | 6 | .007 | 4 | .6 | .05 | .006 | 144 | 2.9 | 2.5 | 7 | 3 |
| CV(%)[1]-- | | | | 3.4 | 1.6 | 18 | 6 | 3.3 | 1.9 | 22 | 20 | 6.3 | 18 | 7.9 | 4.4 |
| C61311 | 0 | 2 | W-234571 | 5.48 | 447 | .055 | 76 | 20 | 3.06 | .03 | 802 | 55 | 30 | 115 | 81 |
| C61321 | 0 | 2 | W-234531 | 5.48 | 427 | .055 | 71 | 20 | 3.07 | .03 | 886 | 51 | 22 | 98 | 80 |
| C61331 | 0 | 2 | W-234532 | 5.36 | 420 | .075 | 69 | 21 | 3.08 | .05 | 849 | 49 | 26 | 88 | 80 |
| $\bar{x}$--- | | | | 5.44 | 431 | .062 | 72 | 20.3 | 3.07 | .037 | 846 | 51.7 | 26 | 100 | 80.3 |
| σ---- | | | | .07 | 14 | .012 | 3.6 | .6 | .01 | .012 | 42 | 3 | 4 | 14 | .6 |
| CV(%)[1]-- | | | | 3.2 | 19 | 5 | 2.8 | .3 | 31 | 5 | 5.9 | 7.7 | 15 | .7 | |
| C61411 | 0 | 2 | W-234579 | 5.37 | 414 | .055 | 74 | 19 | 2.92 | .04 | 706 | 50 | 26 | 110 | 75 |
| C61421 | 0 | 2 | W-234533 | 4.95 | 374 | .042 | 62 | 15 | 2.82 | .03 | 574 | 42 | 16 | 77 | 68 |
| C61431 | 0 | 2 | W-234534 | 5.28 | 372 | .042 | 67 | 18 | 3.01 | .03 | 581 | 42 | 17 | 88 | 73 |
| $\bar{x}$--- | | | | 5.2 | 387 | .046 | 67.7 | 17.3 | 2.92 | .033 | 620 | 44.7 | 19.7 | 91.7 | 72 |
| σ---- | | | | .22 | 24 | .008 | 6 | 2.1 | .1 | .006 | 74 | 4.6 | 5.5 | 17 | 3.6 |
| CV(%)[1]-- | | | | 4.3 | 6.1 | 16 | 8.9 | 12 | 3.3 | 17 | 12 | 10 | 28 | 18 | 5 |

[1] Coefficient of variation

variability is less than 6 percent. From this, we conclude that the distribution of Ba is fairly uniform within circular areas on the continental slope having a diameter of 400 m. This size circle in most cases contains all the replicate box cores at a given station. The samples from Station 1, Cruises 3 and 6, and from Station 13, Cruise 6, show a higher coefficient of variation than other stations because the replicates include one sample that has elevated Ba, presumably caused by the addition of drilling mud.

Distribution of metals in surface sediments

We have plotted the concentration of metals, organic carbon, and textural parameters for each station occupied during Cruise 1 in the order of their latitude from north to south (Fig. 2A, B, C, and D and Table 5). Organic carbon and textural data were provided by the Battelle-WHOI contractors for this program.

The concentrations of metals in these sediments are the same or lower than they are in average shales from various locations around the world (Krauskopf, 1967), a similarity which suggests that these predrilling sediments had not been contaminated prior to this program. The variation in metal concentrations is small, generally within a factor of 2 over the entire study area.

The variation in concentration of metals, organic carbon, and clay is very similar from station to station. The close correlation among these variables can be explained by the varying proportion of clay in the sediment, which is expected to contain the highest concentration of the metals analyzed. At Station 11, the clay fraction, organic carbon, and most of the metals are at higher concentrations than those at adjacent stations shown in Figure 2C and 2D. At Station 12, we observed the lowest concentrations of clay, organic carbon, and most of the metals.

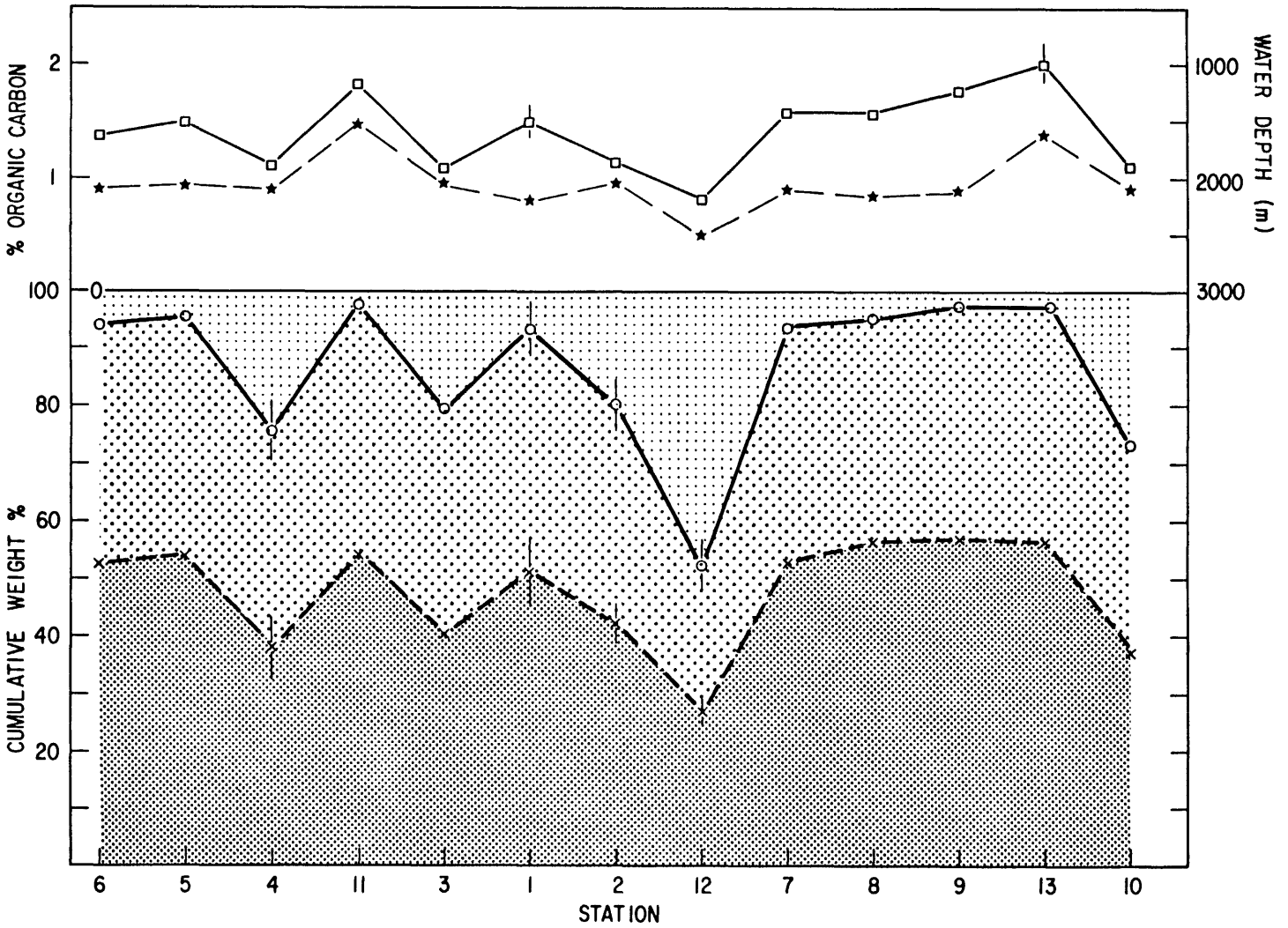


Figure 2A. Average concentration of organic carbon ( □ in percent) and water depth ( ★ in meters) at stations from Cruise 1 listed from north to south. Error bars represent standard deviation among three replicates.

2B. Average concentrations of clay ( ▩ ), silt ( ▩ ), and sand ( ▩ ) in cumulative wieght percent at stations from Cruise 1 listed from north to south. Error bars represent standard deviation among three replicates.

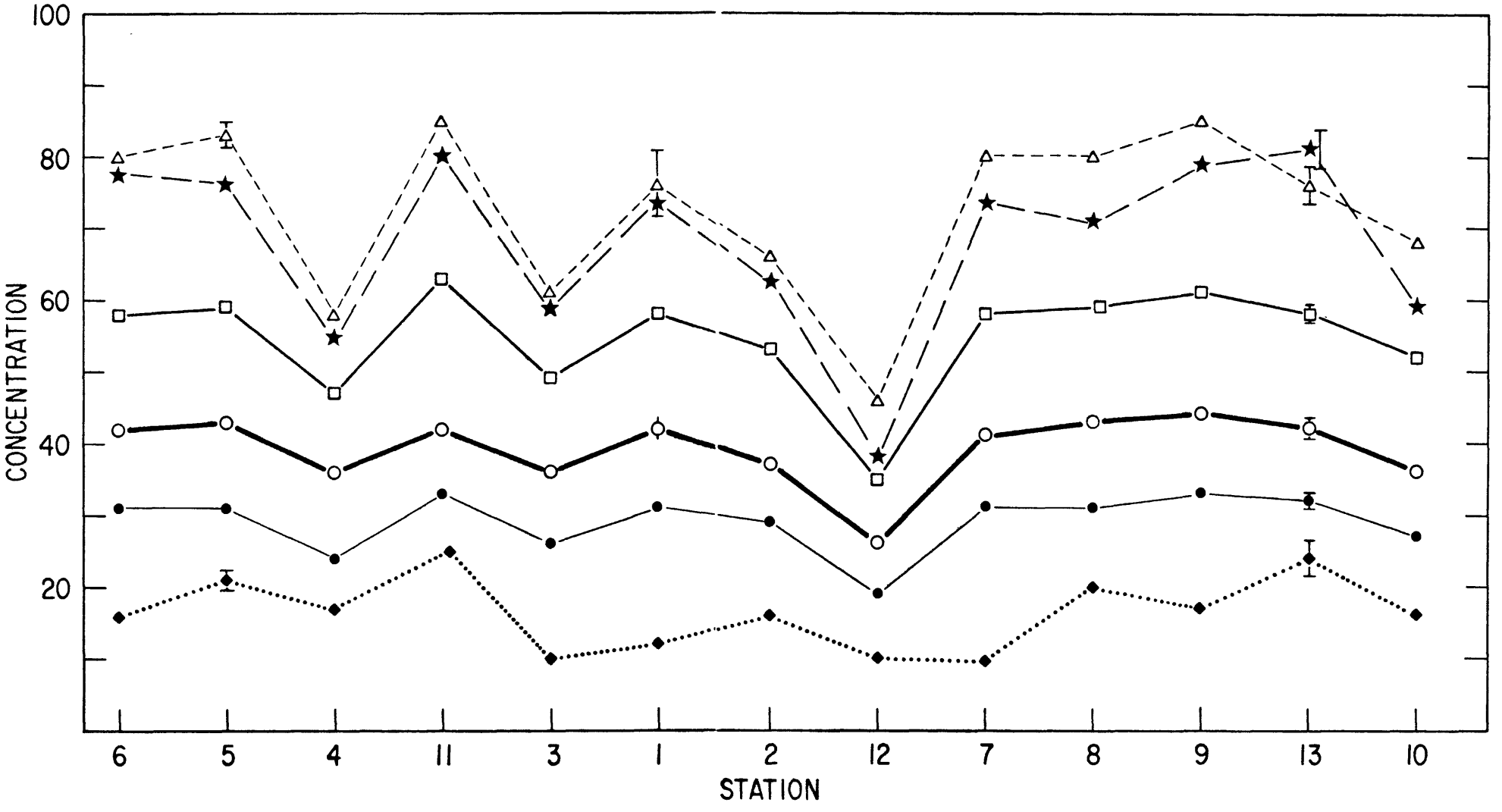


Figure 2C. Concentrations of metals in station blends from Cruise 1. Stations listed from north to south. (Al, □ % x 10; Ba, ○ ppm x $10^{-1}$; Cr, ★ ppm; Cu, ◆ ppm; Fe, ● % x 10; Zn, △ ppm.) Error bars represent standard deviation among three replicates at Stations 1, 5, and 13. Where error bars do not appear at these stations, error is within the area of the symbol.

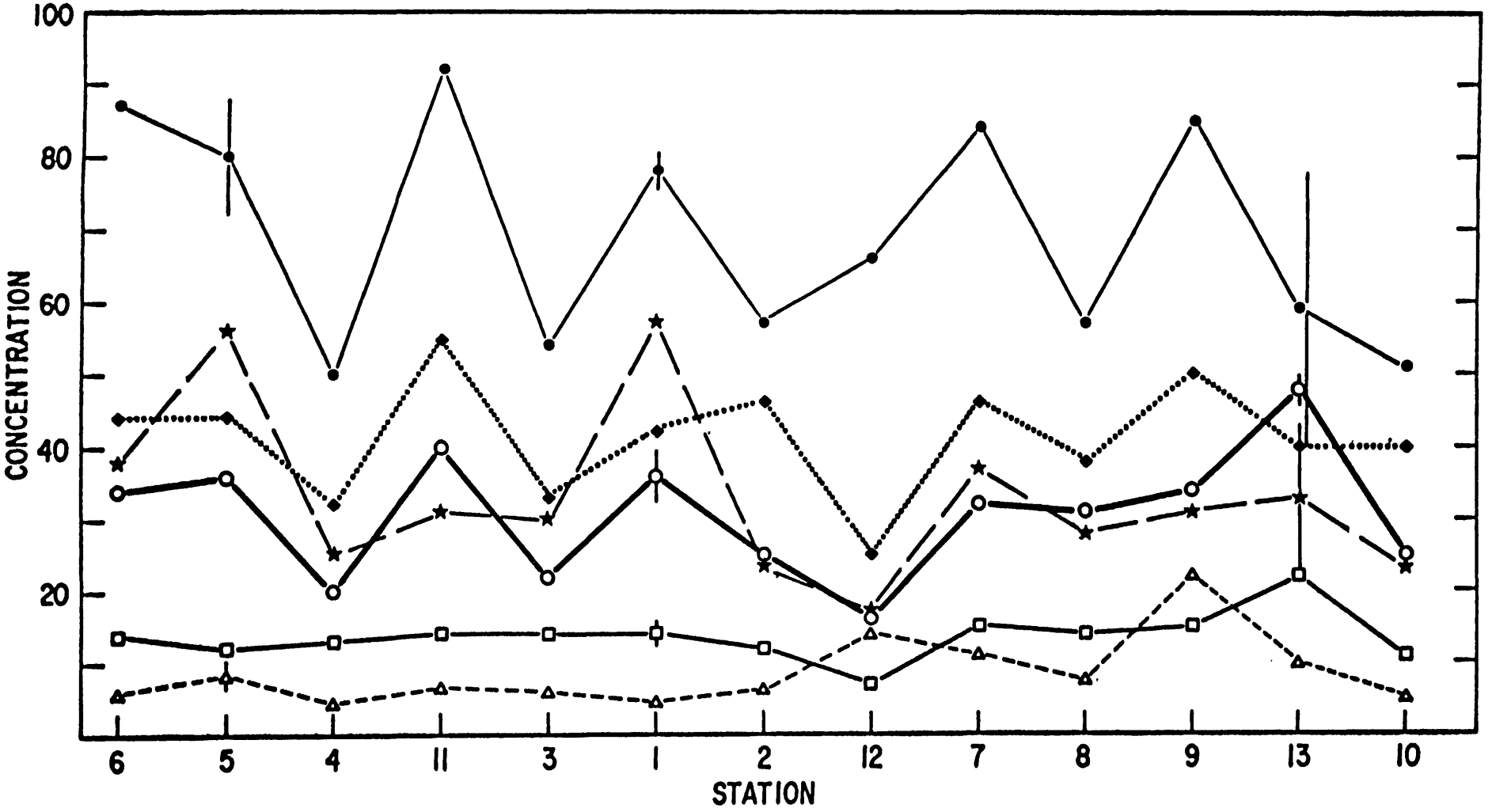


Figure 2D. Concentration of metals in station blends from Cruise 1. Stations listed from north to south. (Cd, △ ppm x $10^2$; Hg, ★ ppm x $10^3$; Mn, ● ppm x $10^{-1}$; Ni, ○ ppm; Pb, □ ppm; V, ◆ ppm x 1/2.) Error bars represent standard deviation among three replicates at Stations 1, 5, and 13. Where error bars do not appear at these stations, error is within the area of the symbol.

Table 5. - Chemical analysis of station blends.

| Field no. | Top (cm) | Btm (cm) | Lab no. | Al (%) | Ba (ppm) | Cd (ppm) | Cr (ppm) | Cu (ppm) | Fe (%) | Hg (ppm) | Mn (ppm) | Ni (ppm) | Pb (ppm) | V (ppm) | Zn (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C10100 | 0 | 2 | W-228518 | 5.80 | 420 | .045 | 73 | 12 | 3.10 | .057 | 780 | 36 | 14.0 | 83 | 76 |
| C20100 | 0 | 2 | W-228530 | 5.50 | 440 | .060 | 71 | 14 | 3.00 | .028 | 670 | 30 | 12.0 | 91 | 75 |
| C30100 | 0 | 2 | W-229811 | 5.25 | 444 | .041 | 75 | 18 | 2.97 | .031 | 519 | 36 | 13.0 | 90 | 71 |
| C40100 | 0 | 2 | W-231781 | 5.30 | 415 | .100 | 74 | 22 | 2.89 | .023 | 750 | 36 | 12.0 | 87 | 73 |
| C50100 | 0 | 2 | W-233024 | 4.53 | 364 | .033 | 69 | 16 | 2.57 | .025 | 494 | 34 | 9.1 | 74 | 66 |
| C60100 | 0 | 2 | W-234511 | 4.98 | 451 | .020L | 67 | 17 | 2.90 | .020 | 565 | 39 | 14.0 | 74 | 68 |
| C10200 | 0 | 2 | W-228519 | 5.30 | 370 | .063 | 63 | 16 | 2.90 | .023 | 570 | 25 | 12.0 | 91 | 66 |
| C20200 | 0 | 2 | W-228531 | 5.20 | 370 | .050 | 60 | 15 | 2.70 | .025 | 550 | 27 | 14.0 | 83 | 65 |
| C30200 | 0 | 2 | W-229812 | 4.82 | 386 | .045 | 69 | 17 | 2.72 | .027 | 607 | 30 | 11.0 | 84 | 63 |
| C40200 | 0 | 2 | W-231782 | 5.14 | 374 | .055 | 78 | 19 | 2.77 | .024 | 712 | 32 | 12.0 | 87 | 68 |
| C50200 | 0 | 2 | W-233025 | 4.28 | 323 | .042 | 64 | 14 | 2.32 | .005 | 502 | 30 | 13.0 | 70 | 60 |
| C60200 | 0 | 2 | W-234512 | 4.49 | 362 | .050 | 59 | 15 | 2.54 | .020 | 530 | 35 | 15.0 | 74 | 58 |
| C10300 | 0 | 2 | W-228520 | 4.90 | 360 | .060 | 58 | 10 | 2.60 | .030 | 540 | 22 | 14.0 | 66 | 61 |
| C20300 | 0 | 2 | W-228532 | 4.80 | 340 | .045 | 52 | 13 | 2.40 | .020 | 700 | 25 | 14.0 | 81 | 58 |
| C30300 | 0 | 2 | W-229813 | 4.20 | 335 | .120 | 55 | 13 | 2.25 | .024 | 439 | 24 | 10.0 | 76 | 50 |
| C40300 | 0 | 2 | W-231783 | 4.28 | 319 | .028 | 62 | 16 | 2.24 | .020 | 448 | 22 | 9.1 | 68 | 55 |
| C50300 | 0 | 2 | W-233026 | 4.26 | 333 | .066 | 64 | 16 | 2.29 | .010 | 476 | 35 | 9.1 | 78 | 63 |
| C60300 | 0 | 2 | W-234513 | 4.54 | 365 | .030 | 59 | 15 | 2.54 | .010 | 559 | 34 | 14.0 | 74 | 58 |
| C10400 | 0 | 2 | W-228521 | 4.70 | 360 | .045 | 54 | 17 | 2.40 | .025 | 500 | 20 | 13.0 | 63 | 58 |
| C20400 | 0 | 2 | W-228533 | 5.20 | 390 | .071 | 60 | 17 | 2.60 | .020 | 470 | 31 | 12.0 | 91 | 65 |
| C30400 | 0 | 2 | W-229814 | 4.49 | 365 | .025 | 62 | 14 | 2.43 | .023 | 594 | 30 | 10.0 | 94 | 56 |
| C40400 | 0 | 2 | W-231784 | 4.93 | 374 | .042 | 72 | 18 | 2.65 | .020 | 584 | 32 | 9.1 | 82 | 61 |
| C50400 | 0 | 2 | W-233027 | 4.43 | 354 | .050 | 68 | 17 | 2.41 | .025 | 585 | 36 | 11.0 | 74 | 63 |
| C60400 | 0 | 2 | W-234514 | 4.49 | 364 | .058 | 59 | 16 | 2.51 | .010 | 571 | 44 | 14.0 | 107 | 58 |
| C10500 | 0 | 2 | W-228522 | 5.90 | 430 | .083 | 76 | 21 | 3.10 | .056 | 800 | 36 | 12.0 | 87 | 83 |
| C20500 | 0 | 2 | W-228534 | 5.80 | 430 | .060 | 73 | 13 | 3.10 | .031 | 930 | 38 | 12.0 | 87 | 80 |
| C30500 | 0 | 2 | W-229815 | 5.33 | 438 | .050 | 85 | 21 | 3.04 | .035 | 775 | 44 | 14.0 | 98 | 76 |
| C40500 | 0 | 2 | W-231785 | 5.37 | 407 | .091 | 78 | 24 | 2.97 | .028 | 843 | 39 | 14.0 | 105 | 76 |
| C50500 | 0 | 2 | W-233028 | 4.93 | 380 | .055 | 75 | 20 | 2.73 | .030 | 723 | 41 | 11.0 | 94 | 75 |
| C60500 | 0 | 2 | W-234515 | 5.03 | 408 | .066 | 66 | 20 | 2.86 | .020 | 540 | 39 | 14.0 | 85 | 68 |
| C10600 | 0 | 2 | W-228523 | 5.80 | 420 | .060 | 78 | 16 | 3.10 | .038 | 870 | 34 | 14.0 | 87 | 80 |
| C20600 | 0 | 2 | W-228535 | 5.60 | 410 | .150 | 68 | 10 | 2.90 | .027 | 800 | 32 | 12.0 | 83 | 75 |
| C30600 | 0 | 2 | W-229816 | 5.10 | 406 | .050 | 70 | 19 | 2.86 | .030 | 777 | 35 | 13.0 | 87 | 68 |
| C40600 | 0 | 2 | W-231786 | 5.37 | 412 | .050 | 85 | 24 | 2.94 | .028 | 887 | 40 | 18.0 | 92 | 71 |
| C50600 | 0 | 2 | W-233029 | 4.96 | 382 | .088 | 75 | 20 | 2.74 | .020 | 570 | 43 | 13.0 | 84 | 71 |
| C60600 | 0 | 2 | W-234516 | 4.98 | 424 | .042 | 64 | 20 | 2.84 | .020 | 754 | 40 | 15.0 | 90 | 68 |
| C10700 | 0 | 2 | W-228524 | 5.80 | 410 | .110 | 73 | 9.5 | 3.10 | .037 | 840 | 32 | 15.0 | 91 | 80 |
| C20700 | 0 | 2 | W-228536 | 5.90 | 430 | .055 | 73 | 20 | 3.00 | .028 | 760 | 34 | 12.0 | 100 | 80 |
| C30700 | 0 | 2 | W-229817 | 5.48 | 443 | .063 | 80 | 22 | 3.10 | .030 | 710 | 39 | 11.0 | 98 | 76 |
| C40700 | 0 | 2 | W-231787 | 5.40 | 411 | .055 | 78 | 21 | 2.95 | .025 | 599 | 34 | 14.0 | 92 | 73 |
| C50700 | 0 | 2 | W-233030 | 5.12 | 399 | .063 | 77 | 21 | 2.83 | .030 | 468 | 43 | 9.9 | 88 | 75 |
| C60700 | 0 | 2 | W-234517 | 5.25 | 427 | .038 | 70 | 20 | 3.00 | .020 | 659 | 42 | 15.0 | 85 | 71 |

Table 5. - Chemical analysis of station blends. - Continued

| Field no. | Top (cm) | Btm (cm) | Lab no. | Al (%) | Ba (ppm) | Cd (ppm) | Cr (ppm) | Cu (ppm) | Fe (%) | Hg (ppm) | Mn (ppm) | Ni (ppm) | Pb (ppm) | V (ppm) | Zn (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C10800 | 0 | 2 | W-228525 | 5.90 | 430 | .075 | 71 | 20 | 3.10 | .028 | 570 | 31 | 14.0 | 75 | 80 |
| C20800 | 0 | 2 | W-228537 | 6.10 | 430 | .083 | 79 | 21 | 3.10 | .027 | 610 | 38 | 12.0 | 110 | 81 |
| C30800 | 0 | 2 | W-229818 | 5.63 | 441 | .058 | 82 | 22 | 3.18 | .030 | 510 | 45 | 14.0 | 102 | 80 |
| C10900 | 0 | 2 | W-228526 | 6.10 | 440 | .220 | 79 | 17 | 3.30 | .031 | 850 | 34 | 15.0 | 100 | 85 |
| C20900 | 0 | 2 | W-228538 | 6.30 | 440 | .091 | 79 | 22 | 3.30 | .033 | 800 | 37 | 13.0 | 100 | 81 |
| C30900 | 0 | 2 | W-229819 | 5.64 | 451 | .066 | 82 | 23 | 3.25 | .023 | 723 | 47 | 13.0 | 106 | 80 |
| C40900 | 0 | 2 | W-231788 | 5.72 | 429 | .063 | 83 | 24 | 3.16 | .025 | 587 | 45 | 12.0 | 110 | 85 |
| C50900 | 0 | 2 | W-233031 | 5.55 | 426 | .063 | 82 | 21 | 3.11 | .025 | 891 | 47 | 13.0 | 86 | 85 |
| C60900 | 0 | 2 | W-234518 | 5.15 | 430 | .058 | 69 | 21 | 2.97 | .020 | 513 | 44 | 15.0 | 96 | 70 |
| C11000 | 0 | 2 | W-228527 | 5.20 | 360 | .050 | 63 | 16 | 2.70 | .023 | 510 | 25 | 11.0 | 79 | 68 |
| C21000 | 0 | 2 | W-228539 | 5.00 | 350 | .055 | 60 | 16 | 2.60 | .030 | 520 | 24 | 7.5 | 87 | 65 |
| C31000 | 0 | 2 | W-229820 | 4.64 | 363 | .033 | 66 | 15 | 2.61 | .020 | 554 | 30 | 10.0 | 84 | 61 |
| C41000 | 0 | 2 | W-231789 | 4.75 | 345 | .033 | 70 | 17 | 2.60 | .028 | 594 | 36 | 9.1 | 82 | 68 |
| C51000 | 0 | 2 | W-233032 | 4.63 | 341 | .042 | 68 | 15 | 2.56 | .020 | 582 | 35 | 13.0 | 78 | 66 |
| C61000 | 0 | 2 | W-234519 | 4.39 | 371 | .033 | 57 | 16 | 2.46 | .010 | 525 | 33 | 12.0 | 80 | 58 |
| C11100 | 0 | 2 | W-228528 | 6.30 | 420 | .066 | 80 | 25 | 3.30 | .031 | 920 | 40 | 14.0 | 110 | 85 |
| C21100 | 0 | 2 | W-228540 | 6.10 | 410 | .075 | 76 | 20 | 3.20 | .033 | 660 | 32 | 14.0 | 96 | 83 |
| C31100 | 0 | 2 | W-229821 | 5.35 | 409 | .058 | 76 | 20 | 3.05 | .030 | 669 | 43 | 13.0 | 84 | 75 |
| C41100 | 0 | 2 | W-231790 | 5.52 | 392 | .033 | 79 | 21 | 3.08 | .028 | 699 | 43 | 14.0 | 94 | 83 |
| C51100 | 0 | 2 | W-233033 | 5.27 | 374 | .066 | 77 | 18 | 2.99 | .030 | 654 | 44 | 16.0 | 78 | 76 |
| C61100 | 0 | 2 | W-234520[1] | 4.40 | 295 | .030 | 129 | 15 | 6.96 | .010 | 398 | 36 | 12.0 | 158 | 66 |
| C11200 | 0 | 2 | W-228529 | 3.50 | 260 | .140 | 38 | 10 | 1.90 | .017 | 660 | 16 | 7.0 | 50 | 46 |
| C21200 | 0 | 2 | W-228541 | 3.80 | 270 | .220 | 44 | 10 | 2.00 | .017 | 660 | 19 | 5.8 | 69 | 50 |
| C31200 | 0 | 2 | W-229822 | 3.21 | 258 | .050 | 46 | 11 | 1.82 | .020 | 590 | 19 | 6.3 | 54 | 43 |
| C41200 | 0 | 2 | W-231791 | 3.20 | 246 | .028 | 46 | 11 | 1.73 | .016 | 626 | 17 | 6.3 | 45 | 43 |
| C51200 | 0 | 2 | W-233034 | 3.14 | 248 | .038 | 49 | 11 | 1.73 | .020 | 593 | 23 | 7.5 | 52 | 45 |
| C61200 | 0 | 2 | W-234521 | 3.06 | 241 | .042 | 43 | 9.6 | 1.78 | .010 | 611 | 20 | 4.6 | 42 | 38 |
| C11300 | 0 | 2 | W-228627 | 5.80 | 420 | .100 | 83 | 24 | 3.20 | .033 | 590 | 48 | 22.0 | 80 | 76 |
| C21300 | 0 | 2 | W-228542 | 6.30 | 430 | .070 | 82 | 23 | 3.40 | .038 | 790 | 36 | 16.0 | 116 | 90 |
| C31300 | 0 | 2 | W-229823 | 5.12 | 404 | .058 | 76 | 20 | 2.94 | .037 | 695 | 44 | 16.0 | 87 | 78 |
| C41300 | 0 | 2 | W-231792 | 5.70 | 407 | .075 | 81 | 28 | 3.21 | .044 | 776 | 46 | 23.0 | 98 | 88 |
| C51300 | 0 | 2 | W-233035 | 5.28 | 400 | .075 | 82 | 22 | 3.02 | .050 | 804 | 48 | 20.0 | 94 | 88 |
| C61300 | 0 | 2 | W-234522 | 5.40 | 434 | .050 | 71 | 20 | 3.11 | .030 | 841 | 47 | 18.0 | 98 | 78 |
| C41400 | 0 | 2 | W-231793 | 5.57 | 393 | .055 | 78 | 22 | 3.08 | .044 | 764 | 40 | 22.0 | 96 | 88 |
| C51400 | 0 | 2 | W-233036 | 5.10 | 386 | .083 | 78 | 20 | 2.85 | .045 | 610 | 45 | 24.0 | 86 | 85 |
| C61400 | 0 | 2 | W-234523 | 5.33 | 410 | .050 | 69 | 18 | 3.02 | .030 | 652 | 45 | 10.0 | 88 | 75 |

[1] Possibly contaminated with metal fragment.

According to some preliminary microscopic analyses of the sand fraction by Mr. Brian Dade, WHOI, the very high (50%) sand fraction at Station 12 is composed primarily of foraminifera tests. Because the metal concentration of calcite making up the foram tests is much lower than concentrations found in the clay minerals, the sand fraction in these samples essentially dilutes the metal concentrations with little influence on their relative proportions. Similar covariation in metals, organic carbon, and clay content was observed among the stations of the Georges Bank Monitoring Program (Bothner and others, 1982). On Georges Bank, however, the sand fraction was composed primarily of quartz and feldspar.

Changes in metal concentration as a result of drilling

Ba was the only metal found to increase in concentration as a result of drilling. The concentration increases were found only at one station adjacent to the drilling rig in Block 372. The magnitude of increases were small. We found that one core collected at Station 1 on Cruises 3 and 6 (Table 4C and 4F) had Ba concentrations 13 percent and 32 percent higher, respectively, than the predrilling mean value of 422 ±15 ppm. The Ba profile with depth in the core from Cruise 3 (see next section) confirms that the surface material is enriched.

The fact that only one of three subcores from the same box core shows the increase in Ba above background suggests that the distribution of Ba resulting from drilling is patchy on on a very small scale. The patchy increase in Ba may be due to the random addition of relatively large paticles of barite. We have identified large particles of barite (60 x 90 μm) in sediment trap samples (discussed in a following section).

At Station 13, 1.4 km southwest of the drill site in Block 92, and at Station 14, 0.6 km from the drill site, no indication of increased Ba was observed during analyses of replicates (Table 4) and station blends (Table 5).

In an attempt to concentrate any drilling mud, we separated the size fraction finer than 60 μm. Based on the textural analyses of standard barite by the American Petroleum Institute, approximately 96 percent of the barite is finer than 60 μm. By removing the natural sediment fraction coarser than 60 μm, the chemical signal of drilling mud in the remaining fine fraction can be significantly enhanced. This technique proved to be valuable on Georges Bank where the coarse fraction represented more than 98 percent of the sample (Bothner and others, 1985). On the slope and rise off the Middle Atlantic states, and due in part to the lower sand content (<20%) at most stations (Fig. 2B), the drilling-mud signal in the fine fraction at the drill sites (Table 6) was no more obvious than in the total sample.

## Trace-metal variations with depth in sediments

Samples from four stations have been subsampled as a function of sediment depth to determine the depth profiles of metal concentrations. The metal concentrations are shown in Table 7.

In the core collected at Station 1 before drilling began, the concentration of Ba and the Ba to Al ratio were essentially constant for the entire length of the core (Fig. 3). The Ba to Al ratio is plotted because it partially normalizes the Ba data for inhomogeneity in clay, calcium carbonate, and/or salt content of the sediments.

In the core collected during Cruises 2 and 3, the Ba concentration and the Ba to Al ratio were higher in surface sediments than in subsurface sediments. In postdrilling cores, the Ba maximum concentration and Ba to Al

Table 6. Chemical analyses of the fine fraction (less than 60 μm) from station blends.

| Field no. | Top (cm) | Btm (cm) | Lab no. | Al % | Ba (ppm) | Cd (ppm) | Cr (ppm) | Cu (ppm) | Fe % | Hg (ppm) | Mn (ppm) | Ni (ppm) | Pb (ppm) | V (ppm) | Zn (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C10100X | 0 | 2 | W-228543 | 6.10 | 430 | .091 | 79 | 24 | 3.20 | .039 | 780 | 36 | 14.0 | 120 | 85 |
| C20100X | 0 | 2 | W-228547 | 6.10 | 460 | .190 | 79 | 14 | 3.20 | .033 | 670 | 32 | 13.0 | 120 | 80 |
| C30100X | 0 | 2 | W-229824 | 5.47 | 445 | .045 | 80 | 21 | 3.08 | .031 | 532 | 47 | 12.0 | 87 | 78 |
| C40100X | 0 | 2 | W-231777 | 5.56 | 440 | .050 | 81 | 23 | 3.08 | .028 | 773 | 37 | 13.0 | 105 | 85 |
| C50100X | 0 | 2 | W-233012 | 5.06 | 409 | .055 | 73 | 21 | 2.77 | .025 | 556 | 38 | 16.0 | 78 | 71 |
| C60100X | 0 | 2 | W-234542 | 5.69 | 480 | .050 | 70 | 21 | 3.20 | .040 | 624 | 48 | 16.0 | 90 | 76 |
| C10200X | 0 | 2 | W-228544 | 6.30 | 430 | .050 | 79 | 21 | 3.30 | .043 | 610 | 32 | 15.0 | 120 | 81 |
| C20200X | 0 | 2 | W-228548 | 6.10 | 420 | .060 | 79 | 22 | 3.10 | .025 | 600 | 36 | 14.0 | 100 | 75 |
| C30200X | 0 | 2 | W-229825 | 5.43 | 417 | .048 | 83 | 22 | 3.06 | .029 | 698 | 47 | 12.0 | 96 | 76 |
| C60200X | 0 | 2 | W-234543 | 5.47 | 429 | .047 | 66 | 21 | 3.05 | .030 | 626 | 45 | 16.0 | 98 | 72 |
| C10300X | 0 | 2 | W-228545 | 5.90 | 410 | .083 | 76 | 16 | 3.10 | .033 | 590 | 30 | 15.0 | 110 | 76 |
| C20300X | 0 | 2 | W-228549 | 5.90 | 420 | .180 | 76 | 22 | 3.00 | .029 | 500 | 32 | 11.0 | 100 | 76 |
| C10400X | 0 | 2 | W-228546 | 5.80 | 400 | .046 | 76 | 19 | 2.90 | .037 | 560 | 32 | 14.0 | 100 | 73 |
| C20400X | 0 | 2 | W-228550 | 5.80 | 390 | .066 | 73 | 22 | 3.00 | .025 | 810 | 31 | 15.0 | 100 | 73 |
| C30400X | 0 | 2 | W-229826 | 5.22 | 402 | .045 | 81 | 22 | 2.87 | .024 | 702 | 47 | 12.0 | 96 | 70 |
| C40400X | 0 | 2 | W-231778 | 5.43 | 420 | .055 | 81 | 27 | 2.97 | .044 | 662 | 39 | 12.0 | 101 | 76 |
| C60400X | 0 | 2 | W-234544 | 5.23 | 414 | .042 | 62 | 21 | 2.89 | .040 | 639 | 46 | 14.0 | 90 | 68 |
| C50600X | 0 | 2 | W-233013 | 5.31 | 419 | .075 | 80 | 22 | 2.98 | .025 | 603 | 43 | 17.0 | 82 | 76 |
| C11300X | 0 | 2 | W-228628 | 6.00 | 430 | .083 | 89 | 26 | 3.30 | .033 | 590 | 49 | 22.0 | 90 | 76 |
| C21300X | 0 | 2 | W-228551 | 6.30 | 420 | .078 | 83 | 23 | 3.30 | .056 | 690 | 38 | 21.0 | 120 | 90 |
| C31300X | 0 | 2 | W-229827 | 5.74 | 434 | .066 | 86 | 23 | 3.33 | .042 | 743 | 54 | 17.0 | 94 | 86 |
| C41300X | 0 | 2 | W-231779 | 5.79 | 415 | .073 | 85 | 25 | 3.28 | .058 | 781 | 46 | 22.0 | 110 | 90 |
| C51300X | 0 | 2 | W-233014 | 5.35 | 398 | .080 | 78 | 25 | 3.08 | .060 | 779 | 45 | 20.0 | 82 | 81 |
| C61300X | 0 | 2 | W-234545 | 5.68 | 452 | .063 | 70 | 22 | 3.28 | .040 | 859 | 54 | 22.0 | 102 | 81 |
| C41400X | 0 | 2 | W-231780 | 5.70 | 398 | .063 | 81 | 22 | 3.17 | .044 | 776 | 42 | 22.0 | 110 | 78 |
| C51400X | 0 | 2 | W-233015 | 5.37 | 391 | .075 | 80 | 25 | 3.02 | .050 | 633 | 51 | 22.0 | 82 | 85 |
| C61400X | 0 | 2 | W-234546 | 5.66 | 448 | .050 | 71 | 21 | 3.22 | .030 | 675 | 49 | 20.0 | 128 | 77 |

Table 7. - Chemical analyses of core samples subsectioned in 2 cm intervals.

| Field no. | Top Dep (cm) | Bot Dep (cm) | Lab no. | Al (%) | Ba (ppm) | Cd (ppm) | Cr (ppm) | Cu (ppm) | Fe (%) | Hg (ppm) | Mn (ppm) | Ni (ppm) | Pb (ppm) | V (ppm) | Zn (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C10111 | 0 | 2 | W-228480 | 5.00 | 410 | 0.030 | 65 | 16 | 2.90 | 0.060 | 830 | 39 | 15.0 | 90 | 63 |
| C10111 | 2 | 4 | W-228481 | 5.00 | 410 | .048 | 69 | 12 | 2.90 | .040 | 960 | 40 | 13.0 | 90 | 753 |
| C10111 | 4 | 6 | W-228482 | 5.00 | 410 | .048 | 65 | 13 | 2.90 | .037 | 950 | 39 | 15.0 | 83 | 73 |
| C10111 | 8 | 10 | W-228483 | 5.00 | 410 | .055 | 68 | 21 | 2.80 | .023 | 490 | 39 | 14.0 | 89 | 76 |
| C10111 | 12 | 14 | W-228484 | 5.00 | 410 | .083 | 71 | 17 | 2.80 | .030 | 410 | 39 | 12.0 | 87 | 76 |
| C10111 | 16 | 18 | W-228485 | 5.00 | 410 | .091 | 69 | 12 | 2.80 | .030 | 320 | 36 | 12.0 | 100 | 75 |
| C10111 | 22 | 24 | W-228486 | 5.00 | 410 | .080 | 67 | 15 | 2.70 | .030 | 320 | 39 | 11.0 | 90 | 70 |
| C10111 | 28 | 30 | W-228487 | 4.90 | 400 | .110 | 67 | 14 | 2.70 | .028 | 320 | 40 | 12.0 | 87 | 73 |
| C20131 | 0 | 2 | W-228488 | 4.90 | 430 | .075 | 76 | 15 | 2.90 | .026 | 680 | 40 | 16.0 | 85 | 81 |
| C20131 | 2 | 4 | W-228489 | 5.00 | 400 | .055 | 71 | 18 | 3.00 | .036 | 660 | 41 | 14.0 | 85 | 76 |
| C20131 | 4 | 6 | W-228490 | 4.90 | 410 | .048 | 65 | 14 | 2.90 | .026 | 450 | 40 | 15.0 | 90 | 70 |
| C20131 | 8 | 10 | W-228491 | 4.90 | 400 | .066 | 68 | 15 | 2.80 | .027 | 340 | 40 | 13.0 | 87 | 75 |
| C20131 | 12 | 14 | W-228492 | 5.10 | 420 | .063 | 69 | 22 | 2.90 | .027 | 350 | 40 | 12.0 | 87 | 73 |
| C20131 | 16 | 18 | W-228493 | 5.10 | 400 | .075 | 72 | 29 | 2.90 | .021 | 330 | 44 | 11.0 | 85 | 73 |
| C20131 | 22 | 24 | W-228494 | 5.00 | 390 | .063 | 72 | 17 | 2.90 | .027 | 330 | 44 | 11.0 | 93 | 75 |
| C20131 | 28 | 30 | W-228495 | 5.10 | 390 | .083 | 71 | 23 | 2.90 | .023 | 330 | 42 | 11.0 | 89 | 75 |
| C30111 | 0 | 2 | W-229828 | 5.08 | 493 | .041 | 74 | 22 | 2.87 | .027 | 565 | 41 | 12.0 | 90 | 73 |
| C30111 | 2 | 4 | W-229790 | 5.62 | 509 | .057 | 80 | 23 | 3.12 | .024 | 542 | 40 | 9.8 | 102 | 89 |
| C30111 | 4 | 6 | W-229791 | 5.47 | 441 | .066 | 84 | 21 | 2.90 | .021 | 317 | 48 | 7.3 | 95 | 87 |
| C30111 | 8 | 10 | W-229792 | 5.64 | 451 | .065 | 87 | 22 | 3.16 | .021 | 341 | 50 | 8.7 | 102 | 90 |
| C30111 | 12 | 14 | W-229793 | 5.70 | 450 | .065 | 82 | 23 | 3.25 | .035 | 353 | 46 | 9.4 | 100 | 89 |
| C30111 | 16 | 18 | W-229794 | 5.77 | 453 | .066 | 84 | 23 | 3.05 | .020 | 354 | 46 | 7.3 | 98 | 89 |
| C30111 | 22 | 24 | W-229795 | 5.78 | 445 | .075 | 82 | 24 | 3.13 | .020 | 357 | 42 | 7.9 | 95 | 90 |
| C30111 | 24 | 26 | W-229796 | 5.66 | 449 | .077 | 82 | 30 | 3.17 | .016 | 360 | 44 | 7.9 | 95 | 90 |
| C40121 | 0 | 2 | W-232023 | 5.08 | 404 | .037 | 79 | 19 | 2.81 | .040 | 819 | 36 | 9.1 | 87 | 61 |
| C40121 | 2 | 4 | W-232024 | 5.37 | 412 | .050 | 80 | 20 | 2.98 | .040 | 603 | 36 | 10.0 | 94 | 61 |
| C40121 | 4 | 6 | W-232025 | 5.39 | 423 | .050 | 80 | 22 | 2.98 | .040 | 391 | 36 | 10.0 | 104 | 65 |
| C40121 | 6 | 8 | W-232026 | 5.38 | 423 | .058 | 80 | 22 | 2.94 | .040 | 355 | 39 | 7.5 | 100 | 70 |
| C40121 | 8 | 10 | W-232027 | 5.33 | 423 | .240 | 81 | 23 | 2.92 | .040 | 355 | 39 | 7.5 | 90 | 70 |
| C40121 | 14 | 16 | W-232028 | 5.54 | 415 | .071 | 84 | 23 | 2.99 | .040 | 346 | 36 | 9.6 | 102 | 75 |
| C40121 | 20 | 22 | W-232029 | 5.43 | 419 | .075 | 80 | 23 | 3.00 | .040 | 359 | 37 | 9.8 | 107 | 75 |
| C40121 | 24 | 26 | W-232030 | 5.45 | 414 | .055 | 83 | 22 | 3.00 | .040 | 362 | 36 | 9.1 | 102 | 61 |
| C50111 | 0 | 2 | W-233016 | 4.72 | 382 | .055 | 70 | 15 | 2.59 | .030 | 516 | 32 | 12.0 | 74 | 68 |
| C50111 | 2 | 4 | W-233769 | 5.40 | 408 | .050 | 70 | 20 | 2.89 | .050 | 595 | 45 | 7.8 | 117 | 75 |
| C50111 | 4 | 6 | W-233770 | 5.28 | 417 | .058 | 71 | 21 | 2.82 | .050 | 372 | 43 | 8.6 | 119 | 71 |
| C50111 | 6 | 8 | W-233771 | 5.47 | 418 | .083 | 70 | 22 | 2.89 | .050 | 326 | 46 | 9.3 | 123 | 68 |
| C50111 | 8 | 10 | W-233772 | 5.40 | 407 | .071 | 70 | 22 | 2.86 | .050 | 323 | 45 | 9.3 | 119 | 68 |
| C50111 | 14 | 16 | W-233773 | 5.39 | 417 | .083 | 70 | 22 | 2.86 | .050 | 327 | 48 | 8.6 | 123 | 68 |
| C50111 | 20 | 22 | W-233774 | 5.49 | 404 | .075 | 71 | 21 | 2.95 | .030 | 328 | 44 | 7.0 | 107 | 71 |
| C50111 | 26 | 28 | W-233775 | 5.51 | 412 | .071 | 70 | 22 | 2.97 | .040 | 338 | 50 | 7.0 | 109 | 66 |
| C60100 | 0 | 2 | W-234511 | 4.98 | 451 | .020L | 67 | 17 | 2.90 | .020 | 565 | 39 | 14.0 | 74 | 68 |
| C60121 | 2 | 4 | W-234535 | 5.68 | 452 | .025 | 72 | 22 | 3.23 | .030 | 798 | 48 | 16.0 | 98 | 77 |
| C60121 | 4 | 6 | W-234536 | 5.90 | 458 | .046 | 71 | 22 | 3.33 | .030 | 778 | 53 | 15.0 | 77 | 78 |
| C60121 | 6 | 8 | W-234537 | 5.82 | 455 | .050 | 72 | 21 | 3.22 | .030 | 388 | 51 | 14.0 | 104 | 78 |
| C60121 | 8 | 10 | W-234538 | 5.86 | 466 | .083 | 71 | 22 | 3.17 | .020 | 365 | 51 | 16.0 | 104 | 76 |
| C60121 | 14 | 16 | W-234539 | 5.59 | 475 | .091 | 72 | 20 | 2.96 | .020 | 360 | 51 | 15.0 | 137 | 76 |
| C60121 | 20 | 22 | W-234540 | 5.62 | 448 | .100 | 73 | 21 | 3.10 | .030 | 356 | 55 | 12.0 | 90 | 77 |
| C60121 | 28 | 30 | W-234541 | 5.65 | 463 | .091 | 69 | 22 | 3.19 | .020 | 360 | 49 | 12.0 | 112 | 75 |
| C10611 | 0 | 2 | W-228496 | 5.10 | 430 | .090 | 71 | 19 | 2.80 | .029 | 740 | 45 | 17.0 | 75 | 78 |
| C10611 | 2 | 4 | W-228497 | 5.30 | 440 | .075 | 73 | 17 | 3.00 | .027 | 680 | 51 | 14.0 | 90 | 81 |
| C10611 | 4 | 6 | W-228498 | 5.30 | 450 | .120 | 76 | 18 | 2.90 | .021 | 370 | 47 | 13.0 | 97 | 80 |
| C10611 | 8 | 10 | W-228499 | 5.30 | 440 | .130 | 72 | 27 | 2.80 | .025 | 330 | 47 | 14.0 | 87 | 80 |
| C10611 | 12 | 14 | W-228500 | 5.30 | 450 | .075 | 72 | 16 | 2.90 | .034 | 330 | 47 | 14.0 | 90 | 80 |
| C10611 | 16 | 18 | W-228501 | 5.30 | 460 | .110 | 76 | 15 | 2.90 | .013 | 340 | 51 | 13.0 | 91 | 80 |
| C10611 | 22 | 24 | W-228502 | 5.20 | 420 | .110 | 75 | 17 | 2.90 | .036 | 340 | 49 | 11.0 | 100 | 81 |
| C20611 | 0 | 2 | W-228503 | 4.80 | 420 | .063 | 69 | 17 | 2.70 | .034 | 880 | 45 | 15.0 | 100 | 71 |
| C20611 | 2 | 4 | W-228504 | 5.00 | 410 | .120 | 69 | 16 | 2.80 | .027 | 820 | 45 | 14.0 | 89 | 75 |
| C20611 | 4 | 6 | W-228505 | 5.10 | 420 | .075 | 71 | 17 | 2.70 | .032 | 350 | 42 | 13.0 | 100 | 80 |
| C20611 | 8 | 10 | W-228506 | 5.30 | 410 | .091 | 71 | 18 | 2.90 | .034 | 330 | 48 | 13.0 | 85 | 76 |
| C20611 | 12 | 14 | W-228507 | 5.20 | 400 | .190 | 71 | 21 | 2.90 | .031 | 330 | 48 | 15.0 | 100 | 80 |
| C20611 | 16 | 18 | W-228508 | 5.20 | 410 | .091 | 69 | 21 | 2.90 | .020 | 330 | 44 | 13.0 | 100 | 80 |
| C20611 | 20 | 22 | W-228509 | 5.20 | 420 | .100 | 73 | 20 | 3.00 | .057 | 340 | 47 | 13.0 | 100 | 80 |

Table 7. - Chemical analyses of core samples subsectioned in 2 cm intervals. - Continued

| Field no. | Top Dep (cm) | Bot Dep (cm) | Lab no. | Al (%) | Ba (ppm) | Cd (ppm) | Cr (ppm) | Cu (ppm) | Fe (%) | Hg (ppm) | Mn (ppm) | Ni (ppm) | Pb (ppm) | V (ppm) | Zn (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C30631 | 0 | 2 | W-229835 | 5.24 | 409 | .045 | 82 | 22 | 3.01 | .022 | 1202 | 47 | 13.0 | 94 | 73 |
| C30631 | 2 | 4 | W-229797 | 5.76 | 458 | .054 | 84 | 25 | 3.24 | .021 | 801 | 48 | 12.0 | 102 | 90 |
| C30631 | 4 | 6 | W-229798 | 5.64 | 455 | .077 | 82 | 24 | 3.09 | .020 | 409 | 42 | 11.0 | 98 | 90 |
| C30631 | 8 | 10 | W-229799 | 5.49 | 456 | .100 | 79 | 24 | 3.02 | .020 | 331 | 46 | 13.0 | 98 | 87 |
| C30631 | 12 | 14 | W-229800 | 5.62 | 445 | .100 | 76 | 24 | 3.11 | .020 | 338 | 42 | 13.0 | 98 | 85 |
| C30631 | 16 | 18 | W-229801 | 5.74 | 457 | .110 | 82 | 24 | 3.23 | .020 | 341 | 46 | 10.0 | 102 | 87 |
| C30631 | 20 | 22 | W-229802 | 5.74 | 457 | .066 | 60 | 22 | 3.22 | .020 | 341 | 43 | 7.7 | 110 | 87 |
| C30631 | 24 | 26 | W-229803 | 5.83 | 457 | .066 | 88 | 24 | 3.27 | .016 | 346 | 50 | 7.3 | 98 | 90 |
| C40600 | 0 | 2 | W-231786 | 5.37 | 412 | .050 | 85 | 24 | 2.94 | .028 | 887 | 40 | 18.0 | 92 | 71 |
| C40611 | 2 | 4 | W-232031 | 5.60 | 429 | .045 | 84 | 23 | 3.15 | .044 | 1187 | 40 | 11.0 | 104 | 70 |
| C40611 | 4 | 6 | W-232032 | 5.57 | 435 | .055 | 84 | 23 | 3.12 | .044 | 637 | 40 | 10.0 | 104 | 68 |
| C40611 | 6 | 8 | W-232033 | 5.58 | 446 | .091 | 84 | 24 | 3.04 | .040 | 357 | 40 | 11.0 | 120 | 68 |
| C40611 | 8 | 10 | W-232034 | 5.63 | 446 | .083 | 83 | 25 | 3.06 | .040 | 345 | 39 | 11.0 | 104 | 75 |
| C40611 | 10 | 12 | W-232035 | 5.58 | 446 | .063 | 82 | 26 | 3.00 | .040 | 340 | 39 | 10.0 | 120 | 75 |
| C40611 | 16 | 18 | W-232036 | 5.52 | 431 | .083 | 84 | 28 | 2.98 | .040 | 345 | 39 | 8.8 | 110 | 61 |
| C40611 | 22 | 24 | W-232037 | 5.52 | 438 | .110 | 82 | 23 | 3.06 | .040 | 356 | 42 | 9.1 | 102 | 76 |
| C40611 | 28 | 30 | W-232038 | 5.56 | 432 | .083 | 83 | 22 | 3.08 | .040 | 358 | 42 | 9.1 | 120 | 70 |
| C50611 | 0 | 2 | W-233017 | 5.13 | 416 | .063 | 75 | 18 | 2.85 | .040 | 618 | 39. | 9.9 | 82 | 73 |
| C50611 | 2 | 4 | W-233762 | 5.61 | 424 | .080 | 77 | 24 | 3.02 | .040 | 587 | 52 | 8.6 | 111 | 71 |
| C50611 | 4 | 6 | W-233763 | 5.64 | 423 | .100 | 76 | 24 | 2.99 | .050 | 413 | 48 | 8.0 | 127 | 75 |
| C50611 | 6 | 8 | W-233764 | 5.75 | 415 | .110 | 73 | 23 | 3.01 | .050 | 326 | 50 | 8.0 | 123 | 76 |
| C50611 | 8 | 10 | W-233765 | 5.79 | 426 | .096 | 74 | 22 | 3.04 | .050 | 316 | 52 | 8.0 | 111 | 71 |
| C50611 | 14 | 16 | W-233766 | 5.70 | 419 | .096 | 74 | 23 | 3.00 | .050 | 317 | 50 | 7.0 | 131 | 76 |
| C50611 | 22 | 24 | W-233767 | 5.75 | 413 | .080 | 75 | 24 | 3.09 | .040 | 334 | 52 | 7.1 | 127 | 75 |
| C50611 | 30 | 32 | W-233768 | 5.66 | 412 | .091 | 75 | 22 | 3.07 | .030 | 347 | 52 | 6.6 | 127 | 70 |
| C60611 | 0 | 2 | W-234563 | 5.17 | 399 | .030 | 72 | 18 | 2.81 | .020 | 644 | 49 | 12.0 | 96 | 71 |
| C60611 | 2 | 4 | W-234564 | 5.42 | 423 | .083 | 80 | 21 | 2.88 | .020 | 376 | 52 | 15.0 | 113 | 76 |
| C60611 | 4 | 6 | W-234565 | 5.50 | 426 | .083 | 80 | 23 | 2.88 | .020 | 324 | 52 | 17.0 | 118 | 76 |
| C60611 | 6 | 8 | W-234566 | 5.63 | 427 | .083 | 78 | 23 | 2.91 | .020 | 322 | 52 | 15.0 | 113 | 75 |
| C60611 | 8 | 10 | W-234567 | 5.44 | 425 | .055 | 76 | 23 | 2.96 | .020 | 325 | 55 | 15.0 | 120 | 76 |
| C60611 | 16 | 18 | W-234568 | 5.51 | 422 | .071 | 80 | 24 | 2.97 | .020 | 338 | 55 | 14.0 | 125 | 73 |
| C60611 | 22 | 24 | W-234569 | 5.50 | 427 | .083 | 76 | 20 | 3.00 | .005L | 339 | 50 | 9.0 | 120 | 71 |
| C60611 | 28 | 30 | W-234570 | 5.60 | 432 | .083 | 80 | 20 | 3.03 | .005L | 353 | 55 | 11.0 | 115 | 73 |
| C11311 | 0 | 2 | W-228600 | 6.00 | 430 | .110 | 83 | 28 | 3.40 | .035 | 800 | 45 | 27.0 | 86 | 81 |
| C11311 | 2 | 4 | W-228601 | 6.00 | 430 | .100 | 86 | 30 | 3.40 | .031 | 700 | 45 | 19.0 | 84 | 81 |
| C11311 | 4 | 6 | W-228602 | 6.10 | 440 | .083 | 89 | 29 | 3.40 | .023 | 350 | 45 | 17.0 | 100 | 76 |
| C11311 | 8 | 10 | W-228603 | 6.20 | 460 | .230 | 88 | 28 | 3.20 | .017 | 320 | 47 | 12.0 | 110 | 80 |
| C11311 | 12 | 14 | W-228604 | 6.10 | 440 | .180 | 86 | 25 | 3.10 | .020 | 320 | 47 | 15.0 | 86 | 78 |
| C11311 | 16 | 18 | W-228605 | 6.10 | 440 | .180 | 86 | 29 | 3.20 | .017 | 330 | 44 | 13.0 | 92 | 76 |
| C11311 | 24 | 26 | W-228606 | 6.20 | 440 | .200 | 92 | 24 | 3.30 | .017 | 320 | 50 | 9.1 | 100 | 76 |
| C21311 | 0 | 2 | W-228593 | 6.00 | 430 | .096 | 81 | 29 | 3.40 | .060 | 880 | 48 | 24.0 | 84 | 80 |
| C21311 | 2 | 4 | W-228594 | 6.10 | 440 | .075 | 81 | 25 | 3.50 | .034 | 440 | 45 | 16.0 | 80 | 76 |
| C21311 | 4 | 6 | W-228595 | 6.20 | 450 | .160 | 86 | 28 | 3.40 | .025 | 340 | 47 | 14.0 | 86 | 78 |
| C21311 | 8 | 10 | W-228596 | 6.00 | 430 | .190 | 95 | 25 | 3.20 | .023 | 310 | 47 | 13.0 | 84 | 75 |
| C21311 | 12 | 14 | W-228597 | 6.20 | 440 | .170 | 83 | 28 | 3.30 | .023 | 320 | 47 | 11.0 | 84 | 78 |
| C21311 | 16 | 18 | W-228598 | 6.10 | 430 | .200 | 83 | 25 | 3.30 | .023 | 330 | 47 | 13.0 | 89 | 75 |
| C21311 | 24 | 26 | W-228599 | 5.90 | 420 | .220 | 83 | 26 | 3.30 | .018 | 330 | 47 | 11.0 | 90 | 76 |
| C31311 | 0 | 2 | W-229836 | 5.45 | 425 | .066 | 82 | 24 | 3.10 | .032 | 611 | 50 | 25.0 | 104 | 80 |
| C30631 | 2 | 4 | W-229804 | 5.96 | 461 | .058 | 95 | 25 | 3.43 | .033 | 723 | 50 | 18.0 | 107 | 100 |
| C31311 | 4 | 6 | W-229805 | 5.99 | 454 | .050 | 88 | 25 | 3.44 | .031 | 707 | 46 | 17.0 | 107 | 100 |
| C31311 | 8 | 10 | W-229806 | 6.05 | 453 | .100 | 80 | 24 | 3.36 | .026 | 351 | 42 | 14.0 | 115 | 98 |
| C31311 | 12 | 14 | W-229807 | 6.33 | 471 | .130 | 87 | 24 | 3.46 | .020 | 319 | 44 | 9.1 | 110 | 99 |
| C31311 | 16 | 18 | W-229808 | 6.23 | 467 | .120 | 87 | 24 | 3.37 | .020 | 301 | 42 | 7.7 | 107 | 98 |
| C31311 | 24 | 26 | W-229809 | 6.17 | 465 | .130 | 91 | 23 | 3.43 | .020 | 319 | 47 | 7.3 | 110 | 98 |
| C31311 | 28 | 30 | W-229810 | 6.00 | 453 | .130 | 91 | 23 | 3.29 | .020 | 312 | 48 | 9.1 | 107 | 95 |

Table 7. - Chemical analyses of core samples subsectioned in 2 cm intervals. - Continued

| Field no. | Top Dep (cm) | Bot Dep (cm) | Lab no. | Al (%) | Ba (ppm) | Cd (ppm) | Cr (ppm) | Cu (ppm) | Fe (%) | Hg (ppm) | Mn (ppm) | Ni (ppm) | Pb (ppm) | V (ppm) | Zn (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C41311 | 0 | 2 | W-231769 | 5.63 | 412 | .066 | 81 | 26 | 3.15 | .032 | 783 | 40 | 20.0 | 92 | 100 |
| C41331 | 2 | 4 | W-231751 | 5.90 | 442 | .066 | 78 | 25 | 3.28 | .048 | 417 | 43 | 25.0 | 112 | 90 |
| C41331 | 4 | 6 | W-231752 | 6.00 | 437 | .140 | 79 | 27 | 3.29 | .040 | 355 | 45 | 22.0 | 124 | 91 |
| C41331 | 6 | 8 | W-231753 | 6.04 | 450 | .120 | 81 | 26 | 3.23 | .028 | 343 | 43 | 15.0 | 130 | 88 |
| C41331 | 8 | 10 | W-231754 | 6.07 | 444 | .150 | 79 | 26 | 3.26 | .020 | 343 | 43 | 11.0 | 121 | 88 |
| C41331 | 10 | 12 | W-231755 | 6.01 | 445 | .160 | 78 | 23 | 3.22 | .016 | 336 | 46 | 9.6 | 130 | 83 |
| C41331 | 16 | 18 | W-231756 | 5.93 | 434 | .140 | 77 | 24 | 3.24 | .021 | 341 | 40 | 9.6 | 121 | 85 |
| C41331 | 22 | 24 | W-231757 | 5.91 | 434 | .120 | 77 | 24 | 3.26 | .016 | 345 | 45 | 9.6 | 126 | 83 |
| C41331 | 26 | 28 | W-231758 | 5.96 | 476 | .160 | 78 | 24 | 3.27 | .012 | 363 | 45 | 9.6 | 130 | 85 |
| C51311 | 0 | 2 | W-233018 | 5.47 | 404 | .075 | 79 | 20 | 3.12 | .040 | 628 | 48 | 18.0 | 94 | 85 |
| C51311 | 2 | 4 | W-233755 | 6.26 | 428 | .066 | 85 | 24 | 3.51 | .050 | 358 | 60 | 12.0 | 151 | 83 |
| C51311 | 4 | 6 | W-233756 | 6.33 | 435 | .140 | 81 | 25 | 3.48 | .030 | 328 | 54 | 11.0 | 135 | 88 |
| C51311 | 6 | 8 | W-233757 | 6.29 | 437 | .160 | 83 | 27 | 3.36 | .040 | 342 | 56 | 11.0 | 129 | 91 |
| C51311 | 8 | 10 | W-233758 | 6.24 | 431 | .150 | 81 | 23 | 3.31 | .040 | 342 | 60 | 7.1 | 149 | 91 |
| C51311 | 14 | 16 | W-233759 | 6.23 | 433 | .140 | 81 | 23 | 3.28 | .040 | 333 | 60 | 8.0 | 139 | 91 |
| C51311 | 22 | 24 | W-233760 | 6.11 | 437 | .170 | 82 | 23 | 3.33 | .030 | 346 | 66 | 7.0 | 135 | 86 |
| C51311 | 28 | 30 | W-233761 | 6.02 | 416 | .120 | 81 | 22 | 3.27 | .030 | 338 | 60 | 6.6 | 129 | 80 |
| C61311 | 0 | 2 | W-234571 | 5.48 | 447 | .055 | 76 | 20 | 3.06 | .030 | 802 | 55 | 30.0 | 115 | 81 |
| C61311 | 2 | 4 | W-234572 | 6.12 | 436 | .046 | 84 | 22 | 3.48 | .040 | 1297 | 62 | 31.0 | 120 | 100 |
| C61311 | 4 | 6 | W-234573 | 6.22 | 443 | .038 | 86 | 22 | 3.50 | .040 | 464 | 60 | 20.0 | 130 | 85 |
| C61311 | 6 | 8 | W-234574 | 6.28 | 452 | .055 | 86 | 24 | 3.38 | .030 | 356 | 60 | 20.0 | 125 | 96 |
| C61311 | 10 | 8 | W-234575 | 6.21 | 453 | .083 | 84 | 24 | 3.37 | .020 | 348 | 61 | 16.0 | 125 | 85 |
| C61311 | 16 | 18 | W-234576 | 6.10 | 441 | .083 | 84 | 23 | 3.33 | .020 | 349 | 60 | 15.0 | 125 | 83 |
| C61311 | 22 | 24 | W-234577 | 6.07 | 434 | .140 | 86 | 20 | 3.26 | .010 | 341 | 60 | 12.0 | 120 | 80 |
| C61311 | 28 | 30 | W-234578 | 5.99 | 432 | .120 | 86 | 21 | 3.37 | .010 | 354 | 62 | 9.2 | 120 | 80 |
| C11411 | 0 | 2 | W-230725 | 5.91 | 406 | .061 | 76 | 23 | 3.31 | .040 | 766 | 42 | 23.0 | 97 | 83 |
| C11411 | 2 | 4 | W-230726 | 5.94 | 397 | .055 | 75 | 22 | 3.34 | .021 | 565 | 39 | 16.0 | 106 | 83 |
| C11411 | 4 | 6 | W-230727 | 6.00 | 410 | .100 | 74 | 24 | 3.20 | .021 | 334 | 40 | 15.0 | 106 | 85 |
| C11411 | 6 | 8 | W-230728 | 6.03 | 417 | .140 | 78 | 23 | 3.16 | .016 | 328 | 40 | 13.0 | 101 | 83 |
| C11411 | 12 | 14 | W-230729 | 5.84 | 400 | .120 | 68 | 22 | 3.09 | .012 | 319 | 40 | 11.0 | 93 | 80 |
| C11411 | 18 | 20 | W-230730 | 5.84 | 405 | .100 | 73 | 22 | 3.21 | .012 | 327 | 42 | 12.0 | 106 | 78 |
| C11411 | 24 | 26 | W-230731 | 5.86 | 408 | .100 | 75 | 19 | 3.24 | .012 | 324 | 40 | 8.3 | 101 | 78 |
| C11411 | 28 | 30 | W-230732 | 5.87 | 408 | .120 | 73 | 21 | 3.24 | .005L | 335 | 42 | 7.8 | 101 | 81 |
| C11411 | 32 | 34 | W-230733 | 5.97 | 411 | .180 | 76 | 23 | 3.32 | .006 | 338 | 42 | 11.0 | 106 | 81 |
| C41421 | 0 | 2 | W-231773 | 5.59 | 411 | .055 | 79 | 21 | 3.15 | .040 | 832 | 42 | 18.0 | 82 | 88 |
| C41421 | 2 | 4 | W-231759 | 5.93 | 428 | .083 | 77 | 25 | 3.21 | .021 | 386 | 40 | 15.0 | 124 | 83 |
| C41421 | 4 | 6 | W-231760 | 6.00 | 443 | .150 | 78 | 24 | 3.20 | .024 | 350 | 40 | 13.0 | 126 | 83 |
| C41421 | 6 | 8 | W-231761 | 6.00 | 438 | .140 | 78 | 23 | 3.18 | .021 | 345 | 42 | 11.0 | 130 | 83 |
| C41421 | 8 | 10 | W-231762 | 5.95 | 444 | .150 | 78 | 28 | 3.14 | .020 | 346 | 42 | 10.0 | 130 | 85 |
| C41421 | 10 | 12 | W-231763 | 5.96 | 457 | .150 | 77 | 30 | 3.14 | .026 | 344 | 42 | 12.0 | 126 | 83 |
| C41421 | 16 | 18 | W-231764 | 6.00 | 446 | .150 | 78 | 25 | 3.18 | .015 | 345 | 42 | 9.7 | 125 | 83 |
| C41421 | 22 | 24 | W-231765 | 6.07 | 450 | .190 | 76 | 23 | 3.23 | .012 | 339 | 40 | 8.1 | 124 | 83 |
| C51411 | 0 | 2 | W-233019 | 5.20 | 381 | .090 | 77 | 20 | 2.89 | .040 | 641 | 44 | 19.0 | 78 | 85 |
| C51411 | 2 | 4 | W-233037 | 5.70 | 412 | .091 | 84 | 25 | 3.20 | .050 | 721 | 51 | 25.0 | 103 | 90 |
| C51411 | 4 | 6 | W-233038 | 5.86 | 434 | .075 | 85 | 23 | 3.29 | .045 | 728 | 52 | 19.0 | 96 | 88 |
| C51411 | 6 | 8 | W-233039 | 6.03 | 437 | .042 | 86 | 21 | 3.36 | .030 | 486 | 53 | 7.2 | 96 | 88 |
| C51411 | 10 | 12 | W-233040 | 5.97 | 418 | .088 | 85 | 23 | 3.27 | .015 | 357 | 52 | 14.0 | 98 | 87 |
| C51411 | 16 | 18 | W-233043 | 5.91 | 420 | .120 | 82 | 22 | 3.20 | .025 | 347 | 53 | 11.0 | 99 | 85 |
| C51411 | 22 | 24 | W-233042 | 5.82 | 422 | .100 | 83 | 24 | 3.15 | .020 | 336 | 52 | 8.1 | 103 | 85 |
| C61411 | 0 | 2 | W-234579 | 5.37 | 414 | .055 | 74 | 19 | 2.92 | .040 | 706 | 50 | 26.0 | 110 | 75 |
| C61411 | 2 | 4 | W-234580 | 5.89 | 411 | .025 | 80 | 21 | 3.27 | .040 | 698 | 55 | 22.0 | 115 | 80 |
| C61411 | 4 | 6 | W-234581 | 5.99 | 420 | .042 | 82 | 23 | 3.32 | .040 | 344 | 52 | 17.0 | 120 | 81 |
| C61411 | 6 | 8 | W-234582 | 6.08 | 428 | .100 | 82 | 22 | 3.22 | .020 | 327 | 58 | 12.0 | 140 | 80 |
| C61411 | 8 | 10 | W-234583 | 6.07 | 434 | .190 | 78 | 23 | 3.17 | .020 | 323 | 58 | 13.0 | 140 | 81 |
| C61411 | 14 | 16 | W-234584 | 6.01 | 413 | .130 | 80 | 22 | 3.25 | .020 | 326 | 58 | 11.0 | 135 | 78 |
| C61411 | 18 | 20 | W-234585 | 6.02 | 409 | .110 | 80 | 22 | 3.26 | .030 | 329 | 55 | 8.6 | 130 | 80 |
| C61411 | 24 | 26 | W-234586 | 6.38 | 415 | .110 | 80 | 22 | 3.36 | .010 | 349 | 59 | 14.0 | 135 | 78 |

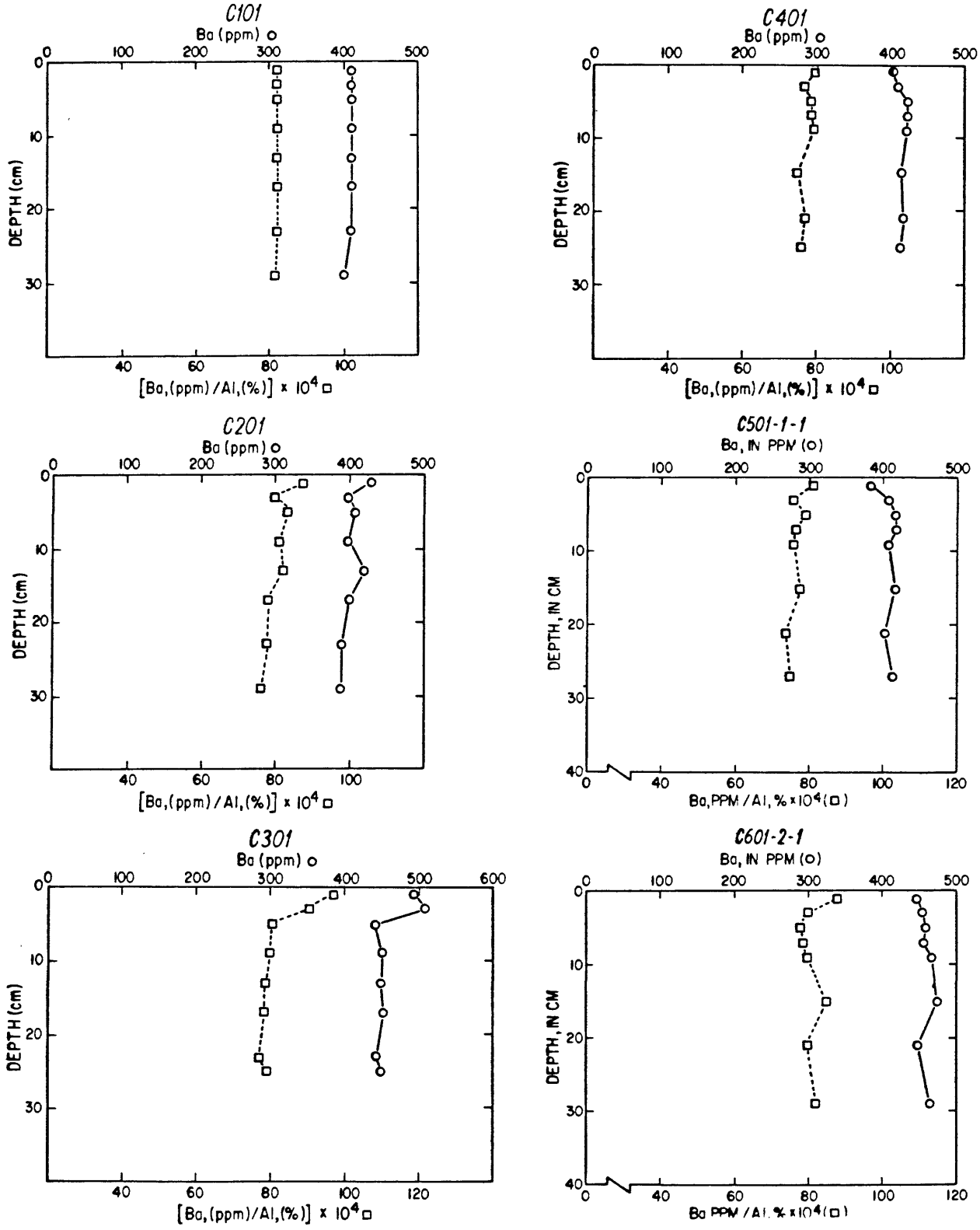


Figure 3. Distribution of barium and barium to aluminum ratio with sediment depth; Cruises 1-6, Station 1. (C101 = Cruise 1, Station 1).

ratio within 4 cm of the sediment surface were 13 and 25 percent higher, respectively, than in samples deeper in the sediment. These trends support the conclusion that a small increase in drilling-related Ba can be measured at Station 1.

Station 6 is located about 83 km from the drilling in Block 372. At this station the distributions of Ba and the Ba-to-Al ratio with depth showed no consistent patterns (Fig. 4). Small increases in the Ba-to-Al ratio were measured in the surface sediments in cores from Cruises 2 and 6, but no increases in Ba concentrations.

Similarly, cores from Station 13 showed no enrichment in the concentration of Ba and the Ba-to-Al ratio was slightly higher in only two of the five postdrilling samples (Fig. 5). This station is located about 1.4 km southwest of the drilling site in Block 93. Drilling began on July 14, 1984 about four weeks before Cruise 2 and was completed November 4, 1984 just before Cruise 3.

Samples from Station 14 (drill site in Block 93) were collected only on Cruises 1, 4, 5, and 6 (Fig. 6). The profiles of Ba and Ba-to-Al ratio are essentially the same for both the predrilling and postdrilling samples.

In cores collected on Cruise 1 at Stations 1, 6, 13, and 14, the concentration of Ba and the Ba-to-Al ratio in the surface sediments were not elevated in comparison with deeper sediments. This suggests that the drilling which occurred before Cruise 1 did not contribute Ba to the general area of this survey to a measurable degree.

The concentrations of Pb and Mn in the upper few centimeters of these cores were consistently higher than in the deeper sediments (Figs. 7-12). The profiles of these metals for all six cruises at a given station are very similar (Table 7, Figs. 7-12) confirming that the changes with depth are

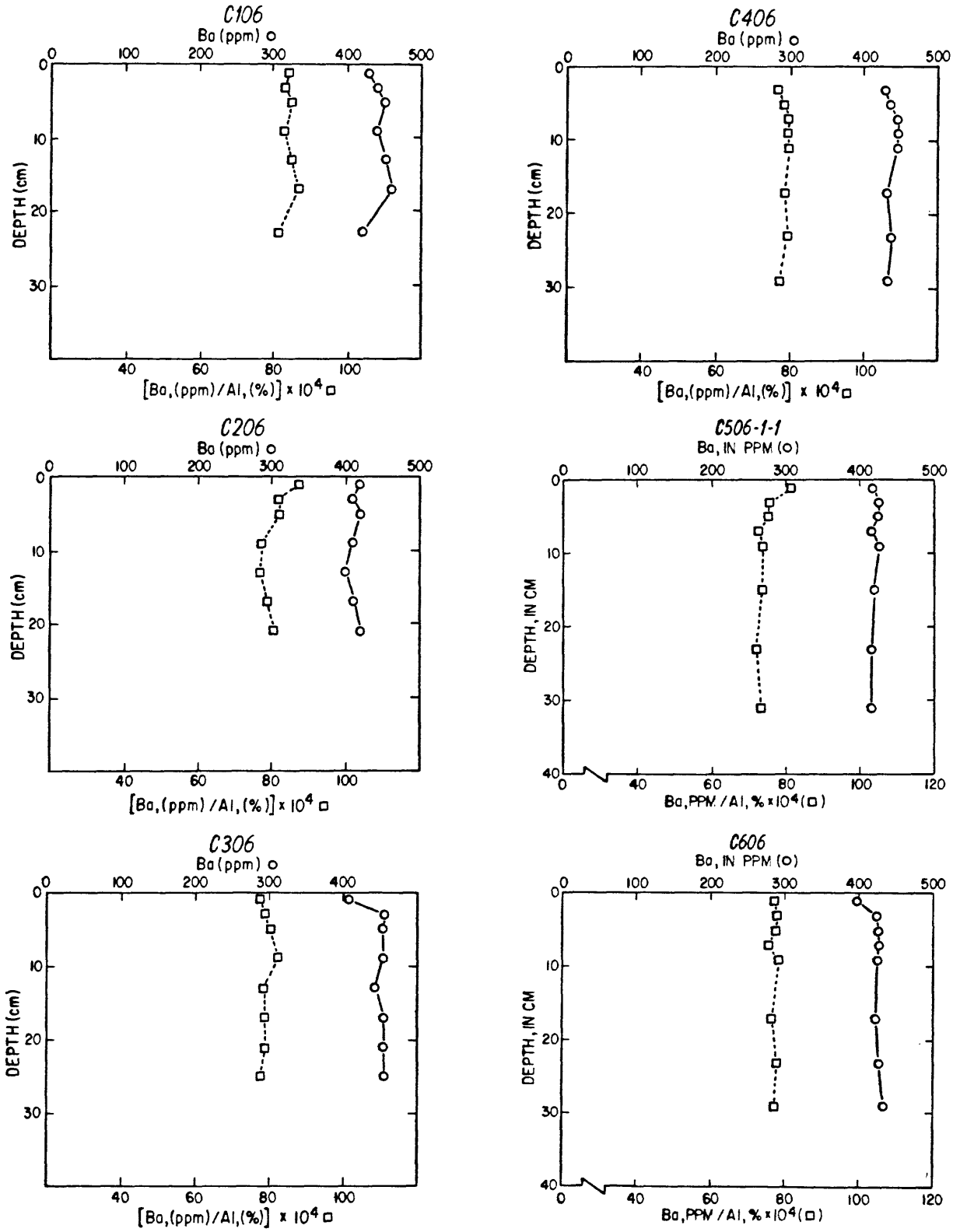


Figure 4. Distribution of barium and barium to aluminum ratio with sediment depth; Cruises 1-6, Station 6. (C106 = Cruise 1, Station 6).

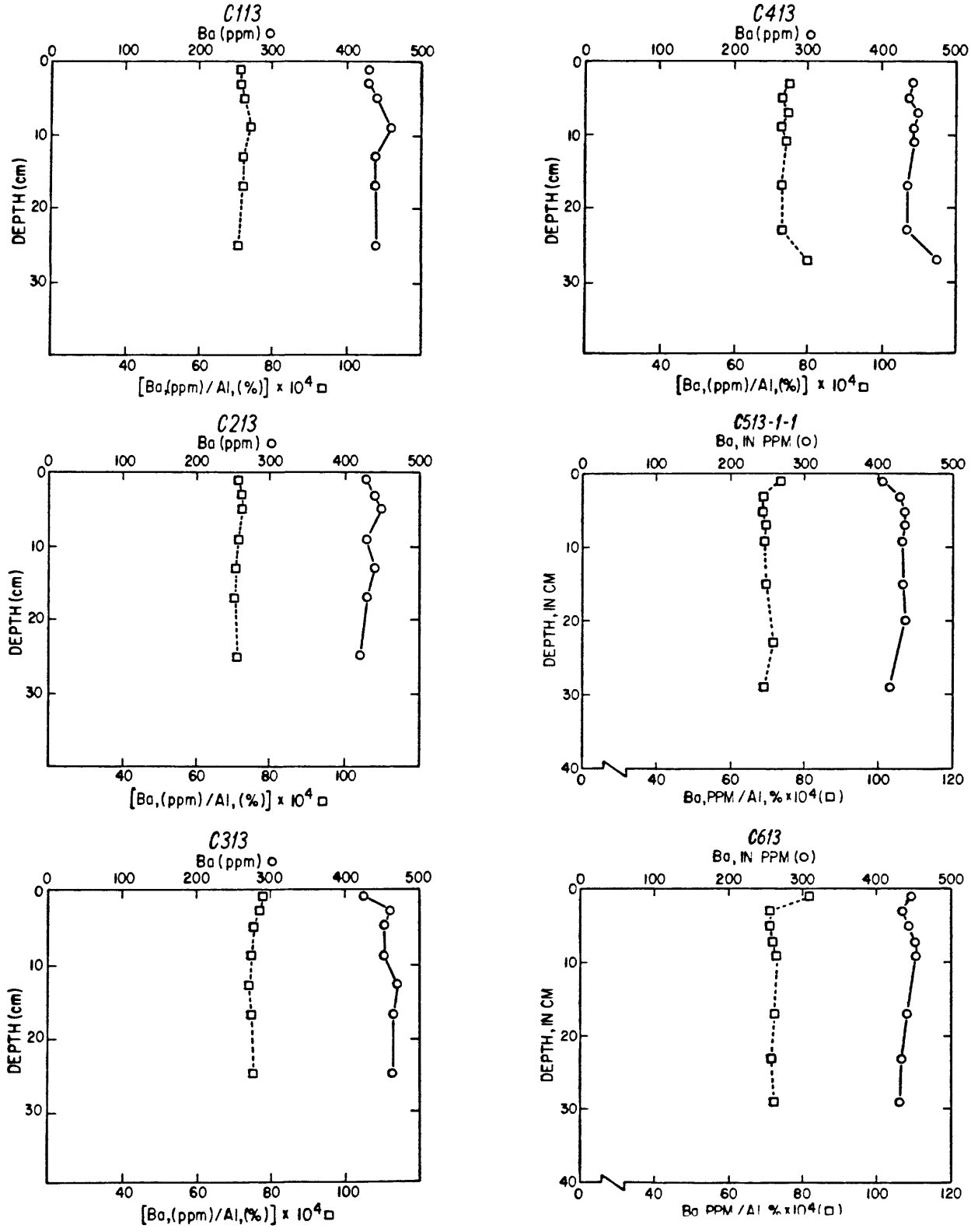


Figure 5. Distribution of barium and barium to aluminum ratio with sediment depth; Cruises 1-6, Station 13. (C113 = Cruise 1, Station 13).

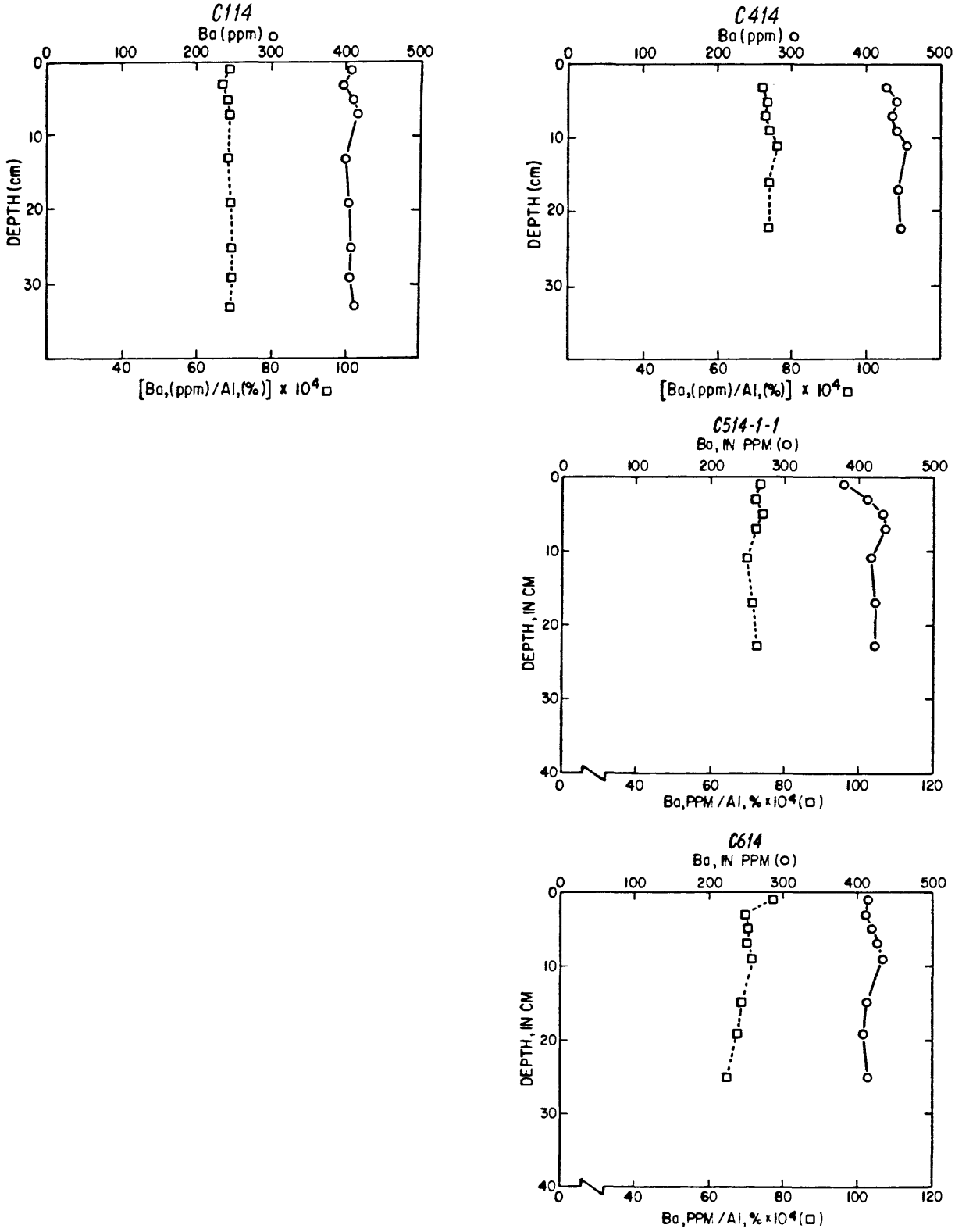


Figure 6. Distribution of barium and barium to aluminum ratio with sediment depth; Cruises 1, 4-6, Station 14. (C114 = Cruise 1, Station 14).

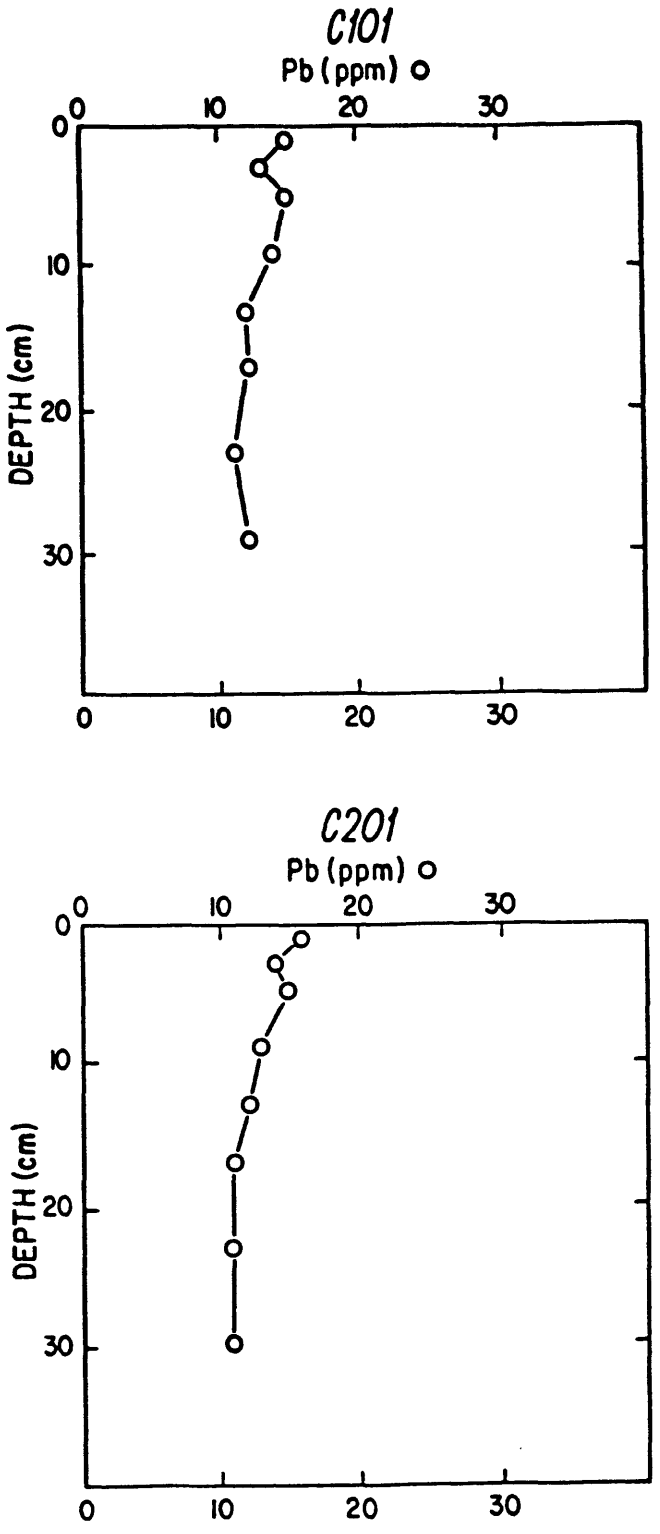


Figure 7. Distribution of lead with sediment depth; Cruises 1 and 2, Station 1. (C101 = Cruise 1, Station 1)

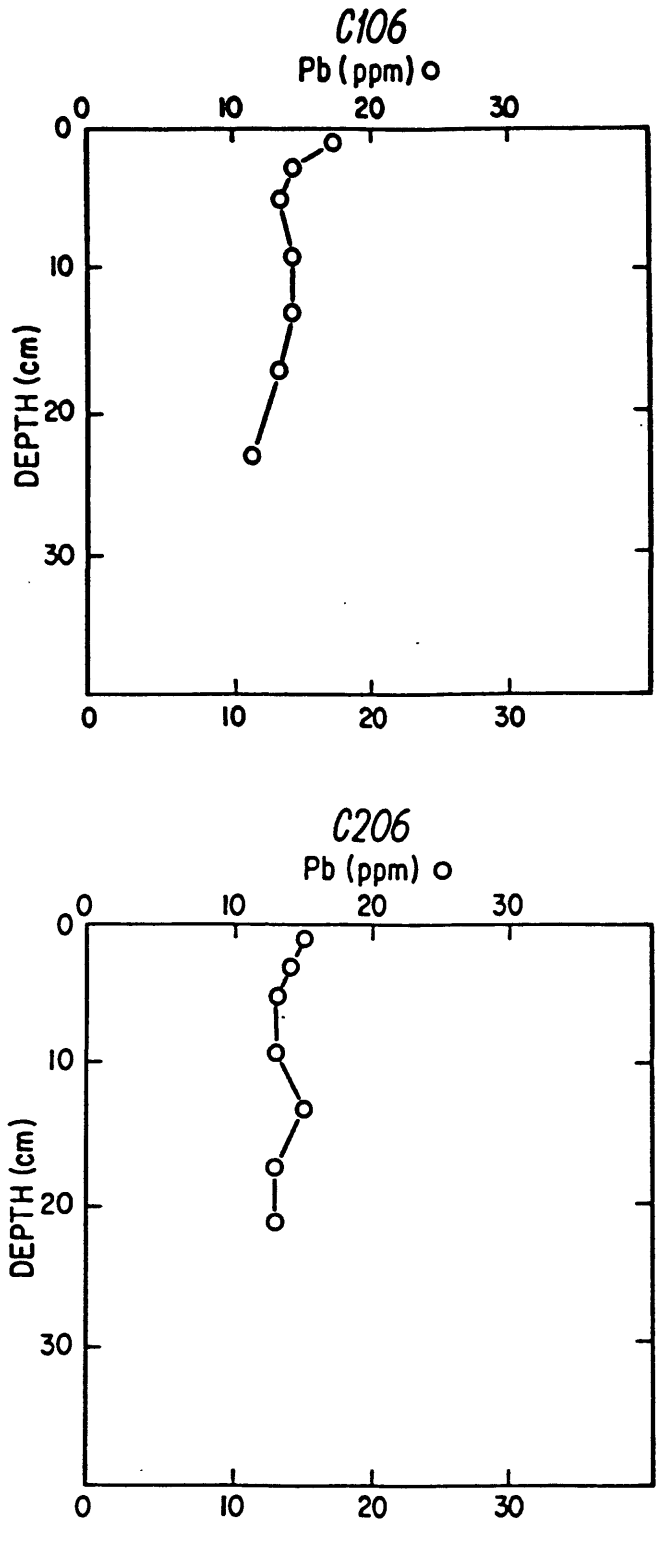


Figure 8. Distribution of lead with sediment depth; Cruises 1 and 2, Station 6. (C106 = Cruise 1, Station 6)

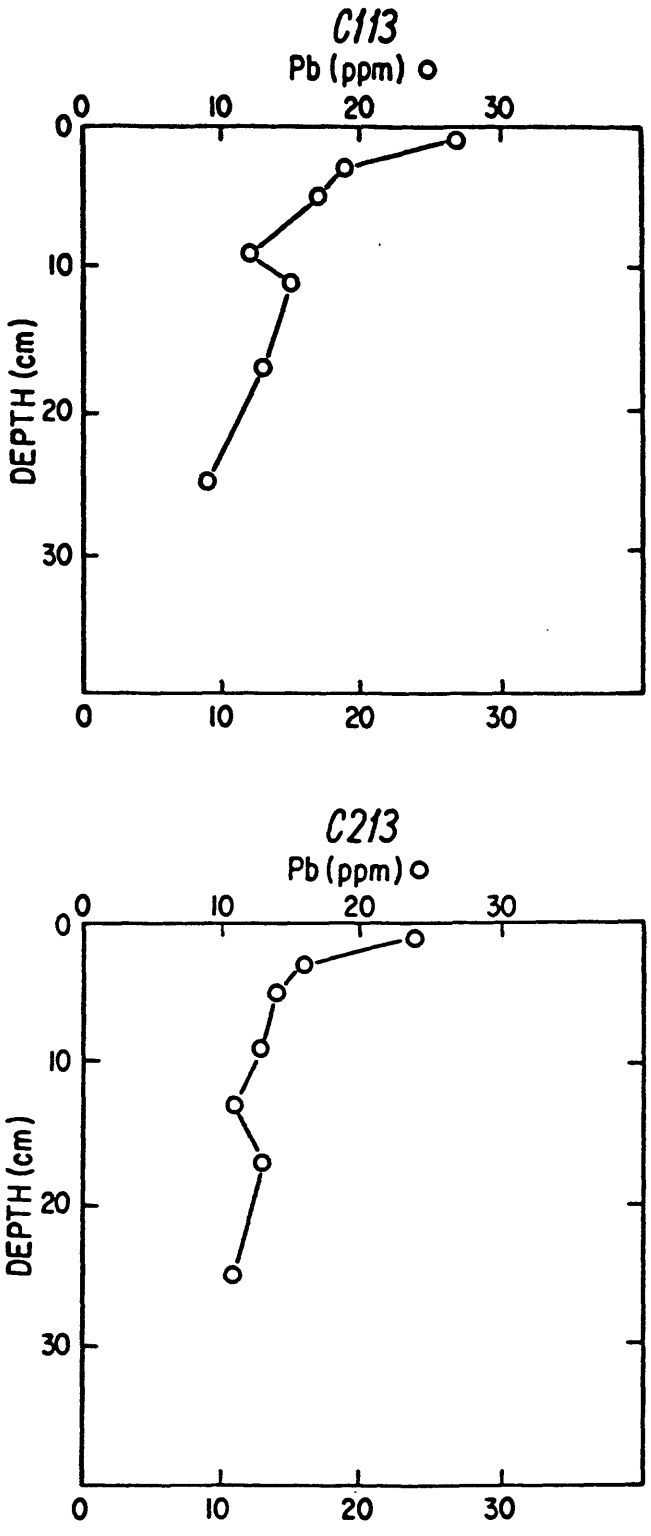


Figure 9. Distribution of lead with sediment depth; Cruises 1 and 2, Station 13. (C113 = Cruise 1, Station 13)

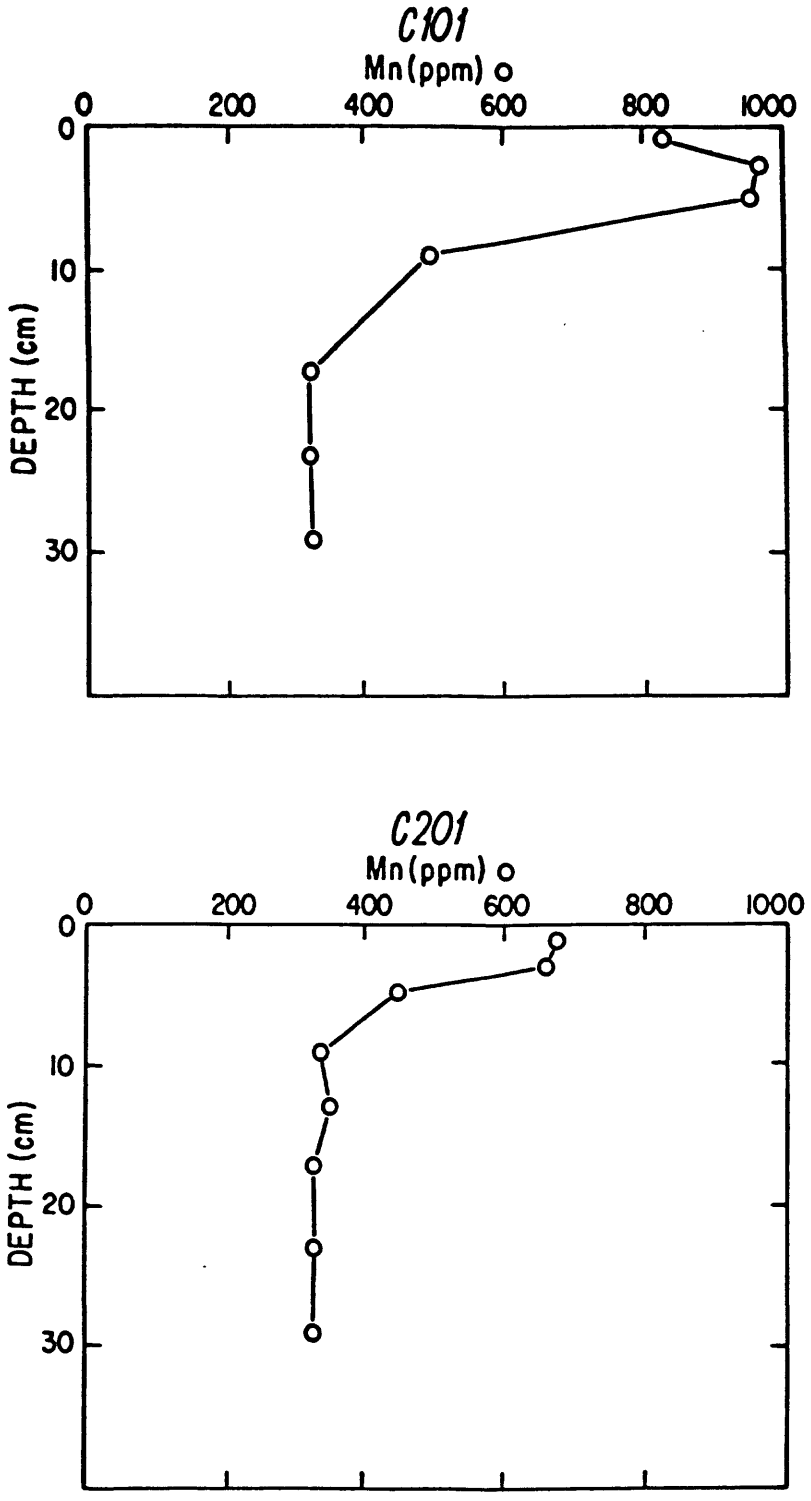


Figure 10. Distribution of manganese with sediment depth; Cruises 1 and 2, Station 1. (C101 = Cruise 1, Station 1)

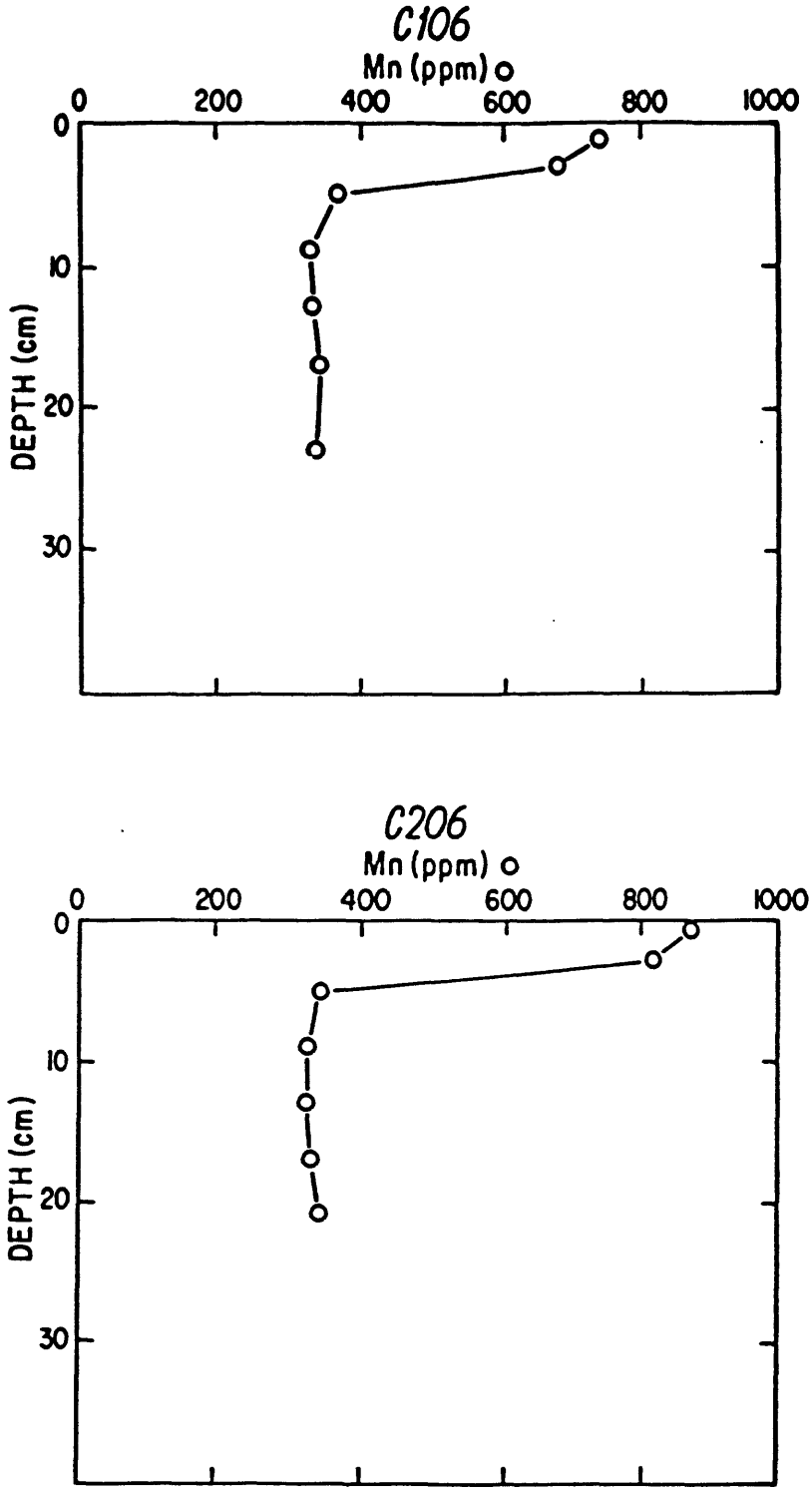


Figure 11. Distribution of manganese with sediment depth; Cruises 1 and 2, Station 6. (C106 = Cruise 1, Station 6)

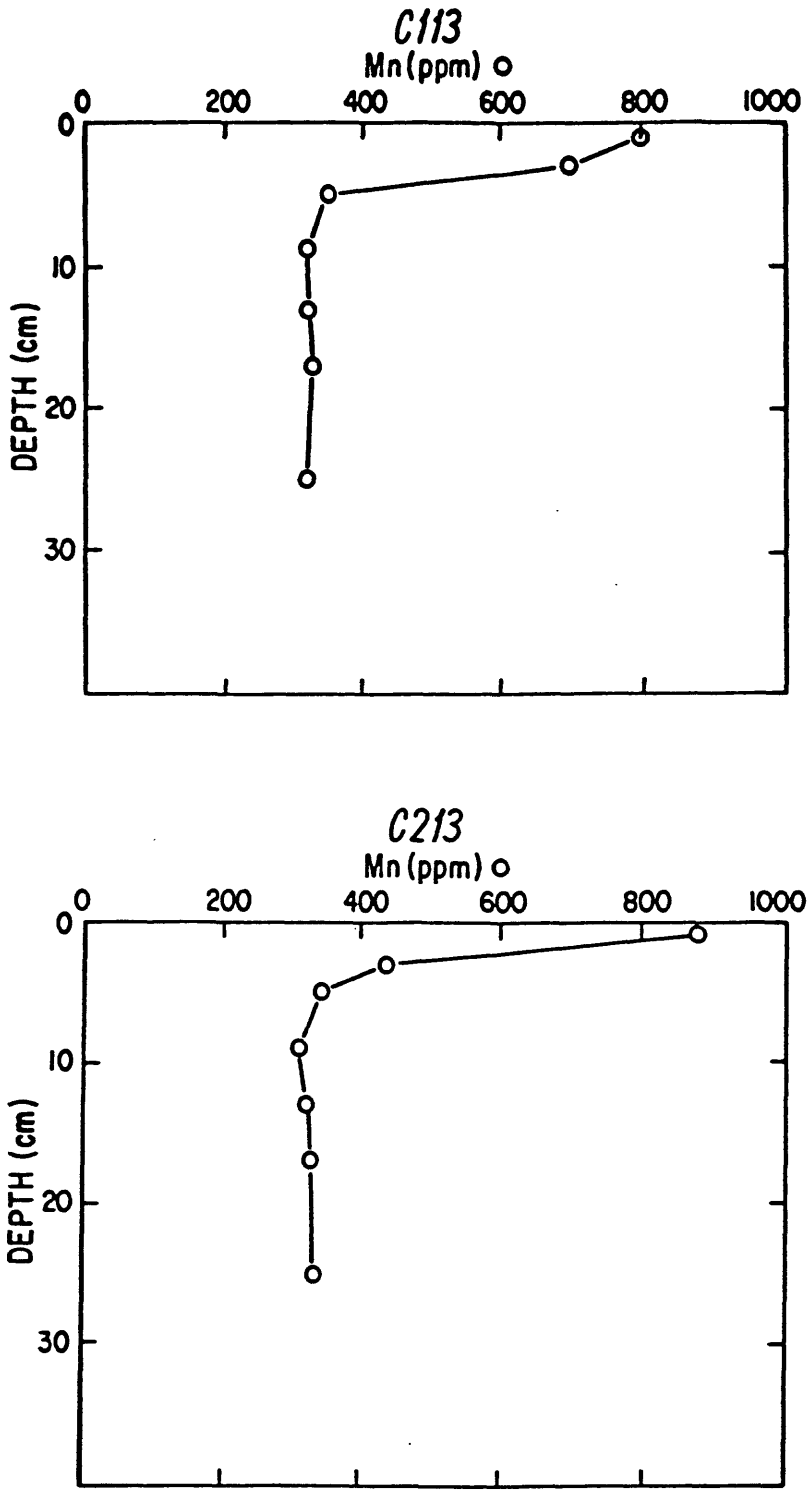


Figure 12. Distribution of manganese with sediment depth; Cruises 1 and 2, Station 13. (C113 = Cruise 1, Station 13)

unrelated to drilling. The Mn profile is typical for sediments that undergo a transition from oxidizing conditions near the water/sediment interface to reducing conditions in deeper sediments. The profile is a result of $MnO_2$ dissolving under reducing conditions, diffusing upward, and precipitating in the oxidizing conditions near the surface (Lynn and Bonati, 1965).

The absence of a gradient in the Ba profile in cores that have a strong gradient in Mn (for example, Stations 1 and 13 from Cruise 1) suggests that naturally occurring Ba is not migrating in the subsurface reducing conditions, at least not at a rate sufficient to measurably change the Ba concentrations of the sediments. Any increases we measure in the surface sediment relative to deeper sediment can thus be attributed to a recent addition of the metal, presumably from drilling activity, rather than to natural diagenetic processes.

The distribution of Pb with depth (Figs. 7-9 and Table 7) is a common feature in areas of fine sediment on the continental shelf and slope (Bothner and others, 1981; Bothner and others, 1985). The surficial sediments are typically as much as 2 to 3 times higher than sediments 25 to 30 cm below the water-sediment interface. The highest concentration measured in these cores is 31 ppm, slightly higher than the value in world average shales (20 ppm, Krauskopf, 1967).

The elevation in surficial sediments is thought to be related to an increased supply of lead to these sediments, probably from the burning of lead alkyls in gasoline in coastal metropolitan areas. The use of lead alkyls began in 1924 and has increased each year from 1940 until the recent switch to unleaded gasoline. The penetration of Pb to a depth of at least 10 cm is probably related to biological reworking of the sediment.

Lead inventories

From the profiles of lead with sediment depth, an inventory of the lead added to these sediments as a result of man's industrial use of lead can be estimated. For this calculation, we assumed that the enhanced concentrations of lead in the near surface sediments are from anthropogenic sources. This assumption seems justified because of the evidence against lead enrichment resulting from post-depositional mobility (Bruland and others, 1974). We also assumed that the background concentration of lead in a particular core was represented by the concentration in the lowest 5 to 10 cm, and remained constant throughout the core. In some cores, modern Pb may have penetrated to the bottom of the cores, which would make our estimate of background too high. The chosen background value was subtracted from the total value for each interval analyzed and the net values were summed to determine the anthropogenic contribution. Interpolated values were used for intervals not analyzed. Correcting for porosity (using water content) and assuming a constant grain density of 2.7 g/cc, the inventory of added lead in $\mu g/cm^2$ was calculated.

The atmospheric flux of lead to the Atlantic Ocean in the vicinity of Bermuda is estimated to have been about 1 $mg/m^2/yr$ during the early 1980's (Church and others, 1984, Jickells and others, 1984a,b; G. T. Shen, written communication, 10 April, 1986). Mr. G. T. Shen, Massachusetts Institute of Technology, has kindly provided data showing the variations in the Pb to Ca ratio in annual growth bands of a coral head (Diploria strigosa) over the last 100 years. Assuming that the record of lead incorporated into coral correlates with the atmospheric flux of lead to the ocean, it is possible to estimate and sum the total deposition of anthropogenic lead on an area basis. The value thus obtained is 6.2 $\mu g/cm^2$.

The estimated inventories of lead at Stations 13 and 14 are 46±17 $\mu g/cm^2$ and 44±22 $\mu g/cm^2$ respectively (Fig.13 ). Somewhat lower values were measured at Stations 1 (16±7 $\mu g/cm^2$) and 6 (25±17 $\mu g/cm^2$). The high standard deviation, among as many as six cores at a single location, is due in part to our inability to accurately estimate background values of lead using these rather short cores.

The average lead inventories measured at these stations are higher than the estimated flux to the sea surface would predict, suggesting that there is preferential accumulation of anthropogenic lead in slope sediments. The magnitude of the lead inventories at these four Middle Atlantic slope stations are within the range measured in the South Atlantic study area (4-68 $ug/cm^2$, Bothner and others, 1987), but much lower than the inventories (100-150 $ug/cm^2$) calculated for the fine grained deposit on the continental shelf south of Martha's Vineyard (Bothner and others, 1981).

In the case of the deposit south of Martha's Vineyard, $^{210}Pb$ and $^{14}C$ radiochemical data have supported the interpretation that high lead inventories are a result of frequent sediment resuspension and a rapid rate of sediment accumulation (Bothner and others, 1981). Similar radiochemical analysis would be extremely useful for interpreting the high inventories of lead on the continental slope. It would also be valuable to determine if the excess lead inventory on the continental slope is accompanied by a deficiency in the inventory of lead in the sandy sediments on the adjacent continental shelf.

The impact of this excess Pb in slope sediments is unknown. Important questions are: How is the Pb bound in the sediments? What is the bioavailability of this Pb? What is the response of organisms at different life stages to long-term, low-level Pb contamination? Although a few studies

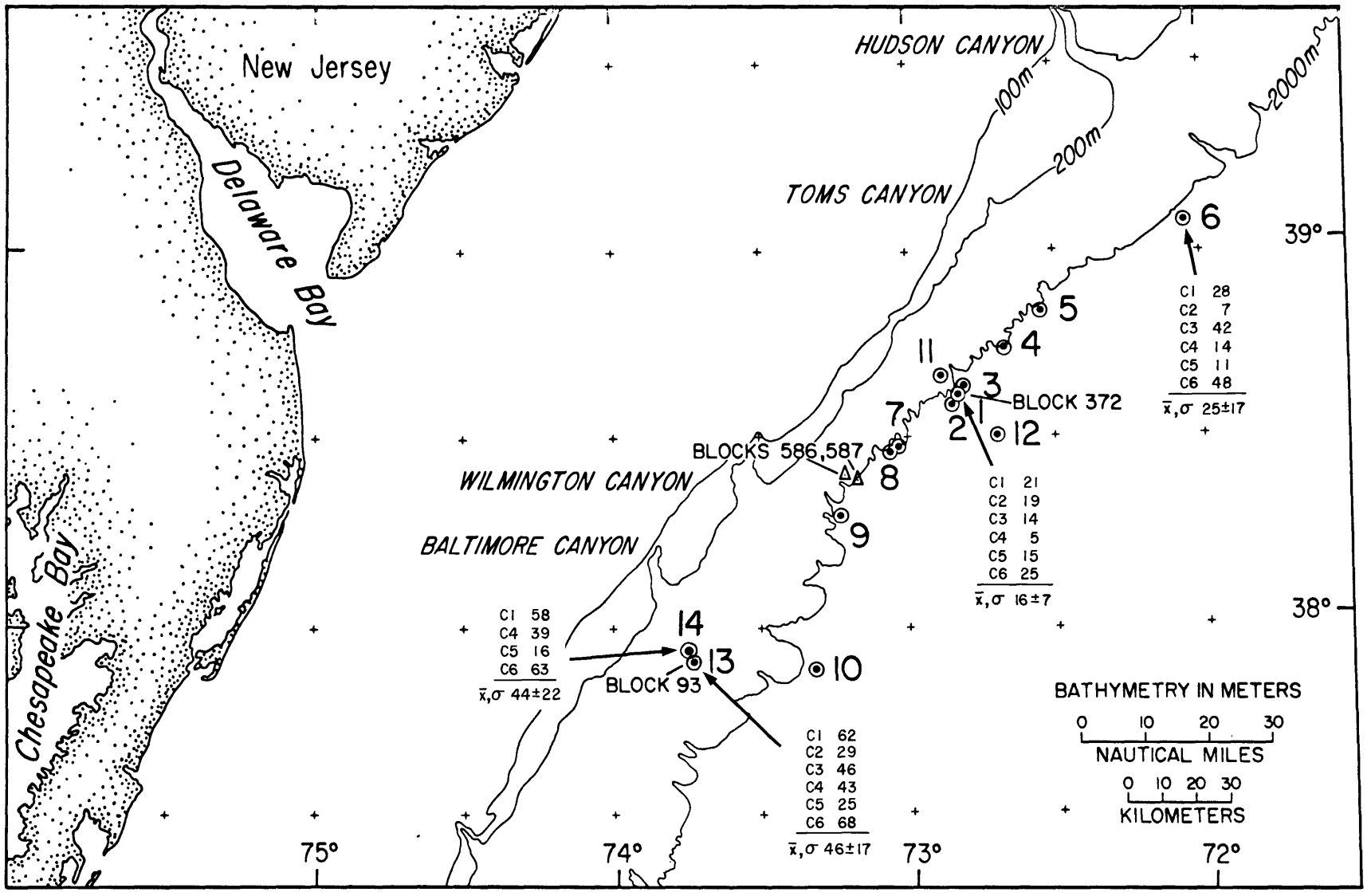


Figure 13. Pb inventory ( $\mu g/cm^2$) at Stations 1, 6, 13 Cruises 1-6; and Station 14 Cruises 1, 4-6. $\bar{x}$ = mean, $\sigma$ = standard deviation.

show a relationship between the concentration of lead in the tissue of deposit feeding organisms and the lead concentration in acid leached sediment (Luoma and Bryan, 1978; Tessier and others, 1984), no guidelines for "safe" levels of lead in sediments have been established. Studies addressing this complex issue are presently funded by the Environmental Protection Agency.

Ba concentration in sediment trap samples

Thirteen sediment traps were deployed 2.8 km southwest of the Shell drilling site in Block 372 (Appendix Table 2) on June 21, 1984. The traps were placed at different elevations above the sea floor on a subsurface current-meter mooring set out by Science Applications, Inc. The traps were deployed for 99 days, which included the last 18 days of the drilling operations. The period near the end of drilling typically includes a final discharge of drilling fluid before the well is plugged and abandoned.

The Ba concentrations are highest in the sediment trap located nearest the surface and decrease with increasing trap depth throughout the upper half of the water column (Fig. 14). There is a small increase in Ba concentration from the middle of the water column to the bottom, but this apparent trend needs to be confirmed with additional analyses.

One subsample from trap 901 (220-m water depth) consisted of gray particles having relatively high density and containing at least 27,000 ppm Ba in the <1-mm size fraction (Table 8). This concentration is a lower limit because the acid decomposition method did not completely dissolve the particles. Examination by means of the scanning electron microscope (SEM) indicated that the particulate residue was barium sulfate.

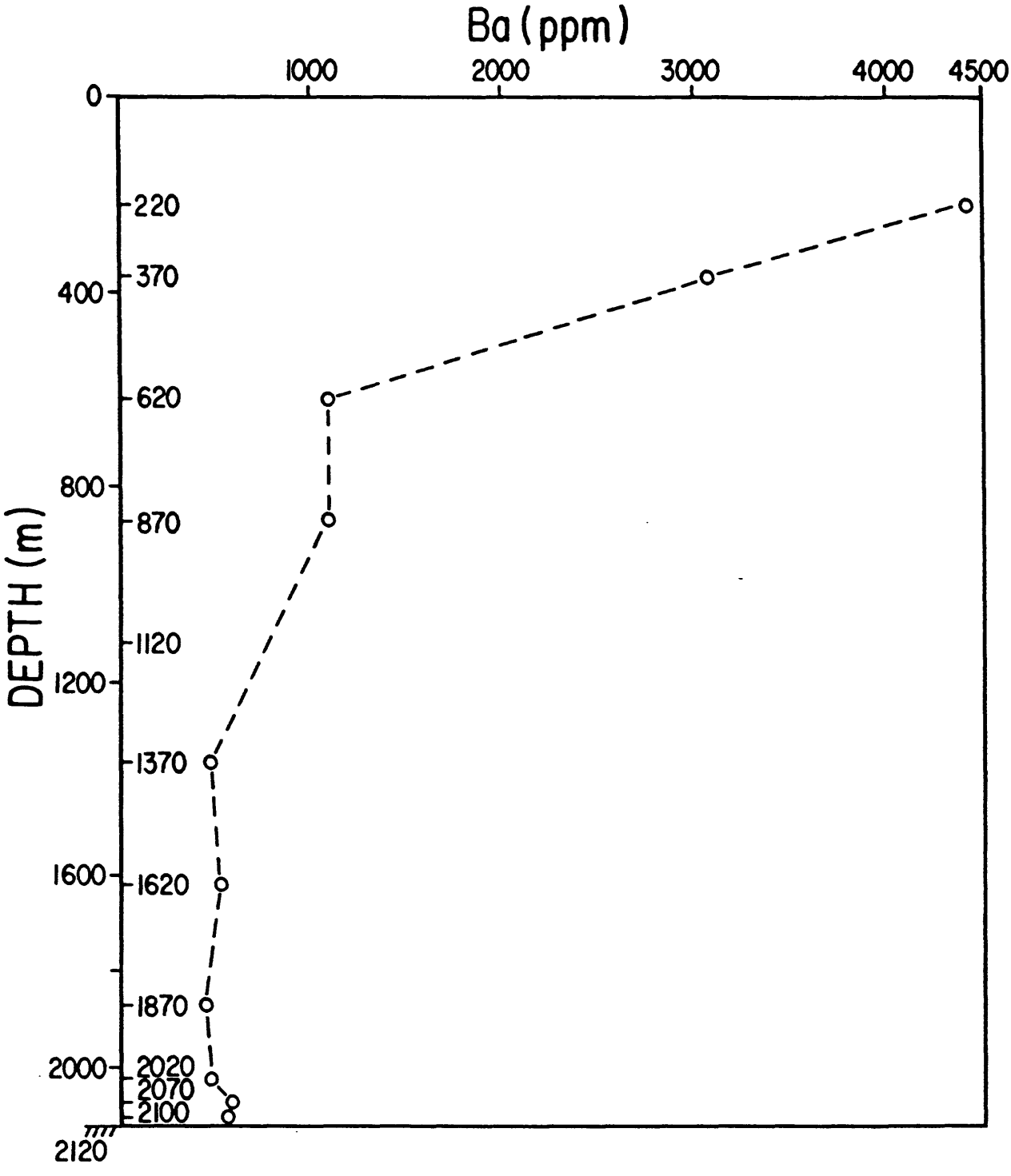


Figure 14. Average Ba concentration (ppm) in sediment trap samples (<1 mm size range) deployed at different depths near Block 93.

Table 8. Chemical analysis of sediment trap samples; mooring location: 38°35.1'N., 72°53.5'W., 2,120 m water depth.

[Missing data indicates insufficent sample size for analysis.]

| Field no.[1] | Top (cm) | Btm (cm) | Lab no. | Trap depth (m) | Al (%) | Ba (ppm) | Cd (ppm) | Cr (ppm) | Cu (ppm) | Fe (%) | Hg (ppm) | Mn (ppm) | Ni (ppm) | Pb (ppm) | V (ppm) | Zn (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ST901-W | 0.5 | 2.5 | W-231615 | 220 | 0.52 | 29 | --- | 28 | -- | 3.05 | --- | --- | 31 | -- | 11 | --- |
| ST901-W | 2.5 | 3 | W-231613 | 220 | .02 | 191 | --- | 13 | -- | .08 | --- | --- | 2 | -- | 7.6 | --- |
| ST901-W | 3 | 5 | W-231614 | 220 | .70 | 5,890 | --- | 77 | -- | .68 | --- | --- | 42 | -- | 23 | --- |
| ST901-Z | 0.5 | 2 | W-231620 | 220 | 1.67 | 896 | 3.790 | 34 | 30 | 1.14 | 0.09 | 358 | 14 | 24 | 20 | 613 |
| ST901-Z | 2.5 | 3 | W-231619 | 220 | .85 | 1,460 | 5.670 | 31 | 34 | .50 | .12 | 240 | 7.8 | 15 | 6.3 | 609 |
| ST901-Z | 3 | 5 | W-231621 | 220 | 1.75 | 8,090 | 3.810 | 45 | 34 | .84 | .15 | 217 | 14 | 58 | 20 | 775 |
| ST901-Z | 5 | 5.3 | W-231622 | 220 | 4.93 | 27,600 | 1.540 | 130 | 45 | 1.86 | --- | 292 | 18 | 14 | 49 | 974 |
| ST901-Y2 | 5 | 5.3 | W-231612 | 220 | 1.94 | 35,800 | --- | 47 | -- | 1.49 | --- | --- | 45 | -- | 28 | --- |
| ST901-Z | 5.3 | 6 | W-231611 | 220 | 5.32 | 11,200 | 1.190 | 140 | 25 | 2.01 | --- | 295 | 48 | 30 | 32 | 634 |
| ST901-P | .5 | 2 | W-231610 | 220 | 1.62 | 2,770 | --- | 110 | -- | .33 | --- | --- | 74 | -- | 36 | --- |
| ST901-P | 2.5 | 3 | W-231609 | 220 | 3.59 | 2,300 | --- | 307 | -- | .72 | --- | --- | 178 | -- | 159 | --- |
| ST901-P | 3 | 5 | W-231607 | 220 | 1.52 | 4,370 | --- | 166 | -- | .30 | --- | --- | 63 | -- | 65 | --- |
| ST901-P | 5 | 5.3 | W-231608 | 220 | 7.27 | 21,000 | --- | 571 | -- | 2.08 | --- | --- | 245 | -- | 131 | --- |
| ST903-W | | | W-231618 | 620 | .03 | 62 | --- | 10 | -- | .06 | --- | --- | <2 | -- | 6 | --- |
| ST903-Z | | | W-231599 | --- | 3.34 | 1,090 | --- | 59 | -- | 1.71 | --- | --- | 51 | -- | 41 | --- |
| ST904-Z | | | W-231600 | 870 | 3.68 | 1,090 | --- | 57 | -- | 1.85 | --- | --- | 49 | -- | 33 | --- |
| ST906-W | | | W-231617 | 1,370 | 5.29 | 958 | --- | 285 | -- | .85 | --- | --- | 348 | -- | 162 | --- |
| ST906-Z | | | W-231601 | -- | 4.07 | 460 | --- | 76 | -- | 2.20 | --- | --- | 62 | -- | 43 | --- |
| ST907-Z | | | W-231602 | 1,620 | 4.62 | 525 | <.020 | 66 | 34 | 2.50 | --- | 419 | 43 | 22 | 52 | 264 |
| ST908-W | | | W-231616 | 1,870 | 6.45 | 725 | --- | 509 | -- | 2.81 | --- | --- | 285 | -- | 151 | --- |
| ST908-Z | | | W-231603 | --- | 4.54 | 447 | .071 | 67 | 43 | 2.48 | .18 | 456 | 46 | 17 | 56 | 146 |
| ST909-Z | | | W-231604 | 2,020 | 5.18 | 476 | .086 | 74 | 38 | 2.92 | --- | 776 | 53 | 23 | 90 | 144 |
| ST910-Z | | | W-231605 | 2,070 | 5.81 | 586 | .110 | 77 | 44 | 3.22 | --- | 681 | 58 | 16 | 106 | 182 |
| ST911-Z | | | W-231606 | 2,100 | 5.64 | 559 | .120 | 78 | 34 | 3.13 | .37 | 633 | 48 | 19 | 85 | 171 |

[1]Field number designation: P = supernatant from centrifugation;
W = >1 mm size fraction;
Y2 = panned concentrate;
Z = <1 mm size fraction.

Physical and chemical isolation of barite particles

We conducted a number of experiments to isolate barite particles that had settled though the water column to the bottom sediments. Our objectives were to determine if barite was present in bottom sediments near a drilling rig and to estimate the settling velocity of barite particles on the basis of particle dimensions. Analysis of particles was carried out using a SEM fitted with an energy-dispersive x-ray spectrometer.

The heavy liquid (bromoform) separation technique described by Carver (1971) was used on the 5-60 μm size fraction of bottom sediments. The density separation of particles in this size range was not efficient enough to concentrate barium and the procedure was abandoned.

The selective chemical leach technique of Church (1970) improved our ability to concentrate and find barite particles. Sediment traps 902, 905, and 912 and sediment samples from Station 1 (Cruises 1 and 3) were prepared for analysis by this method. To evaluate the effect of the selective leaching on barite, we spiked an aliquot of sediment from trap 912 with a small amount of barite ore finer than 30 μm. SEM analysis of the barite surfaces of the leached samples were very similar to those of the unleached particles.

We found that the leaching procedures removed silicate and organic material from all samples except trap 902 which had a high concentration of zooplankton and a resistant organic fraction. Barite was identified in an aliquot of this sample, however, after heavy particles were concentrated by gravity settling. The other trap samples yielded barite particles following the selective leach method. Maximum particle sizes of about 23 x 11 μm were found in each of these three traps (Fig. 15c). The thickness dimension is not easily estimated using the SEM.

In the samples of bottom sediment, 19 barite particles in the size range of 3 x 4 μm per 1,000 particles analyzed were observed in the post-drilling sample. Only 2 particles per 1,000 analyzed were found in the predrilling sample. These may have come from the earlier drilling activity on the continental slope and shelf.

The largest (60 x 90 μm) particles of barite were found in trap 901 by analyzing residues from the $HNO_3$ - $HClO_4$ - HF decomposition. Some of the particles appeared to have retained a basic outline (Fig. 15a) and the measured dimensions are assumed to approximate the original size of the particles entering the trap. Where leaching was extensive (Fig. 15b), the size measurements may underestimate the dimensions of the original particles. This particular sample consisted of a thin layer of grey material apparently highly enriched with drilling mud. A comparable layer was not observed in traps located deeper in the water column.

We estimated the fall velocity of the largest particles and calculated the current speed and direction necessary to account for these particles in the trap. The fall velocity calculations follow the model described by Baba and Komar (1981) and correct for changes in density, viscosity, and grain shape. Hydrographic data in the study area (Lyne and Csanady, 1984) were used to estimate viscosity from tables presented in Riley and Skirrow (1975). Assuming a nominal grain diameter of 60 μm and grain shape 60 x 60 x 90 μm, the fall velocity varies through the upper 200 meters of the water column between 0.589 and 0.467 cm/sec. The current necessary to carry the barite particle of the above specifications to the trap is 7.2 cm/s to the south-west ($240^{o}$). The current-meter data collected at 380-m water depth on a mooring 2 km west of the trap mooring by Science Aplications Inc. showed a current of about 7 cm/s flowing in a southerly direction over the last 18 days of the

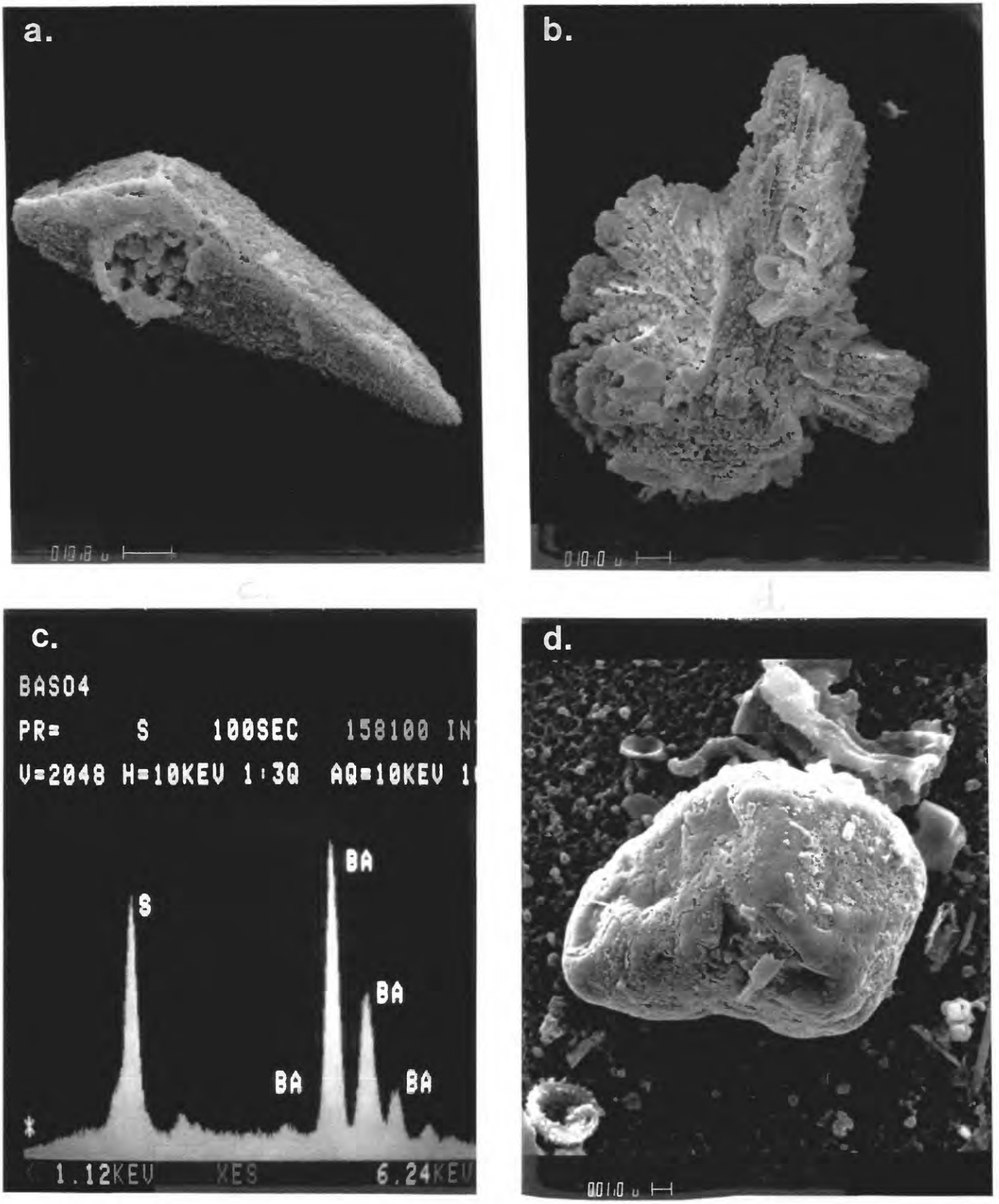


Figure 15. Scanning electron photomicrographs and a typical energy dispersive x-ray spectrum (c) of barite particles. Particles from trap 901 are moderately (a) and extensively (b) etched using $HNO_3$-$HClO_4$-HF acids. Particle (d) from trap 912 was subjected to a milder leaching procedure (Church, 1970).

drilling period. Unfortunately, the current meter at 280-m water depth failed to operate during this deployment period.

If the calculated currents required to transport the largest particles of Ba from the drilling rig to the sediment trap agree with the measured currents, then an interesting question remains regarding the presence of the finer barite particles in the sediment traps. Deuser et al. (1981) found evidence for rapid transport of fine-grained particulates through the water column after incorporation in fecal pellets of zooplankton, and this may be a possible explanation for our observations.

## Trace metals in sediments from recolonization trays

One objective of the biological studies within this program was to estimate settling and recruitment of organisms on the sea bed. To meet this objective, trays filled with mixed azoic sediment were deployed on the sea floor for a period of months using a device known as a free vehicle (Maciolek and others, 1987).

The free-vehicle samples were deployed at Stations 2 and 4 while drilling was underway at Station 1. Trace-metal concentrations were determined to identify accumulations of drilling mud in these trays. The results (Table 9) show no differences in metal concentrations within the trays compared to the range of values obtained at the slope stations from which the sediment was originally derived.

## Trace metals in different size fractions of sediment

Using nylon seives, we separated sediment samples into different size fractions and analyzed each fraction for trace metals. Barite used in drilling mud has a modal size range between 31 and 63 μm (coarse silt), and so

Table 9. - Chemical analyses of sediments from recolonization trays deployed at station 2 (2206 and 2209) and station 4 (2207 and 2210) between May 1984 and November 1984.

| Free Vehicle | Top (cm) | Btm (cm) | Lab no. | Al (%) | Ba (ppm) | Cd (ppm) | Cr (ppm) | Cu (ppm) | Fe (%) | Hg (ppm) | Mn (ppm) | Ni (ppm) | Pb (ppm) | V (ppm) | Zn (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FV2206 | 0 | 2 | W-233008 | 5.67 | 431 | 0.055 | 82 | 22 | 3.16 | 0.030 | 502 | 53 | 13 | 94 | 78 |
| FV2207 | 0 | 2 | W-233009 | 5.37 | 421 | .075 | 80 | 21 | 2.97 | .035 | 500 | 45 | 12 | 90 | 78 |
| FV2209 | 0 | 2 | W-233010 | 5.11 | 390 | .058 | 73 | 19 | 2.83 | .020 | 460 | 44 | 12 | 82 | 75 |
| FV2210 | 0 | 2 | W-233011 | 5.34 | 416 | .083 | 82 | 21 | 2.93 | .030 | 492 | 64 | 18 | 94 | 76 |

analysis of this fraction might specifically concentrate any barite deposited in slope sediments.

The samples analyzed in this detailed manner were collected before and after drilling at Station 14, and after drilling at Station 1 and Station 4 (about 20 km northeast of a drilling site). The results (Table 10) show no increase in Ba in postdrilling samples compared to predrilling samples. With very few exceptions, there is a steady increase in metal concentrations from the coarsest to the finest fraction of the sediment. This trend supports the strong correlation between metal concentration and the percentage of fine sediments that is demonstrated in Figure 2.

Sediment texture

Sediment texture within the upper 30 cm of the sea floor is quite uniform (Fig. 16 and Table 11). On the basis of mean grain size, the sediments are classified as silty clays or clayey silts. The sand component varies between about 1 percent and 15 percent and is composed mostly of foraminifera and diatom tests and minor amounts of rock fragments.

The sand content at Station 1 is higher in samples taken on Cruise 2 than on Cruise 1. This difference is probably not related to the drilling. Although a few large particles, thought to be drill cuttings, were observed in other replicate surface samples from Station 1, Cruise 2 (Battelle and others, 1985), we found no unusual particles in the sand fraction of the subcores we analyzed. Natural variability at this station is a more likely explanation of the apparent difference in texture between samples collected on these two cruises.

Although small differences in the silt and clay content were observed between predrilling and postdrilling cores, the differences are generally

Table 10. - Chemical analyses of the following size fractions of bottom sediment: S0, undifferentiated; S1, >1,000 µm; S2, 1,000-5,000 µm; S3, 500-210 µm; S4, 210-105 µm; S5, 105-60 µm; S6, 60-30 µm; S7, 30-10 µm; S8, 10-1 µm; S9, <1 µm.

| Field no. | Top (cm) | Btm (cm) | Lab no. | Al (%) | Ba (ppm) | Cd (ppm) | Cr (ppm) | Cu (ppm) | Fe (%) | Hg (ppm) | Mn (ppm) | Ni (ppm) | Pb (ppm) | V (ppm) | Zn (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C20410S0 | 0 | 2 | W-231641 | 4.89 | 381 | .058 | 72 | 20 | 2.66 | .028 | 617 | 31 | 11.0 | 82 | 65 |
| C20410S1 | 0 | 2 | W-231642 | 1.32 | 161 | - | 38 | - | .74 | - | - | 7 | - | 14 | - |
| C20410S2 | 0 | 2 | W-231643 | 1.37 | 132 | .063 | 16 | 4.5 | .71 | .042 | 128 | 4 | 3.8 | 11 | 17 |
| C20410S3 | 0 | 2 | W-231644 | 1.13 | 125 | .081 | 22 | 13 | .73 | - | 324 | 6 | 4.2 | 17 | 23 |
| C20410S4 | 0 | 2 | W-231645 | 3.34 | 279 | .170 | 48 | 14 | 1.75 | .068 | 505 | 15 | 5.8 | 56 | 45 |
| C20410S5 | 0 | 2 | W-231646 | 3.69 | 298 | .055 | 47 | 12 | 1.72 | .032 | 512 | 12 | 8.0 | 58 | 42 |
| C20410S6 | 0 | 2 | W-231647 | 4.26 | 327 | .058 | 56 | 15 | 1.86 | .032 | 554 | 18 | 9.1 | 68 | 45 |
| C20410S7 | 0 | 2 | W-231648 | 5.76 | 423 | .075 | 81 | 24 | 3.11 | .088 | 754 | 43 | 14.0 | 112 | 80 |
| C20410S8 | 0 | 2 | W-231649 | 5.99 | 537 | .130 | 85 | 33 | 3.30 | .010 | 897 | 55 | 16.0 | 124 | 95 |
| C20410S9 | 0 | 2 | W-231650 | 7.04 | 537 | .156 | 98 | 39 | 4.10 | .125 | 783 | 60 | 15.6 | 156 | 117 |
| C11400S0 | 0 | 2 | W-231651 | 5.48 | 396 | .066 | 86 | 24 | 3.09 | .061 | 703 | 40 | 18.0 | 112 | 88 |
| C11400S1 | 0 | 2 | W-231652 | 3.94 | 312 | .100 | 61 | 24 | 2.45 | .072 | 567 | 27 | 14.0 | 86 | 73 |
| C11400S5 | 0 | 2 | W-231653 | 3.64 | 293 | .042 | 41 | 12 | 1.45 | .072 | 322 | 12 | 8.3 | 56 | 45 |
| C11400S6 | 0 | 2 | W-231654 | 4.57 | 353 | .030 | 49 | 12 | 1.90 | .056 | 465 | 18 | 15.0 | 56 | 50 |
| C11400S7 | 0 | 2 | W-231655 | 5.47 | 377 | .110 | 73 | 23 | 2.79 | .072 | 699 | 38 | 20.0 | 106 | 76 |
| C11400S8 | 0 | 2 | W-231656 | 5.98 | 407 | .120 | 84 | 27 | 3.29 | .076 | 819 | 49 | 25.0 | 124 | 98 |
| C11400S9 | 0 | 2 | W-231657 | 6.80 | 490 | .157 | 100 | 39 | 4.22 | .096 | 887 | 65 | 28.2 | 163 | 130 |
| C41400S0 | 0 | 2 | W-235351 | 5.45 | 387 | .075 | 68 | 23 | 3.07 | .060 | 699 | 43 | 23.0 | 100 | 79 |
| C41400S1-4* | 0 | 2 | W-235352 | 3.46 | 291 | .079 | 47 | 19 | 2.05 | .090 | 562 | 24 | 19.0 | 80 | 61 |
| C41400S5 | 0 | 2 | W-235353 | 3.87 | 304 | .061 | 59 | 15 | 1.84 | .120 | 509 | 29 | 18.0 | 61 | 51 |
| C41400S6 | 0 | 2 | W-235354 | 4.90 | 364 | .068 | 100 | 17 | 2.37 | .070 | 609 | 37 | 20.0 | 79 | 56 |
| C41400S7 | 0 | 2 | W-235355 | 5.64 | 385 | .084 | 62 | 21 | 2.86 | .090 | 732 | 38 | 22.0 | 110 | 68 |
| C41400S8 | 0 | 2 | W-235356 | 5.00 | 453 | .120 | 100 | 35 | 3.94 | .170 | 943 | 60 | 35.0 | 140 | 110 |
| C41400S9 | 0 | 2 | W-235357 | 5.68 | 486 | .114 | 90 | 40 | 3.88 | .160 | 805 | 62 | 24.0 | 145 | 104 |
| C40100S0 | 0 | 2 | W-235344 | 5.23 | 404 | .082 | 57 | 22 | 2.95 | .040 | 358 | 39 | 15.0 | 100 | 73 |
| C40100S1-4* | 0 | 2 | W-235345 | 2.48 | 248 | .077 | 40 | 11 | 1.64 | .040 | 456 | 22 | 9.9 | 48 | 44 |
| C40100S5 | 0 | 2 | W-235346 | 3.62 | 291 | .032 | 80 | 20 | 1.78 | .050 | 533 | 38 | 12.0 | 52 | 41 |
| C40100S6 | 0 | 2 | W-235347 | 4.24 | 329 | .046 | 42 | 12 | 1.79 | .060 | 553 | 27 | 12.0 | 62 | 42 |
| C40100S7 | 0 | 2 | W-235348 | 5.07 | 346 | .059 | 54 | 16 | 2.37 | .050 | 790 | 33 | 16.0 | 88 | 57 |
| C40100S8 | 0 | 2 | W-235349 | 5.92 | 430 | .059 | 73 | 21 | 3.05 | .150 | 855 | 43 | 14.0 | 120 | 79 |
| C40100S9 | 0 | 2 | W-235350 | 6.78 | 517 | .098 | 83 | 37 | 3.86 | .070 | 861 | 58 | 18.0 | 144 | 101 |

* Size fractions 1-4 combined because of small sample size.

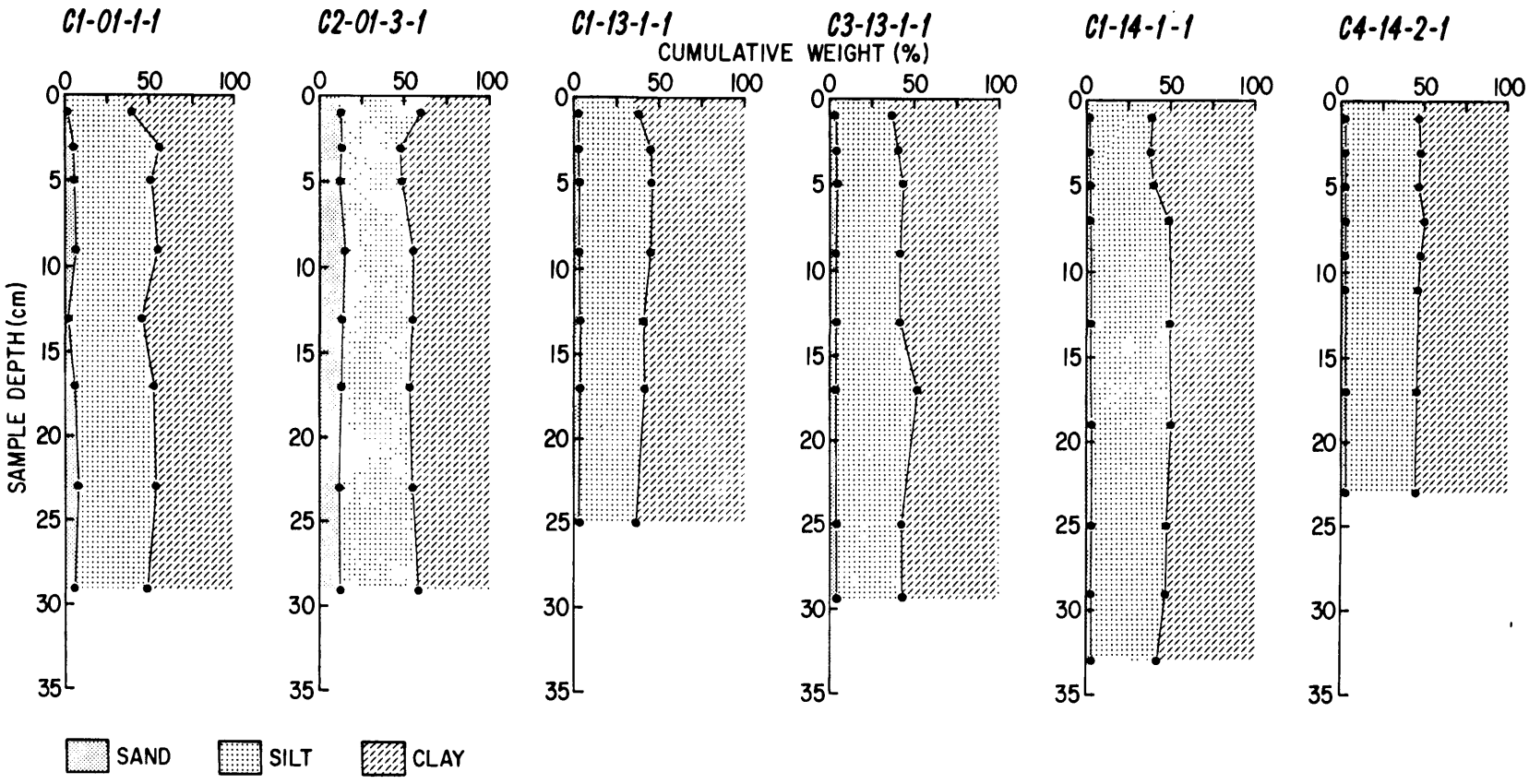


Figure 16. Grain-size analysis of sediment cores before drilling (Cruise 1) and after drilling (Cruises 2-4).

Table 11. - Textural analysis of select cores from the Mid-Atlantic Slope and Rise. [Values accurate to two significant figures]

| Field no. | Depth (cm) | Gravel (%) | Sand (%) | Silt (%) | Clay (%) | Mean (ϕ) | Median (ϕ) | St.dev. (ϕ) | Very coarse sand (%) | Coarse sand (%) | Medium sand (%) | Fine sand (%) | Very fine sand (%) | Silt 5 phi | Silt 6 phi | Silt 7 phi | Silt 8 phi | Clay 9 phi | Clay 10 phi | Clay >10 phi |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C10121* | 0-2 | 0.00 | 1.52 | 35.66 | 62.81 | 8.62 | 10.06 | 2.29 | 0.00 | 0.00 | 0.00 | 0.00 | 1.52 | 10.19 | 8.05 | 8.43 | 8.99 | 5.47 | 4.26 | 53.08 |
| C10111 | 2-4 | .00 | 6.37 | 49.86 | 43.77 | 7.48 | 6.95 | 2.61 | .00 | .00 | .00 | .00 | 6.37 | 20.02 | 12.44 | 11.79 | 5.62 | 5.41 | .70 | 37.66 |
| C10111 | 4-6 | .00 | 6.05 | 44.49 | 49.46 | 7.82 | 7.94 | 2.53 | .00 | .00 | .00 | .00 | 6.05 | 14.20 | 11.67 | 9.63 | 8.99 | 7.59 | 1.03 | 40.84 |
| C10111 | 8-10 | .00 | 7.00 | 50.47 | 42.52 | 7.51 | 7.36 | 2.48 | .00 | .00 | .00 | .00 | 7.00 | 16.25 | 10.80 | 11.68 | 11.74 | 5.58 | 5.54 | 31.40 |
| C10111 | 12-14 | .00 | .71 | 47.52 | 51.77 | 8.13 | 8.35 | 2.40 | .00 | .00 | .00 | .00 | .71 | 14.56 | 11.28 | 12.52 | 9.16 | 5.05 | .37 | 46.35 |
| C10111 | 16-18 | .00 | 6.71 | 45.91 | 47.38 | 7.71 | 7.67 | 2.51 | .00 | .00 | .00 | .00 | 6.71 | 12.91 | 13.38 | 11.70 | 7.92 | 6.55 | 3.82 | 37.01 |
| C10111 | 22-24 | .00 | 7.04 | 49.09 | 43.88 | 7.44 | 7.23 | 2.51 | .00 | .00 | .00 | .00 | 7.04 | 17.87 | 11.71 | 11.55 | 7.96 | 7.74 | 4.95 | 31.19 |
| C10111 | 28-30 | .00 | 6.47 | 42.70 | 50.83 | 7.87 | 8.16 | 2.56 | .00 | .00 | .00 | .00 | 6.47 | 14.30 | 10.32 | 10.44 | 7.64 | 5.12 | 4.95 | 40.76 |
| C11311 | 0-2 | .00 | 1.62 | 36.46 | 61.91 | 8.74 | 10.10 | 2.13 | .00 | .00 | .00 | .00 | 1.62 | 1.25 | 14.91 | 9.88 | 10.42 | 6.11 | .09 | 55.71 |
| C11311 | 2-4 | .00 | 1.39 | 45.32 | 53.29 | 8.17 | 9.06 | 2.27 | .00 | .00 | .00 | .00 | 1.39 | 10.95 | 13.36 | 7.88 | 13.13 | 2.41 | 14.60 | 36.28 |
| C11311 | 4-6 | .00 | 1.55 | 43.60 | 54.87 | 8.32 | 8.84 | 2.28 | .00 | .00 | .00 | .00 | 1.55 | 8.71 | 11.92 | 11.69 | 11.27 | 5.78 | 3.28 | 45.81 |
| C11311 | 8-10 | .00 | 1.26 | 43.14 | 55.60 | 8.32 | 8.93 | 2.26 | .00 | .00 | .00 | .00 | 1.26 | 8.90 | 11.69 | 12.06 | 10.49 | 6.00 | 5.34 | 44.26 |
| C11311 | 12-14 | .00 | 1.43 | 40.44 | 58.13 | 8.13 | 8.62 | 2.35 | .00 | .00 | .00 | .00 | 1.43 | 13.92 | 11.05 | 11.59 | 3.88 | 13.03 | 4.54 | 40.56 |
| C11311 | 16-18 | .00 | 1.76 | 40.02 | 58.22 | 8.43 | 8.98 | 2.25 | .00 | .00 | .00 | .00 | 1.76 | 7.46 | 9.85 | 15.26 | 7.45 | 8.35 | .96 | 48.91 |
| C11311 | 24-26 | .00 | 2.06 | 34.13 | 63.82 | 8.66 | 10.05 | 2.18 | .00 | .00 | .00 | .00 | 2.06 | 8.00 | 4.80 | 10.93 | 10.40 | 11.14 | .27 | 52.41 |
| C11411 | 0-2 | .00 | 1.98 | 38.91 | 59.12 | 8.42 | 9.42 | 2.28 | .00 | .00 | .00 | .00 | 1.98 | 7.45 | 13.53 | 9.36 | 8.56 | 7.00 | 5.03 | 47.09 |
| C11411 | 2-4 | .00 | 1.60 | 37.01 | 61.40 | 8.55 | 10.02 | 2.24 | .00 | .00 | .00 | .00 | 1.60 | 7.45 | 9.77 | 12.34 | 7.45 | 7.77 | 2.59 | 51.04 |
| C11411 | 4-6 | .00 | 1.46 | 39.61 | 58.83 | 8.53 | 10.02 | 2.26 | .00 | .00 | .00 | .00 | 1.46 | 7.59 | 10.96 | 11.37 | 9.69 | 3.77 | 4.08 | 50.98 |
| C11411 | 6-8 | .00 | 1.96 | 48.11 | 49.92 | 7.96 | 7.99 | 2.28 | .00 | .00 | .00 | .00 | 1.96 | 10.92 | 13.02 | 14.20 | 9.97 | 9.52 | 4.07 | 36.33 |
| C11411 | 12-14 | .00 | 2.76 | 47.58 | 49.67 | 7.96 | 7.97 | 2.25 | .00 | .00 | .00 | .00 | 2.76 | 7.94 | 15.81 | 11.73 | 12.10 | 10.54 | 3.64 | 35.49 |
| C11411 | 18-20 | .00 | 2.76 | 48.93 | 48.32 | 7.90 | 7.85 | 2.33 | .00 | .00 | .00 | .00 | 2.76 | 12.74 | 10.96 | 13.60 | 11.63 | 8.27 | 3.66 | 36.39 |
| C11411 | 24-26 | .00 | 2.80 | 45.10 | 52.10 | 7.93 | 8.16 | 2.31 | .00 | .00 | .00 | .00 | 2.80 | 12.90 | 11.02 | 11.16 | 10.02 | 13.06 | 3.66 | 35.38 |
| C11411 | 28-30 | .00 | 2.72 | 45.72 | 51.57 | 8.05 | 8.15 | 2.29 | .00 | .00 | .00 | .00 | 2.72 | 9.72 | 11.40 | 14.88 | 9.72 | 10.32 | 1.69 | 39.56 |
| C11411 | 32-34 | .00 | 2.40 | 39.50 | 58.11 | 8.32 | 8.78 | 2.28 | .00 | .00 | .00 | .00 | 2.40 | 7.96 | 12.42 | 10.48 | 8.64 | 10.41 | 2.52 | 45.18 |
| C20131 | 0-2 | .00 | 12.75 | 45.90 | 41.35 | 7.33 | 7.17 | 2.64 | .00 | .00 | .00 | .00 | 12.75 | 16.27 | 7.94 | 11.24 | 10.45 | 6.22 | 1.98 | 33.15 |
| C20131 | 2-4 | .00 | 11.85 | 35.21 | 52.93 | 7.93 | 8.64 | 2.68 | .00 | .00 | .00 | .00 | 11.85 | 10.12 | 9.28 | 6.81 | 9.00 | 4.56 | 3.94 | 44.43 |
| C20131 | 4-6 | .00 | 11.92 | 37.39 | 50.70 | 7.82 | 8.15 | 2.66 | .00 | .00 | .00 | .00 | 11.92 | 9.52 | 11.76 | 6.41 | 9.70 | 4.73 | 4.61 | 41.36 |
| C20131 | 8-10 | .00 | 14.83 | 40.36 | 44.80 | 7.36 | 7.21 | 2.67 | .00 | .00 | .00 | .00 | 14.83 | 8.46 | 20.39 | 4.90 | 6.61 | 5.46 | 6.82 | 32.52 |
| C20131 | 12-14 | .00 | 14.03 | 40.66 | 45.30 | 7.46 | 7.25 | 2.63 | .00 | .00 | .00 | .00 | 14.03 | 8.52 | 14.10 | 11.81 | 6.24 | 7.16 | 4.00 | 34.14 |
| C20131 | 16-18 | .00 | 13.29 | 40.15 | 46.56 | 7.56 | 7.64 | 2.55 | .00 | .00 | .00 | .00 | 13.29 | 8.69 | 9.20 | 12.79 | 9.48 | 8.19 | 6.54 | 31.83 |
| C20131 | 22-24 | .00 | 12.66 | 43.77 | 43.57 | 7.44 | 7.20 | 2.60 | .00 | .00 | .00 | .00 | 12.66 | 12.28 | 9.01 | 14.48 | 8.00 | 7.81 | 1.27 | 34.50 |
| C20131 | 28-30 | .00 | 13.23 | 44.70 | 42.07 | 7.37 | 7.28 | 2.60 | .00 | .00 | .00 | .00 | 13.23 | 10.80 | 14.48 | 8.35 | 11.08 | 7.45 | 1.75 | 32.87 |
| C31311 | 0-2 | .00 | 2.32 | 34.33 | 63.34 | 8.61 | 10.06 | 2.29 | .00 | .00 | .00 | .00 | 2.32 | 8.81 | 6.00 | 15.19 | 4.34 | 6.51 | 3.59 | 53.24 |
| C31311 | 2-4 | .00 | 2.26 | 38.87 | 58.88 | 8.38 | 9.15 | 2.29 | .00 | .00 | .00 | .00 | 2.26 | 9.40 | 9.63 | 10.78 | 9.06 | 8.17 | 4.75 | 45.96 |
| C31311 | 4-6 | .00 | 2.58 | 43.62 | 53.80 | 8.22 | 8.91 | 2.31 | .00 | .00 | .00 | .00 | 2.58 | 8.52 | 13.67 | 10.18 | 11.26 | 4.17 | 7.46 | 42.17 |
| C31311 | 8-10 | .00 | 2.43 | 39.80 | 57.77 | 8.29 | 9.08 | 2.29 | .00 | .00 | .00 | .00 | 2.43 | 8.26 | 14.46 | 7.51 | 9.57 | 6.95 | 9.91 | 40.91 |
| C31311 | 12-14 | .00 | 2.23 | 37.48 | 60.28 | 8.39 | 9.16 | 2.23 | .00 | .00 | .00 | .00 | 2.23 | 8.58 | 9.81 | 10.08 | 9.02 | 8.55 | 10.48 | 41.25 |
| C31311 | 16-18 | .00 | 2.77 | 51.27 | 45.96 | 7.96 | 7.74 | 2.21 | .00 | .00 | .00 | .00 | 2.77 | 8.69 | 11.52 | 15.40 | 15.66 | 1.73 | 12.90 | 31.33 |
| C31311 | 24-26 | .00 | 3.13 | 38.54 | 58.33 | 8.32 | 9.12 | 2.22 | .00 | .00 | .00 | .00 | 3.13 | 7.48 | 9.50 | 11.45 | 10.12 | 6.74 | 13.61 | 37.98 |
| C31311 | 28-30 | .00 | 2.90 | 41.17 | 55.94 | 8.12 | 9.00 | 2.31 | .00 | .00 | .00 | .00 | 2.90 | 13.03 | 7.84 | 10.94 | 9.36 | 5.95 | 16.65 | 33.34 |
| C41421 | 0-2 | .00 | 3.11 | 44.18 | 52.72 | 8.07 | 8.89 | 2.32 | .00 | .00 | .00 | .00 | 3.11 | 9.10 | 14.58 | 11.70 | 8.80 | 3.03 | 14.89 | 34.80 |
| C41421 | 2-4 | .00 | 2.16 | 46.86 | 50.99 | 8.07 | 8.17 | 2.31 | .00 | .00 | .00 | .00 | 2.16 | 10.49 | 13.12 | 12.09 | 11.15 | 5.80 | 6.00 | 39.19 |
| C41421 | 4-6 | .00 | 2.09 | 44.70 | 53.21 | 8.10 | 8.46 | 2.36 | .00 | .00 | .00 | .00 | 2.09 | 12.75 | 10.41 | 13.04 | 8.49 | 7.00 | 4.72 | 41.49 |
| C41421 | 6-8 | .00 | 2.17 | 48.48 | 49.36 | 8.11 | 7.96 | 2.26 | .00 | .00 | .00 | .00 | 2.17 | 9.29 | 12.60 | 10.33 | 16.25 | 3.93 | 6.94 | 38.49 |
| C41421 | 8-10 | .00 | 2.19 | 45.83 | 51.99 | 8.04 | 8.23 | 2.37 | .00 | .00 | .00 | .00 | 2.19 | 12.04 | 11.60 | 15.91 | 6.28 | 8.50 | 1.15 | 42.34 |
| C41421 | 10-12 | .00 | 2.32 | 46.87 | 50.81 | 8.09 | 8.14 | 2.28 | .00 | .00 | .00 | .00 | 2.32 | 9.58 | 12.82 | 10.94 | 13.53 | 5.69 | 7.12 | 38.00 |
| C41421 | 16-18 | .00 | 2.32 | 44.46 | 53.23 | 7.98 | 8.48 | 2.48 | .00 | .00 | .00 | .00 | 2.32 | 17.11 | 11.44 | 10.05 | 5.85 | 6.76 | 4.63 | 41.84 |
| C41421 | 22-24 | .00 | 2.21 | 41.95 | 55.85 | 8.26 | 8.70 | 2.33 | .00 | .00 | .00 | .00 | 2.21 | 9.79 | 11.51 | 11.75 | 8.90 | 8.31 | 1.67 | 45.87 |

*Replicate 2 used because insufficient sample from replicate 1.

within the 10-percent resolution of the analysis method and therefore not attributable to accumulation of drilling muds or cuttings.

## SUMMARY OF IMPORTANT FINDINGS

1. At Station 1, adjacent to the drilling in Block 372, there are indications of small and localized additions of drilling mud to the bottom sediments. In one replicate core from Cruise 3, the top 4 cm of sediment had Ba concentrations as much as 13 percent higher than deeper sediments. In one replicate from Cruise 6 the top sample was 20 percent higher than deeper sediment. Ba to Al ratios in the same interval were 25 percent higher. The fact that this increase was measured in only one of three subcores from the same replicate box core indicates that the elevations of Ba from drilling are patchy on a very small scale, possibly due to the random addition of relatively large particles of barite. There is no systematic temporal change in the average Ba concentration at any of the stations sampled.

   The small increase in Ba is probably not deleterious to benthic marine organisms. This opinion is based on its patchy occurrence and on the data generated during the Georges Bank Monitoring Program which showed no environmental effects to benthic organisms attributable to drilling at stations where Ba increased as much as 5.9 times background levels (Battelle-WHOI, 1985). Barium in the form of barium sulfate is also known to be of low toxicity from its wide use in the field of medicine. However, because of a lack of scientific data, there is some uncertainty in predicting the response of marine organisms to long term, low level contamination.

2. The strongest signal from drilling mud was observed in sediment trap

samples collected within the upper 850 m of the water column at a mooring 2.8 km southwest of the drilling rig in Block 372. Discrete particles of barite as large as 60 x 60? x 90 μm were identified by means of a scanning electron microscope. Their occurrence in sediment traps suggests that these large particles fall individually through the water column at speeds predicted by a comprehensive model based on Stokes Law.

3. There are no changes in Ba concentration at Station 14 and 13, .65 km and 1.4 km, respectively, from the drill site in Block 93.

4. In cores collected on Cruise 1 at Stations 1, 6, 13, and 14, the concentration of Ba and the Ba-to-Al ratio in the surface sediments were not elevated with respect to deeper sediments. This suggests that the drilling mud from exploratory wells, which were active on the continental slope and shelf before Cruise 1, either was not deposited in the general area of this survey or was diluted to levels below detection by natural sediments.

5. Within the surface sediments sampled in this program, the analyzed metals are the same or lower in concentration than they are in average shales from around the world, an indication of uncontaminated sediments. For example, the highest concentration of Ba in sediments collected at the drill site in Block 372 after the completion of drilling was 555 ppm, less than the published value of 580 ppm for average shales (Krauskopf, 1967).

6. Pb concentrations are as much as three times higher in the upper 5 to 10 cm than they are in deeper sediments of the cores collected. The highest concentration measured in this study area is 31 ppm, slightly higher than the value in world average shales (20 ppm). Similar Pb profiles have been previously described in sediments from other locations

off the U.S. East Coast. The enrichment is thought to be related to the burning of gasoline containing lead additives and its subsequent atmospheric transport to offshore marine areas. Too little data are available in the literature to evaluate the potential impact of this increase in Pb. Data are lacking on the speciation and bioavailability of lead in sediments and on the effects of small increases (compared to the increases in some estuaries) of Pb on organisms inhabiting this deep environment.

7. The inventories of anthropogenic lead in sediments of the continental slope off the Middle Atlantic states appear to be higher by a factor of 2 to 7 than would be predicted from estimates of the long-term atmospheric flux of lead. This implies a preferential focusing of lead disposition (and of other sediment-reactive pollutants) in slope sediments, perhaps by increased scavenging of lead from the water column. We recommend analysis of $^{210}Pb$, $^{137}Cs$, and Pu isotopes on selected cores from the same area to test this hypothesis and to help describe the processes.

8. The analysis of sediment texture in sediment cores revealed no differences in predrilling and postdrilling samples at stations adjacent to drilling operations. This suggests that measurable amounts of drill cuttings are not accumulating at the locations sampled.

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Appendix Table 1. - Navigation data for samples analyzed for trace metals.

[Time delay X (Nantucket Island, Mass.) and time delay Y (Carolina Beach, N.C.) are Loran-C time delay values for the 9960 Loran-C chain]

| Field no. | Sta. | Yr | Mo | Dy | Water depth (m) | TDX (μs) | TDY (μs) | Latitude Deg. Min. | Longitude Deg. Min. |
|---|---|---|---|---|---|---|---|---|---|
| Core profiles | | | | | | | | | |
| C10111 | 01 | 1984 | 3 | 31 | 2195 | 26365.60 | 42588.70 | 38 35.9085 | -72 52.8983 |
| C20131 | 01 | 1984 | 8 | 3 | 2194 | 26365.20 | 42589.00 | 38 35.9357 | -72 52.8284 |
| C30111 | 01 | 1984 | 12 | 2 | 2165 | 26366.00 | 42588.10 | 38 35.8499 | -72 52.9697 |
| C40121 | 01 | 1985 | 5 | 17 | 2180 | 26365.80 | 42588.40 | 38 35.8791 | -72 52.9340 |
| C50111 | 01 | 1985 | 8 | 5 | 2185 | 26365.70 | 42588.70 | 38 35.9094 | -72 52.9154 |
| C60100 | 01 | 1985 | 11 | 13 | 2195 | 26365.90 | 42588.60 | 38 35.9010 | -72 52.9501 |
| C10611 | 06 | 1984 | 5 | 3 | 2090 | 26062.80 | 42877.70 | 39 05.5429 | -72 02.9310 |
| C20611 | 06 | 1984 | 3 | 1 | 2084 | 26062.70 | 42878.10 | 39 05.5880 | -72 02.9186 |
| C30631 | 06 | 1984 | 11 | 28 | 2085 | 26063.30 | 42878.40 | 39 05.6229 | -72 03.0197 |
| C40600 | 06 | 1985 | 5 | 15 | 2087 | 26063.30 | 42878.20 | 39 05.6003 | -72 03.0177 |
| C50611 | 06 | 1985 | 8 | 2 | 2080 | 26063.10 | 42878.20 | 39 05.6000 | -72 02.9850 |
| C60611 | 06 | 1985 | 11 | 10 | 2089 | 26064.00 | 42878.40 | 39 05.6241 | -72 03.1341 |
| C11311 | 13 | 1984 | 4 | 2 | 1603 | 26628.40 | 42121.00 | 37 53.2693 | -73 45.0185 |
| C21311 | 13 | 1984 | 8 | 7 | 1614 | 26628.00 | 42121.20 | 37 53.2794 | -73 44.9400 |
| C31311 | 13 | 1984 | 11 | 30 | 1615 | 26628.50 | 42120.90 | 37 53.2620 | -73 45.0390 |
| C51311 | 13 | 1985 | 8 | 9 | 1490 | 26626.40 | 42126.70 | 37 53.7745 | -73 44.5521 |
| C61311 | 13 | 1985 | 11 | 15 | 1609 | 26628.50 | 42121.20 | 37 53.2910 | -73 45.0342 |
| C11411 | 14 | 1984 | 4 | 2 | 1503 | 26627.20 | 42125.90 | 37 53.7156 | -73 44.7153 |
| C41421 | 14 | 1985 | 5 | 19 | 1492 | 26626.30 | 42127.10 | 37 53.8110 | -73 44.5270 |
| C51411 | 14 | 1985 | 8 | 10 | 1490 | 26626.40 | 42126.70 | 37 53.7745 | -73 44.5521 |
| C61411 | 14 | 1985 | 11 | 15 | 1515 | 26625.80 | 42125.80 | 37 53.6735 | -73 44.4533 |
| Station blends | | | | | | | | | |
| C10100 | 01 | 1984 | 3 | 31 | 2177 | 26365.20 | 42589.30 | 38 35.9671 | -72 52.8269 |
| C10200 | 02 | 1984 | 4 | 1 | 2021 | 26369.60 | 42586.00 | 38 35.6672 | -72 53.5960 |
| C10300 | 03 | 1984 | 5 | 5 | 2057 | 26356.20 | 42598.20 | 38 36.8079 | -72 51.2469 |
| C10400 | 04 | 1984 | 5 | 8 | 2108 | 26296.70 | 42674.80 | 38 44.3716 | -72 40.9176 |
| C10500 | 05 | 1984 | 5 | 8 | 2067 | 26249.90 | 42734.40 | 38 50.4352 | -72 33.0450 |
| C10600 | 06 | 1984 | 5 | 3 | 2089 | 26062.90 | 42877.70 | 39 05.5431 | -72 02.9474 |
| C10700 | 07 | 1984 | 5 | 6 | 2107 | 26423.00 | 42498.80 | 38 27.2520 | -73 03.3668 |
| C10800 | 08 | 1984 | 5 | 8 | 2149 | 26431.40 | 42498.20 | 38 27.2964 | -73 04.8347 |
| C10900 | 09 | 1984 | 5 | 6 | 2106 | 26480.70 | 42391.80 | 38 17.1690 | -73 14.4620 |
| C11000 | 10 | 1984 | 5 | 7 | 2095 | 26496.30 | 42137.00 | 37 51.7331 | -73 19.8003 |
| C11100 | 11 | 1984 | 5 | 7 | 1518 | 26386.40 | 42627.50 | 38 40.1426 | -72 56.2076 |
| C11200 | 01 | 1984 | 5 | 8 | 2501 | 26302.30 | 42532.20 | 38 29.2604 | -72 42.1044 |
| C11300 | 13 | 1984 | 4 | 3 | 1613 | 26628.40 | 42121.20 | 37 53.2887 | -73 45.0154 |
| C11400 | 14 | 1984 | 4 | 2 | 1500 | 26626.80 | 42126.70 | 37 53.7838 | -73 44.6274 |

Appendix Table 1. - Navigation data for samples analyzed for trace metals. Continued.

[Time delay X (Nantucket Island, Mass.) and time delay Y (Carolina Beach, N.C.) are Loran-C time delay values for the 9960 Loran-C chain]

| Field no. | Sta. | Yr | Mo | Dy | Water depth (m) | TDX (μs) | TDY (μs) | Latitude Deg. Min. | Longitude Deg. Min. |
|---|---|---|---|---|---|---|---|---|---|
| Station blends - Continued | | | | | | | | | |
| C20100 | 01 | 1984 | 8 | 3 | 2194 | 26365.70 | 42590.10 | 38 36.0556 | -72 52.9083 |
| C20200 | 02 | 1984 | 8 | 3 | 2014 | 26369.90 | 42586.30 | 38 35.7015 | -72 53.6458 |
| C20300 | 03 | 1984 | 8 | 3 | 2055 | 26357.10 | 42597.90 | 38 36.7853 | -72 51.4019 |
| C20400 | 04 | 1984 | 8 | 1 | 2114 | 26296.80 | 42675.60 | 38 44.4574 | -72 40.9328 |
| C20500 | 05 | 1984 | 8 | 1 | 2084 | 26249.40 | 42734.00 | 38 50.3892 | -72 32.9619 |
| C20600 | 06 | 1984 | 8 | 1 | 2077 | 26062.70 | 42878.30 | 39 05.6106 | -72 02.9206 |
| C20700 | 07 | 1984 | 8 | 5 | 2102 | 26422.80 | 42499.20 | 38 27.2906 | -73 03.3290 |
| C20800 | 08 | 1984 | 8 | 6 | 2159 | 26430.80 | 42497.00 | 38 27.1659 | -73 04.7396 |
| C20900 | 09 | 1984 | 8 | 6 | 2112 | 26480.60 | 42391.90 | 38 17.1775 | -73 14.4432 |
| C21000 | 10 | 1984 | 8 | 7 | 2100 | 26495.80 | 42137.20 | 37 51.7414 | -73 19.7030 |
| C21100 | 11 | 1984 | 8 | 5 | 1509 | 26386.80 | 42627.40 | 38 40.1358 | -72 56.2756 |
| C21200 | 12 | 1984 | 8 | 5 | 2509 | 26301.50 | 42532.10 | 38 29.2402 | -72 41.9639 |
| C21300 | 13 | 1984 | 8 | 8 | 1617 | 26628.70 | 42120.40 | 37 53.2183 | -73 45.0845 |
| C30100 | 01 | 1984 | 12 | 2 | 2175 | 26366.00 | 42588.40 | 38 35.8812 | -72 52.9682 |
| C30200 | 02 | 1984 | 12 | 2 | 2013 | 26369.70 | 42585.80 | 38 35.6474 | -72 53.6142 |
| C30300 | 03 | 1984 | 12 | 3 | 2050 | 26357.50 | 43597.90 | 40 24.3556 | -72 41.2359 |
| C30400 | 04 | 1984 | 12 | 5 | 2107 | 26297.50 | 42674.30 | 38 44.3245 | -72 41.0531 |
| C30500 | 05 | 1984 | 12 | 5 | 2082 | 26249.80 | 42733.80 | 38 50.3700 | -72 33.0283 |
| C30600 | 06 | 1984 | 11 | 28 | 2088 | 26062.30 | 42877.70 | 39 05.5421 | -72 02.8492 |
| C30700 | 07 | 1984 | 12 | 2 | 2110 | 26423.00 | 42498.50 | 38 27.2212 | -73 03.3690 |
| C30800 | 08 | 1984 | 12 | 1 | 2153 | 26430.90 | 42497.00 | 38 27.1671 | -73 04.7570 |
| C30900 | 09 | 1984 | 12 | 1 | 2107 | 26480.30 | 42392.00 | 38 17.1829 | -73 14.3887 |
| C31000 | 10 | 1984 | 11 | 30 | 2100 | 26496.40 | 42136.90 | 37 51.7254 | -73 19.8203 |
| C31100 | 11 | 1984 | 12 | 4 | 1527 | 26386.40 | 42626.90 | 38 40.0804 | -72 56.2114 |
| C31200 | 12 | 1984 | 12 | 4 | 2507 | 26301.90 | 42531.70 | 38 29.2024 | -72 42.0347 |
| C31300 | 13 | 1984 | 11 | 30 | 1614 | 26628.30 | 42120.90 | 37 53.2573 | -73 45.0013 |
| C40100 | 01 | 1985 | 5 | 17 | 2192 | 26365.90 | 42588.40 | 38 35.8802 | -72 52.9511 |
| C40200 | 02 | 1985 | 5 | 17 | 2011 | 26369.70 | 42586.10 | 38 35.6786 | -72 53.6126 |
| C40300 | 03 | 1985 | 5 | 16 | 2051 | 26357.10 | 42597.80 | 38 36.7749 | -72 51.4024 |
| C40400 | 04 | 1985 | 5 | 16 | 2097 | 26297.50 | 42675.00 | 38 44.3989 | -72 41.0517 |
| C40500 | 05 | 1985 | 5 | 16 | 2078 | 26249.60 | 42734.30 | 38 50.4227 | -72 32.9952 |
| C40600 | 06 | 1985 | 5 | 15 | 2087 | 26063.30 | 42878.20 | 39 05.6003 | -72 03.0177 |
| C40700 | 07 | 1985 | 5 | 18 | 2102 | 26480.60 | 42392.20 | 38 17.2078 | -73 14.4403 |
| C40900 | 09 | 1985 | 5 | 18 | 2102 | 26480.60 | 42392.20 | 38 17.2078 | -73 14.4403 |
| C41000 | 10 | 1985 | 5 | 19 | 2095 | 26496.10 | 42136.90 | 37 51.7182 | -73 19.7631 |
| C41100 | 11 | 1985 | 5 | 17 | 1510 | 26386.70 | 42627.20 | 38 40.1142 | -72 56.2600 |
| C41200 | 12 | 1985 | 5 | 18 | 2505 | 26301.70 | 42531.90 | 38 29.2213 | -72 41.9993 |
| C41300 | 13 | 1985 | 5 | 19 | 1609 | 26628.50 | 42120.90 | 37 53.2620 | -73 45.0389 |
| C41400 | 14 | 1985 | 5 | 19 | 1491 | 26626.40 | 42127.00 | 37 53.8036 | -73 44.5474 |

Appendix Table 1. - Navigation data for samples analyzed for trace metals. Continued.

[Time delay X (Nantucket Island, Mass.) and time delay Y (Carolina Beach, N.C.) are Loran-C time delay values for the 9960 Loran-C chain]

| Field no. | Sta. | Yr | Mo | Dy | Water depth (m) | TDX (μs) | TDY (μs) | Latitude Deg. Min. | Longitude Deg. Min. |
|---|---|---|---|---|---|---|---|---|---|
| Station blends - Continued | | | | | | | | | |
| C50100 | 01 | 1985 | 8 | 5 | 2185 | 26365.70 | 42588.70 | 38 35.9095 | -72 52.9154 |
| C50200 | 02 | 1985 | 8 | 5 | 2008 | 26369.50 | 42586.30 | 38 35.6975 | -72 53.5774 |
| C50300 | 03 | 1985 | 8 | 5 | 2053 | 26356.70 | 42598.00 | 38 36.7919 | -72 51.3332 |
| C50400 | 04 | 1985 | 8 | 3 | 2095 | 26297.30 | 42675.00 | 38 44.3974 | -72 41.0180 |
| C50500 | 05 | 1985 | 8 | 3 | 2079 | 26249.60 | 42734.00 | 38 50.3904 | -72 32.9951 |
| C50600 | 06 | 1985 | 8 | 2 | 2080 | 26063.20 | 42878.20 | 39 05.6001 | -72 03.0014 |
| C50700 | 07 | 1985 | 8 | 7 | 2089 | 26063.40 | 42878.00 | 39 05.5779 | -72 03.0321 |
| C50900 | 09 | 1985 | 8 | 8 | 2100 | 26480.80 | 42392.30 | 38 17.2211 | -73 14.4750 |
| C51000 | 10 | 1985 | 8 | 10 | 2094 | 26496.40 | 42137.10 | 37 51.7456 | -73 19.8183 |
| C51100 | 11 | 1985 | 8 | 6 | 1503 | 26386.80 | 42627.30 | 38 40.1254 | -72 56.2762 |
| C51200 | 12 | 1985 | 8 | 7 | 2495 | 26301.80 | 42532.00 | 38 29.2332 | -72 42.0167 |
| C51300 | 13 | 1985 | 8 | 9 | 1607 | 26628.40 | 42120.90 | 37 53.2597 | -73 45.0201 |
| C51400 | 14 | 1985 | 8 | 10 | 1490 | 26626.40 | 42126.70 | 37 53.7745 | -73 44.5521 |
| C60100 | 01 | 1985 | 11 | 13 | 2195 | 26365.90 | 42588.60 | 38 35.9010 | -72 52.9501 |
| C60200 | 02 | 1985 | 11 | 13 | 2014 | 26369.50 | 42586.50 | 38 35.7183 | -72 53.5763 |
| C60300 | 03 | 1985 | 11 | 13 | 2061 | 26357.30 | 42598.30 | 38 36.8291 | -72 51.4342 |
| C60400 | 04 | 1985 | 11 | 11 | 2108 | 26297.40 | 42674.60 | 38 44.3556 | -72 41.0357 |
| C60500 | 05 | 1985 | 11 | 11 | 2084 | 26249.40 | 42734.40 | 38 50.4323 | -72 32.9620 |
| C60600 | 06 | 1985 | 11 | 10 | 2091 | 26063.40 | 42877.80 | 39 05.5553 | -72 03.0301 |
| C60700 | 07 | 1985 | 11 | 10 | 2067 | 26423.00 | 42499.00 | 38 27.2726 | -73 03.3653 |
| C60900 | 09 | 1985 | 11 | 17 | 2107 | 26481.60 | 42391.90 | 38 17.1932 | -73 14.6216 |
| C61000 | 10 | 1985 | 11 | 16 | 2107 | 26494.30 | 42139.00 | 37 51.8876 | -73 19.4001 |
| C61100 | 11 | 1985 | 11 | 13 | 1514 | 26386.80 | 42627.00 | 38 40.0943 | -72 56.2781 |
| C61200 | 12 | 1985 | 11 | 14 | 2503 | 26302.20 | 42531.80 | 38 29.2167 | -72 42.0873 |
| C61300 | 13 | 1985 | 11 | 16 | 1609 | 26628.50 | 42120.80 | 37 53.2523 | -73 45.0405 |
| C61400 | 14 | 1985 | 11 | 15 | 1503 | 26626.20 | 42126.40 | 37 53.7409 | -73 44.5192 |

Appendix Table 1. - Navigation data for samples analyzed for trace metals. Continued.

[Time delay X (Nantucket Island, Mass.) and time delay Y (Carolina Beach, N.C.) are Loran-C time delay values for the 9960 Loran-C chain]

| Field no. | Sta. | Yr | Mo | Dy | Water depth (m) | TDX (μs) | TDY (μs) | Latitude Deg. Min. | Longitude Deg. Min. |
|---|---|---|---|---|---|---|---|---|---|
| Replicate box core and within-box core comparisons | | | | | | | | | |
| C10111 | 01 | 1984 | 3 | 31 | 2195 | 26365.60 | 42588.70 | 38 35.9084 | -72 52.8983 |
| C10121 | 01 | 1984 | 3 | 31 | 2195 | 26365.60 | 42589.00 | 38 35.9398 | -72 52.8968 |
| C10122 | 01 | 1984 | 3 | 31 | 2195 | 26365.60 | 42589.00 | 38 35.9398 | -72 52.8968 |
| C10123 | 01 | 1984 | 3 | 31 | 2195 | 26365.60 | 42589.00 | 38 35.9398 | -72 52.8968 |
| C10131 | 01 | 1984 | 3 | 31 | 2143 | 26364.30 | 42590.20 | 38 36.0520 | -72 52.6686 |
| C10511 | 05 | 1984 | 5 | 8 | 2055 | 26250.10 | 42734.90 | 38 50.4903 | -72 33.0782 |
| C10521 | 05 | 1984 | 5 | 4 | 2065 | 26249.90 | 42734.30 | 38 50.4245 | -72 33.0450 |
| C10531 | 05 | 1984 | 5 | 8 | 2080 | 26249.70 | 42734.00 | 38 50.3910 | -72 33.0117 |
| C11311 | 13 | 1984 | 4 | 2 | 1613 | 26628.40 | 42121.00 | 37 53.2693 | -73 45.0185 |
| C11321 | 13 | 1984 | 4 | 2 | 1613 | 26628.40 | 42121.30 | 37 53.2984 | -73 45.0138 |
| C11331 | 13 | 1984 | 4 | 3 | 1613 | 26628.40 | 42121.20 | 37 53.2887 | -73 45.0154 |
| C20111 | 01 | 1984 | 8 | 3 | 2209 | 26366.30 | 42590.10 | 38 36.0616 | -72 53.0108 |
| C20112 | 01 | 1984 | 8 | 3 | 2209 | 26366.30 | 42590.10 | 38 36.0616 | -72 53.0108 |
| C20113 | 01 | 1984 | 8 | 3 | 2209 | 26366.30 | 42590.10 | 38 36.0616 | -72 53.0108 |
| C20121 | 01 | 1984 | 8 | 3 | 2179 | 26365.70 | 42591.10 | 38 36.1599 | -72 52.9033 |
| C20131 | 01 | 1984 | 8 | 3 | 2194 | 26365.20 | 42589.00 | 38 35.9357 | -72 52.8284 |
| C20211 | 02 | 1984 | 8 | 3 | 2019 | 26369.30 | 42586.50 | 38 35.7163 | -72 53.5421 |
| C20221 | 02 | 1984 | 8 | 3 | 2014 | 26369.70 | 42586.10 | 38 35.6786 | -72 53.6126 |
| C20231 | 02 | 1984 | 8 | 3 | 2004 | 26370.60 | 42586.20 | 38 35.6982 | -72 53.7660 |
| C20411 | 04 | 1984 | 8 | 1 | 2124 | 26297.20 | 42675.30 | 38 44.4286 | -72 41.0006 |
| C20421 | 04 | 1984 | 8 | 1 | 2114 | 26298.30 | 42675.60 | 38 44.4688 | -72 41.1848 |
| C20431 | 04 | 1984 | 8 | 2 | 2099 | 26296.80 | 42675.90 | 38 44.4893 | -72 40.9322 |
| C20611 | 06 | 1984 | 3 | 1 | 2084 | 26062.70 | 42878.10 | 39 05.5880 | -72 02.9186 |
| C20621 | 06 | 1984 | 8 | 1 | 2084 | 26062.70 | 42878.30 | 39 05.6106 | -72 02.9206 |
| C20631 | 06 | 1984 | 8 | 1 | 2084 | 26062.80 | 42878.50 | 39 05.6334 | -72 02.9389 |
| C21311 | 13 | 1984 | 8 | 7 | 1614 | 26628.00 | 42121.20 | 37 53.2794 | -73 44.9406 |
| C21321 | 13 | 1984 | 8 | 8 | 1619 | 26629.30 | 42120.20 | 37 53.2129 | -73 45.2008 |
| C21331 | 13 | 1984 | 8 | 8 | 1619 | 26628.80 | 42119.70 | 37 53.1529 | -73 45.1145 |
| C30111 | 1 | 1984 | 12 | 2 | 2165 | 26366.00 | 42588.10 | 38 35.8499 | -72 52.9697 |
| C30112 | 01 | 1984 | 12 | 2 | 2165 | 26366.00 | 42588.10 | 38 35.8499 | -72 52.9697 |
| C30113 | 01 | 1984 | 12 | 2 | 2165 | 26366.00 | 42588.10 | 38 35.8499 | -72 52.9697 |
| C30121 | 01 | 1984 | 12 | 2 | 2175 | 26366.10 | 42588.40 | 38 35.8822 | -72 52.9853 |
| C30131 | 01 | 1984 | 12 | 3 | 2185 | 26366.00 | 42588.70 | 38 35.9125 | -72 52.9666 |

Appendix Table 1. - Navigation data for samples analyzed for trace metals. Continued.

[Time delay X (Nantucket Island, Mass.) and time delay Y (Carolina Beach, N.C.) are Loran-C time delay values for the 9960 Loran-C chain]

| Field no. | Sta. | Yr | Mo | Dy | Water depth (m) | TDX (μs) | TDY (μs) | Latitude Deg. Min. | Longitude Deg. Min. |
|---|---|---|---|---|---|---|---|---|---|
| Replicate box core and within-box core comparisons - Continued | | | | | | | | | |
| C30611 | 06 | 1984 | 11 | 28 | 2090 | 26061.70 | 42877.40 | 39 05.5071 | -72 02.7480 |
| C30621 | 06 | 1984 | 11 | 28 | 2090 | 26061.90 | 42877.30 | 39 05.4961 | -72 02.7798 |
| C30631 | 06 | 1984 | 11 | 28 | 2085 | 26063.30 | 42878.40 | 39 05.6229 | -72 03.0197 |
| C31311 | 13 | 1984 | 11 | 30 | 1615 | 26628.50 | 42120.90 | 37 53.2620 | -73 45.0390 |
| C31321 | 13 | 1984 | 11 | 30 | 1615 | 26628.10 | 42121.30 | 37 53.2914 | -73 44.9573 |
| C31331 | 13 | 1984 | 11 | 30 | 1612 | 26628.50 | 42120.40 | 37 53.2136 | -73 45.0469 |
| C40111 | 01 | 1985 | 5 | 17 | 2200 | 26366.10 | 42588.40 | 38 35.8822 | -72 52.9853 |
| C40121 | 01 | 1985 | 5 | 17 | 2180 | 26365.80 | 42588.40 | 38 35.8792 | -72 52.9340 |
| C40131 | 01 | 1985 | 5 | 17 | 2195 | 26365.80 | 42588.50 | 38 35.8896 | -72 52.9335 |
| C41311 | 13 | 1985 | 5 | 19 | 1615 | 26628.40 | 42120.80 | 37 53.2500 | -73 45.0217 |
| C41321 | 13 | 1985 | 5 | 19 | 1607 | 26628.70 | 42121.00 | 37 53.2763 | -73 45.0751 |
| C41331 | 13 | 1985 | 5 | 19 | 1605 | 26628.50 | 42120.80 | 37 53.2523 | -73 45.0405 |
| C41411 | 14 | 1985 | 5 | 19 | 1490 | 26626.50 | 42126.90 | 37 53.7962 | -73 44.5678 |
| C41412 | 14 | 1985 | 5 | 19 | 1490 | 26626.50 | 42126.90 | 37 53.7962 | -73 44.5678 |
| C41413 | 14 | 1985 | 5 | 19 | 1490 | 26626.50 | 42126.90 | 37 53.7962 | -73 44.5678 |
| C41421 | 14 | 1985 | 5 | 19 | 1492 | 26626.30 | 42127.10 | 37 53.8109 | -73 44.5270 |
| C41431 | 14 | 1985 | 5 | 19 | 1490 | 26626.30 | 42127.00 | 37 53.8013 | -73 44.5286 |
| C51411 | 14 | 1985 | 8 | 10 | 1490 | 26626.40 | 42126.70 | 37 53.7745 | -73 44.5521 |
| C51421 | 14 | 1985 | 8 | 10 | 1490 | 26626.40 | 42126.70 | 37 53.7745 | -73 44.5521 |
| C51431 | 14 | 1985 | 8 | 10 | 1484 | 26625.90 | 42127.90 | 37 53.8792 | -73 44.4392 |
| C51412 | 14 | 1985 | 8 | 10 | 1490 | 26626.40 | 42126.70 | 37 53.7745 | -73 44.5521 |
| C51413 | 14 | 1985 | 8 | 10 | 1490 | 26626.40 | 42126.70 | 37 53.7745 | -73 44.5521 |
| C60111 | 01 | 1985 | 11 | 13 | 2194 | 26365.80 | 42588.20 | 38 35.8583 | -72 52.9350 |
| C60112 | 01 | 1985 | 11 | 13 | 2194 | 26365.80 | 42588.20 | 38 35.8583 | -72 52.9350 |
| C60113 | 01 | 1985 | 11 | 13 | 2194 | 26365.80 | 42588.20 | 38 35.8583 | -72 52.9350 |
| C60121 | 01 | 1985 | 11 | 13 | 2199 | 26365.80 | 42588.60 | 38 35.9000 | -72 52.9330 |
| C60131 | 01 | 1985 | 11 | 13 | 2194 | 26366.20 | 42588.90 | 38 35.9354 | -72 52.9999 |
| C60611 | 06 | 1985 | 11 | 10 | 2089 | 26064.00 | 42878.40 | 39 05.6241 | -72 03.1341 |
| C60621 | 06 | 1985 | 11 | 10 | 2191 | 26063.30 | 42878.10 | 39 05.5890 | -72 03.0167 |
| C60631 | 06 | 1985 | 11 | 10 | 2192 | 26062.80 | 42877.00 | 39 05.4637 | -72 02.9241 |
| C61311 | 13 | 1985 | 11 | 15 | 1609 | 26628.50 | 42121.20 | 37 53.2910 | -73 45.0342 |
| C61321 | 13 | 1985 | 11 | 16 | 1611 | 26628.60 | 42120.80 | 37 53.2547 | -73 45.0594 |
| C61331 | 13 | 1985 | 11 | 16 | 1607 | 26628.50 | 42120.80 | 37 53.2523 | -73 45.0405 |

Appendix Table 1. - Navigation data for samples analyzed for trace metals. Continued.

[Time delay X (Nantucket Island, Mass.) and time delay Y (Carolina Beach, N.C.) are Loran-C time delay values for the 9960 Loran-C chain]

| Field no. | Sta. | Yr | Mo | Dy | Water depth (m) | TDX (μs) | TDY (μs) | Latitude Deg. Min. | Longitude Deg. Min. |
|---|---|---|---|---|---|---|---|---|---|
| Replicate box core and within-box core comparisons - Continued | | | | | | | | | |
| C61411 | 14 | 1985 | 11 | 15 | 1515 | 26625.80 | 42125.80 | 37 53.6735 | -73 44.4533 |
| C61421 | 14 | 1985 | 11 | 15 | 1499 | 26626.40 | 42126.80 | 37 53.7842 | -73 44.5505 |
| C61431 | 14 | 1985 | 11 | 15 | 1489 | 26626.40 | 42126.60 | 37 53.7648 | -73 44.5537 |
| C10111 | 01 | 1984 | 3 | 31 | 2195 | 26365.60 | 42588.70 | 38 35.9085 | -72 52.8983 |
| Fine fraction analyses Fine fraction samples | | | | | | | | | |
| C10100X | 01 | 1984 | 3 | 31 | 2177 | 26365.20 | 42589.30 | 38 35.9670 | -72 52.8269 |
| C20100X | 01 | 1984 | 8 | 3 | 2194 | 26365.70 | 42590.10 | 38 36.0556 | -72 52.9083 |
| C30100X | 01 | 1984 | 12 | 2 | 2175 | 26366.00 | 42588.40 | 38 35.8812 | -72 52.9682 |
| C40100X | 01 | 1985 | 5 | 17 | 2192 | 26365.90 | 42588.40 | 38 35.8802 | -72 52.9511 |
| C50100X | 01 | 1985 | 8 | 5 | 2185 | 26365.70 | 42588.70 | 38 35.9094 | -72 52.9154 |
| C60100X | 01 | 1985 | 11 | 13 | 2195 | 26365.90 | 42588.60 | 38 35.9010 | -72 52.9501 |
| C10200X | 02 | 1984 | 4 | 1 | 2021 | 26369.60 | 42586.00 | 38 35.6672 | -72 53.5960 |
| C20200X | 02 | 1984 | 8 | 3 | 2014 | 26369.90 | 42586.30 | 38 35.7015 | -72 53.6458 |
| C30200X | 02 | 1984 | 12 | 2 | 2013 | 26369.70 | 42585.80 | 38 35.6474 | -72 53.6142 |
| C60200X | 02 | 1985 | 11 | 13 | 2014 | 26369.50 | 42586.50 | 38 35.7183 | -72 53.5763 |
| C10300X | 03 | 1984 | 5 | 5 | 2057 | 26356.20 | 42598.20 | 38 36.8079 | -72 51.2469 |
| C20300X | 03 | 1984 | 8 | 3 | 2055 | 26357.10 | 42597.90 | 38 36.7853 | -72 51.4019 |
| C10400X | 04 | 1984 | 5 | 8 | 2108 | 26296.70 | 42674.80 | 38 44.3716 | -72 40.9176 |
| C20400X | 04 | 1984 | 8 | 1 | 2117 | 26296.80 | 42675.60 | 38 44.4574 | -72 40.9328 |
| C30400X | 04 | 1984 | 12 | 5 | 2107 | 26297.50 | 42674.30 | 38 44.3245 | -72 41.0531 |
| C40400X | 04 | 1985 | 5 | 16 | 2097 | 26297.50 | 42675.00 | 38 44.3989 | -72 41.0517 |
| C60400X | 04 | 1985 | 11 | 11 | 2108 | 26297.40 | 42674.60 | 38 44.3556 | -72 41.0357 |
| C50600X | 06 | 1985 | 8 | 2 | 2080 | 26063.20 | 42878.20 | 39 05.6001 | -72 03.0014 |
| C11300X | 13 | 1984 | 4 | 3 | 1613 | 26628.40 | 42121.20 | 37 53.2887 | -73 45.0154 |
| C21300X | 13 | 1984 | 8 | 8 | 1617 | 26628.70 | 42120.40 | 37 53.2183 | -73 45.0846 |
| C31300X | 13 | 1984 | 11 | 30 | 1614 | 26628.30 | 42120.90 | 37 53.2573 | -73 45.0013 |
| C41300X | 13 | 1985 | 5 | 19 | 1609 | 26628.50 | 42120.90 | 37 53.2620 | -73 45.0390 |
| C51300X | 13 | 1985 | 8 | 9 | 1607 | 26628.40 | 42120.90 | 37 53.2597 | -73 45.0201 |
| C61300X | 13 | 1985 | 11 | 16 | 1609 | 26628.50 | 42120.80 | 37 53.2523 | -73 45.0405 |

Appendix Table 1. - Navigation data for samples analyzed for trace metals. Continued.

[Time delay X (Nantucket Island, Mass.) and time delay Y (Carolina Beach, N.C.) are Loran-C time delay values for the 9960 Loran-C chain]

| Field no. | Sta. | Yr | Mo | Dy | Water depth (m) | TDX (μs) | TDY (μs) | Latitude Deg. Min. | Longitude Deg. Min. |
|---|---|---|---|---|---|---|---|---|---|
| Fine fraction analyses | | | | | Fine fraction samples | | | | |
| C41400X | 14 | 1985 | 5 | 19 | 1491 | 26626.40 | 42127.00 | 37 53.8036 | -73 44.5474 |
| C51400X | 14 | 1985 | 8 | 10 | 1490 | 26626.40 | 42126.70 | 37 53.7745 | -73 44.5521 |
| C61400X | 14 | 1985 | 11 | 15 | 1503 | 26626.20 | 42126.40 | 37 53.7409 | -73 44.5192 |
| Block 372 - Drill rig position | | | | | | | | 38 36.0197 | -72 52.2304 |
| Block 93 - Drill rig position | | | | | | | | 37 53.5767 | -73 44.1668 |

Appendix Table 2. - Sediment Trap Mooring J

| Trap No. | Deployed | Recovered | Water Depth (m) | Meters Above Bottom | TDX | TDY | Latitude Deg. | Latitude Min. | Longitude Deg. | Longitude Min. |
|---|---|---|---|---|---|---|---|---|---|---|
| ST901 | 6/21/1984 | 9/26/1984 | 2120 | 1900 | 26371.4 | 42582.4 | 38 | 35.310 | 72 | 53.923 |
| ST902 | 6/21/1984 | 9/26/1984 | 2120 | 1750 | 26371.4 | 42582.4 | 38 | 35.310 | 72 | 53.923 |
| ST903 | 6/21/1984 | 9/26/1984 | 2120 | 1500 | 26371.4 | 42582.4 | 38 | 35.310 | 72 | 53.923 |
| ST904 | 6/21/1984 | 9/26/1984 | 2120 | 1250 | 26371.4 | 42582.4 | 38 | 35.310 | 72 | 53.923 |
| ST905 | 6/21/1984 | 9/26/1984 | 2120 | 1000 | 26371.4 | 42582.4 | 38 | 35.310 | 72 | 53.923 |
| ST906 | 6/21/1984 | 9/26/1984 | 2120 | 750 | 26371.4 | 42582.4 | 38 | 35.310 | 72 | 53.923 |
| ST907 | 6/21/1984 | 9/26/1984 | 2120 | 500 | 26371.4 | 42582.4 | 38 | 35.310 | 72 | 53.923 |
| ST908 | 6/21/1984 | 9/26/1984 | 2120 | 250 | 26371.4 | 42582.4 | 38 | 35.310 | 72 | 53.923 |
| ST909 | 6/21/1984 | 9/26/1984 | 2120 | 100 | 26371.4 | 42582.4 | 38 | 35.310 | 72 | 53.923 |
| ST910 | 6/21/1984 | 9/26/1984 | 2120 | 50 | 26371.4 | 42582.4 | 38 | 35.310 | 72 | 53.923 |
| ST911 | 6/21/1984 | 9/26/1984 | 2120 | 20 | 26371.4 | 42582.4 | 38 | 35.310 | 72 | 53.923 |
| ST912 | 6/21/1984 | 9/26/1984 | 2120 | 10 | 26371.4 | 42582.4 | 38 | 35.310 | 72 | 53.923 |
| ST913 | 6/21/1984 | 9/26/1984 | 2120 | 4 | 26371.4 | 42582.4 | 38 | 35.310 | 72 | 53.923 |