CHEMICAL AND TEXTURAL CHARACTERISTICS OF SEDIMENTS AT AN EPA REFERENCE SITE FOR DREDGED MATERIAL ON THE CONTINENTAL SLOPE SW OF THE FARALLON ISLANDS

by

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COVER: Photograph showing the hydraulically-damped gravity corer on the deck of the R. V. Pacific Escort in heavy seas off the Farallon Islands.

Executive Summary

A U.S. Environmental Protection Agency (EPA) reference site for dredged material has been established on the Continental Slope off San Francisco in water depths of 800-1500 m. This site, 35 km southwest of the Farallon Islands, serves as a reference for sediment testing in support of dredging and disposal at the San Francisco Deep Ocean Disposal Site (SF-DODS). An estimated 300 million cubic yards of dredged material from San Francisco Bay are expected to be discharged at this site during the next 50 years. Information from the reference site provides an additional baseline for monitoring environmental changes at the SF-DODS. This study provides sediment data on a suite of heavy metals and organic compounds which make up the EPA list of "chemicals of concern" because of their potential toxicity to marine organisms.

A unique aspect of this study is the analysis of contaminants in closely spaced depth intervals of undisturbed sediment cores. Because deeper horizons represent older time periods, these profiles provide information on the magnitude of recent changes in contaminant additions to this reference site. This study also provides the first information in the general dump site area on the concentrations of *Clostridium perfringens* (a bacterium spore used as a tracer for sewage particles) as well as acid volatile sulfide (AVS) and simultaneously extracted metals (SEM). Both AVS and SEM are used to evaluate the bioavailability of metals in sediments.

On the basis of this study, we point out that the analysis of contaminant vs.depth profiles in undisturbed sediment cores would provide important information, not currently available, about the long-term fate and effects of dredged material disposal at the SF-DODS. In addition, data from cores in the dump site over time would reveal whether future temporal changes in contaminant concentrations and inventories are due to sediment mixing, burial, or erosion. We recommend the analysis of core horizons to supplement the current practice of analyzing sediments composited over the top 10 cm. This analysis plan would be particularly useful for quantifying the level of contaminants in surface sediments outside of the SF-DODS boundary, where a sediment-profile camera system identified fine-grained dredge material in a thin (<0.5 cm) surface layer and where changes in the benthic ecology were observed following the dumping in 1995.

The depth profiles of polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs) indicate that surface sediments at this reference site have been influenced slightly by anthropogenic activities. PCBs are man-made compounds. Total PCBs average 2.9 ppb ± 1.0 ppb in surface sediments and are below detection limits (<0.2 ppb) at 20-30 cm depth in the cores. PAHs are introduced to the environment by combustion of fossil fuels and so have a natural source augmented by activities of the industrial age. Individual PAH concentrations (pyrene, fluoranthene, and others) were about a factor of 2 higher in surface sediment than in the 20-30 cm horizon. However, the concentrations of PAHs and PCBs in surface sediments at this reference site are 2-4 orders of magnitude lower than those measured near urban centers.

Most of the other organic compounds analyzed were below the reporting limits of the EPA methods. Those compounds which were above detection limits were typically lower than the ERM (effects range - medium) toxicity guidelines (Long and others, 1995) by a factor of about 50-200, and were lower than the ERL (effects range - low) guidelines by a factor of about 5-50.

Within the suite of heavy metals analyzed, only lead and mercury concentrations were slightly elevated in the surface relative to deeper sediments. The decreasing concentration of these elements with sediment depth may be related in part to similar changes in organic carbon content. The enrichment of lead is less than observed at some locations on the Continental Slope off the East Coast, where lead enrichment of surface sediments is attributed to past use of leaded gasoline.

Acid volatile sulfides (AVS) were essentially zero and the concentration of the "bioavailable fraction" was extremely low. The average concentrations of metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, and zinc) in surface sediments from this reference area are significantly lower than the ERM (effects range - medium) toxic effect guidelines described by Long and others (1995), except for nickel. The concentration of nickel (51 ± 5 ppm) is equivalent to the guideline; however, the guideline is lower than the value in average shale (95 ppm) or average crust (75 ppm). The concentrations of silver, cadmium and selenium in surface sediments at this site are between 1.6 and 3.8 times higher than reported in world average shales, probably as a result of the natural mineralogy.

The concentrations of *Clostridium perfringens* are between 570-1200 spores/g in surface sediments and are below detection limits (<40 spores/g) at depths in cores greater than 10 or 20 cm. It is difficult to explain the elevated counts of this bacterium spore. Marine mammals may be a local source of *Clostridium perfringens*, but no data is available to assess their contribution.

The small enrichments of PAHs, PCBs, mercury, lead, and *Clostridium perfringens* in surface sediments could be the result of a number of processes. Elevated concentrations of the first four parameters are known to be present in the atmosphere downwind of industrialized centers. Low concentrations would be expected in the sediments of the reference site because air masses and wind direction in this region are from the ocean. All five parameters could also be transported to the slope with fine grained sediment from the Continental Shelf. An eddy associated with the coastal current has been shown to transport significant amounts of shelf sediments offshore (Washburn and others, 1993). All five parameters are commonly found in dredged material and sewage effluents, although no local discharges are known to occur at or upstream of this reference site.

The grain size of surface sediments varied within a narrow range and averaged 28% ± 8% sand, 52% ± 6% silt and 20% ± 3.6% clay. The topography of the reference site is complicated, having two valleys and two ridges. The sediment texture becomes finer with depth in one core and coarser with depth in the other. These cores apparently reflect the temporal and spatial variability in sedimentary conditions which is not uncommon in areas of variable topography.

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Introduction

The oceans have been impacted by human activities for many decades. Although concerns about possible environmental damage to the world's oceans were expressed at least thirty years ago, only now is the potential effect of these human activities on the marine ecosystem beginning to be fully comprehended by scientists and the general public. Many harbors and bays require regular dredging to maintain shipping channels. By law the spoils from this dredging must be disposed of in a manner that will not unreasonably degrade the environment and adversely affect human health. San Francisco Bay is one of the many industrialized estuaries around the United States that requires periodic maintenance dredging of navigable waterways to sustain recreational, commercial, and military shipping. An annual economy of $5.4 billion, including 35,000 jobs, is tied to the present marine activities (U.S. EPA, 1993) ; Ogden, Beeman & Assoc., 1988). In order to maintain and expand shipping channels in San Francisco Bay over the next 50 years, an estimated 300 million cubic yards of sediment are expected to be dredged from the Bay and discharged on the Continental Slope (U.S. EPA, 1993). Federal agencies, State agencies, and public interest groups formed a Long Term Management Strategy (LTMS) consortium that determined the need to designate an ocean disposal alternative for dredged material generated from projects in the San Francisco Bay region. Ocean dumping regulations specify that adequate scientific information shall be obtained to assess the environmental impact of this discharge at proposed alternative disposal sites. As part of the processes of obtaining such scientific information, the U.S. Geological Survey (USGS) conducted a geological, geophysical, and geotechnical study of a 1000 square nautical mile (3400 km^2) area west of the Farallon Islands for the U.S. Environmental Protection Agency (Karl, ed., 1992). These data were used in combination with other physical, chemical, and biological oceanographic data in designating a deep-ocean site for the disposal of dredged material generated from San Francisco Bay. The San Francisco Deep Ocean Disposal Site (SF-DODS) was designated by final rule (59 Fed. Reg. 41243) on August 11, 1994.

The Final Rule stipulated various requirements for site use, including pre-disposal sediment testing and annual site monitoring. Sediments proposed for ocean disposal must be evaluated for suitability for ocean disposal in accordance with EPA Ocean Dumping Regulations (40 CFR Part 227). The required bioassays provide a conservative (i.e., environmentally protective) determination of suitability for the marine environment by using appropriately sensitive marine organisms. Only sediments determined to contain levels of chemical constituents that are non-toxic to marine organisms are allowed to be disposed in the ocean. The required testing of proposed dredged sediment also includes a comparison of similar bioassays performed on sediments from the reference site. Previous testing of sediment from this reference site revealed potential problems related to elevated chemical contaminants and higher mortality during bioassays than expected. One goal of this study was to provided EPA Region 9 with more detailed geochemical characterization of the sediments at this reference site.

The information obtained from this study is also valuable for additional assessments of long term environmental changes at the disposal site. Annual site monitoring activities at the SF-DODS and vicinity, required by the Final Rule, include: mapping of the sea floor dredged material deposits within and adjacent to the SF-DODS, benthic sampling within and adjacent to the SF-DODS, and surveys of fish, seabirds and marine mammals in the vicinity of the SF-DODS and the Gulf of the Farallones region. This report documents the sediment characteristics at the reference site, which is located 35 km southwest of the Farallon Islands off San Francisco in water depths of 800-1500 m. The study area (Fig. 1) is about 10 km south of the Gulf of the Farallones National Marine Sanctuary boundary and the boundary for the Farallon Island Radioactive Waste Dump Area. The geologic setting and results of acoustic mapping surveys that include the reference site are presented in Karl and others, 1994 and Karl, ed., 1992. Other geochemical data on the slope close to this study area and on the adjacent continental shelf are contained in a report by Dean and Gardner (1995) . Long-term rates of sediment accumulation in the vicinity of the reference site are estimated to average about 11 cm/1000 years (about 8 $g/cm^2/1000$ yr) over the last 10,000 years (Gardner and others, 1997).

Ocean currents play a significant role in the immediate distribution and long term fate of any wastes discharged at sea. This reference site is located shoreward of the eastern edge of the California Current system in which the mean current in the upper few hundred meters is toward the southeast at a speed less than 10 cm/sec (Noble and others, 1992). This equatorward flow of

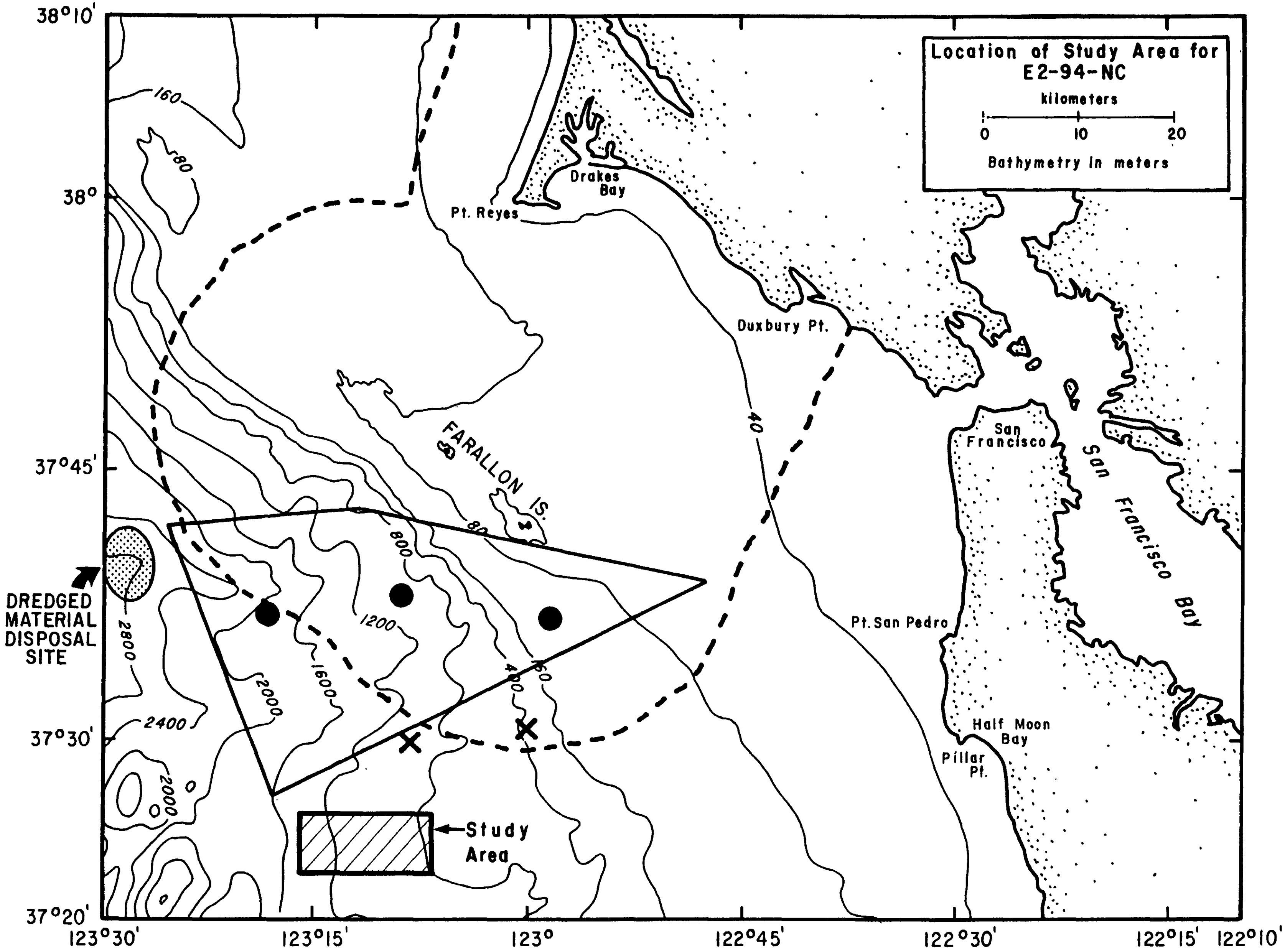


Figure 1. Location of the EPA Reference Site (hatched rectangle) on the Continental Slope southwest of the Farallon Islands and the designated Dredge Material Disposal Site (shaded ellipse). Boundaries are shown for the Gulf of the Farallones National Marine Sanctuary (---) and the Farallon Island Radioactive Waste Dump Area (—). Solid dots indicate the target locations for previous disposal of radioactive wastes. X indicates known shipwrecks (Karl and others, 1994).

the California Current was not definitively observed over the Continental Slope near the Farallones at any time during current measurements in 1991 (Hamilton and Ota, 1993), but significant meanders and eddies have been described (Brink and others, 1991). The flow over the reference site, above 800 m, is normally controlled by the California Undercurrent, which flows northward with current speeds in the upper 200 m that generally range from 15 to 30 cm/s, with maximum speed near 50 cm/s. Occasionally, deep-sea eddies move over the area, reversing the poleward flows for periods of a month or more (Noble and others, 1992 and references cited). In the summer of 1988, an anticyclonic eddy remained over the Continental Shelf north of the Farallon Islands and transported an estimated 10^5 metric tons of suspended sediment from the Shelf to the deep ocean (Washburn and others, 1993).

At 10 m above the seabed in the reference site (at 800 m water depth), currents flowed poleward and slightly onshore, with speeds less than 5 cm/sec. Tidal currents were enhanced near the bed, having near-bed amplitudes 2 -3 times larger than tidal amplitudes at mid-water sites. The near-bed tidal currents reached maximum speeds of 40 cm/sec, which is strong enough in some cases to resuspend bottom sediments (Noble and others, 1992). Bottom currents in this study site are heavily influenced by local topography, and for this reason were not strongly correlated among the 5 stations sited within 30 km of the reference site, covering a depth range from 400-2000 m (Noble and others, 1992).

The designated San Francisco Deep Ocean Disposal Site (SF-DODS) is located about 30 km northwest of the reference site at about 3000 m water depth. In 1993, approximately 1.2 million cubic yards of dredged material from the Alameda Naval Base were discharged and in 1995, approximately 232,000 cubic yards of material from Oakland Harbor were discharged at this site. A detailed study was conducted to map the dredged material footprint and determine the sediment chemistry inside and beyond the disposal boundaries (SAIC, 1996). The footprint was displaced to the northwest of the site perimeter, in general agreement with a particle tracking model developed by Hamilton and Ota (1993). Because of the pre-disposal testing requirements, which determine the suitability of proposed dredged material for ocean disposal, physical impacts (i.e., smothering) are expected to be the primary potential adverse impact resulting from ocean disposal of dredged material. The 5 cm thickness threshold, a trigger set in the Final Rule for site management actions of additional studies, has not been exceeded at or outside of the boundaries. The chemical analyses, conducted on samples composited from the top 10 cm of sediment recovered in box cores, revealed no elevated levels of chemical contaminants and concentrations generally lower than those reported for Oakland Harbor (SAIC, 1996). Baseline pre-dumping surveys of the SF-DODS are reported by SAIC (1991), SAIC (1992a and b), and Blake and others (1992). Detailed depth profiles of contaminant concentrations within the cored surface sediments were not a required assessment for annual site monitoring. The 10-cm depth sampling design was based on an estimated depth of active bioturbation, as assessed from previous studies. However, detailed depth profiles could be used to test the linkage between changes in benthic ecology observed by SAIC (1996) and a thin (<0.5 cm) layer of dredged material observed by sediment vertical photography beyond the boundaries of the SF-DODS.

The sediment characteristics described in this report include an extensive list of organic compounds and trace elements (Table 1) as specified by the EPA. High concentrations of these chemicals are potentially toxic to aquatic life. *Clostridium perfringens,* a bacterium spore characteristic of sewage particles, was also measured in these samples. *Clostridium perfringens* has been used to map the dispersion of sewage particles in marine sediments near major metropolitan centers (Cabelli and others, 1984). Selected samples were analyzed for acid volatile sulfides (AVS) and simultaneously extracted metals (SEM). These parameters are often used to estimate the fraction of metal content in sediments that is available for uptake by marine plants and animals.

Sampling Methods

Sediment cores were taken with a hydraulically-damped gravity corer, which is shown on the cover of this report. This instrument was designed to sample the sediment with minimal disturbance of the water-sediment interface. Collecting undisturbed surface sediment is important because anthropogenic influences on sediment chemistry in the marine environment are relatively recent. Significant information is contained in the top few millimeters, which are often disturbed or lost by other types of samplers. This sampler has been used successfully to collect cores in

Table 1. EPA's specified list of chemical analyses completed on sediments from the Reference Site on the Continental Slope southwest of the Farallon Islands. References to the methods are listed in the bibliography under EPA Methods, 19XX

ANALYTE	EPA METHOD
Organic Tin Compounds	Uhler and Durell, 1989*
Chlorinated Dioxins and Furans	SW8280
Sample Prep (Method 8280)	
Polynuclear Aromatic Hydrocarbons	SW8270/SIM
Sample Prep (Method 8270/SIM)	
Semivolatile Organics (GS/MS)	SW8270
Sample Prep (Method 8270)	SW3550
Organochlorine Pesticides and PCBs	SW8080
Sample Prep (Method 8080)	SW3550
Diesel Range Organics	SW8015
Sample Prep (Method 8015)	SW3550
PCB Congeners	E680 (Mod.)
Sample Prep (Method 680 Mod.)	
Arsenic, Furnace	SW7060
Selenium, Furnace	SW7740
Acid Digestion, Metals (As, Se)	SW3020
Cadmium, Furnace	SW7131
Chromium, Total, Furnace	SW7191
Lead, Furnace	SW7421
Silver, Furnace	SW7761
Acid Digestion, Metals (Furnace)	SW3020
Copper, ICP	SW6010
Nickel, ICP	SW6010
Zinc, ICP	SW6010
Acid Digestion, Metals (ICP)	SW3010
Mercury	SW7471
Total Cyanide	SW9012
Total Organic Carbon	SW9060

* This method is commonly used in EPA and ACOE sponsored studies, but is not formally designated as an EPA method.

both muddy and sandy sediment from the east coast Continental Shelf and estuaries such as Boston Harbor and Long Island Sound.

The USGS hydraulically-damped gravity corer consists of a four-legged frame with a central sliding shaft that holds a 318 kg weight stand and a clear polycarbonate core barrel 1 m long and 10.7 cm internal diameter. The apparatus is constructed of aluminum, plastic, and stainless steel in order to minimize heavy metal contamination. The key feature of this corer is the hydraulic damping mechanism that consists of a water-filled piston, which empties at a selectable rate. In this respect, the corer follows a design described by Pamatmat, 1971, and recently updated by Jahnke, 199x. When the corer contacts the bottom and releases tension on the winch wire, the water filled piston connected to the sliding shaft controls the speed at which the core barrel enters the sediment. Full travel of the core barrel is typically set for 10-15 seconds. As the core tube enters the sediment, a mechanical switch changes the ping rate of a sonar transducer, providing a confirming signal on the ship's depth recorder. After sufficient time for full core travel (about 20 seconds), the instrument is winched out of the bottom. A check valve seals the top of the core barrel. When the core bottom clears the water sediment interface, a spring-loaded paddle slides against and seals the cutting edge of the core tube. Both sediment and ambient overlying water are captured by seals at the top and bottom of the core tube at the moment of pullout. As soon as the corer is on the deck of the ship, the core quality and sedimentary features are described by visual inspection through the clear core barrel. The core is then removed from the frame, capped and taped at both ends, and stored under refrigeration. Cores are secured in a vertical position at all times. Overlying water is left to completely fill the head space above the water sediment interface for transport and storage. We have found that a sealed core barrel completely full of water (no air space above sediment) can be transported by ship or car without resuspension or other disturbance.

Seven cores were collected from water depths ranging from 950-1300 meters (Fig.2, Appendix Table A). Recovered core lengths ranged from 42-76 centimeters. Sample quality was occasionally reduced when high seas (> 10 foot swells) caused the corer to land roughly on the sea floor or to swing against the ship's side during recovery.

As a precaution against contamination, all core barrels, sampling utensils, and sample

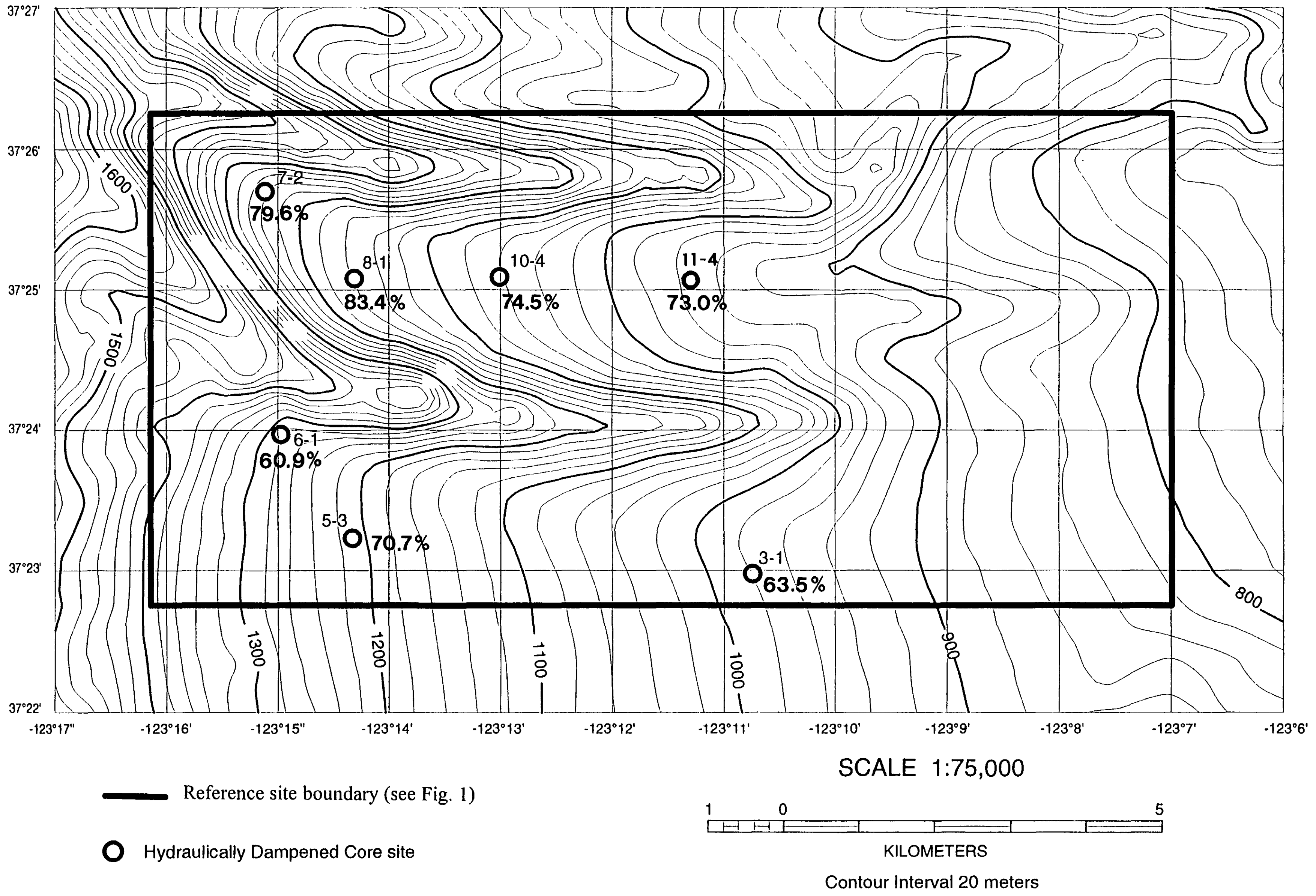


Figure 2. Outline of the EPA Reference Site. Bathymetry, core locations and % mud in surface sediments.

containers were carefully cleaned prior to use. All core barrels and caps were acid washed with 5% nitric acid and rinsed with distilled water and methanol. Subsamples from the cores were taken with spatulas, knives, and spoons custom made from high purity titanium, a material with low contamination potential for both organics and trace metals. To insure against breakage during shipping, subsamples were placed in 500 ml Teflon screw-cap containers which had been cleaned with 5% nitric acid and rinsed with methanol, acetone, toluene, methylene chloride and hexane so that they were appropriately cleaned for both metal and organic analyses.

Cores were sectioned onboard ship by inserting a cleaned piston into the bottom of the core barrel and clamping the barrel in a vertical rack. The sediment core was extruded from the barrel by pushing the piston upward using a long-throw hydraulic jack. Sediment in direct contact with the core barrel was trimmed off and discarded. A 0-1 cm sample was collected from each core. Two cores were selected for detailed sampling with depth. These were sectioned at 1 cm intervals to a depth of 10 cm and at 2 cm intervals for the remaining length of the core. All samples were refrigerated while at sea. At the conclusion of the cruise, core sections were transported to USGS laboratories in Palo Alto, CA, where they were subsampled for trace metals, *Clostridium perfringens* and grain size analysis. The remainder was frozen until analyzed for organic compounds.

Analysis Methods

Sediment Texture

Sediment texture was determined at the U.S. Geological Survey in Woods Hole, MA on wet samples to avoid the formation of "bricks" which typically result from any method of sediment drying (Barbanti and Bothner, 1993). Starting dry weights were calculated from water contents determined on a separate sample aliquot. The preparatory steps were similar to those used by the USGS laboratory in Palo Alto, California so that results from Woods Hole could be readily compared with previous work done in the same general area by the Palo Alto lab (Maher and others, 1991).

Frozen samples were thawed and known wet weights (5-15 grams wet) were subjected to the following protocol:

Transfer weighed sediment to a clean wide mouth centrifuge bottle (250 ml) using filtered (0.45 μm) distilled water (FDW) in a squirt bottle. In order to remove organic carbon, add about 100 ml of dilute H_2O_2 (25 ml of 30% H_2O_2 in 1000 ml of FDW). Add slowly. If there is a frothing reaction, add less initially. Avoid having material bubble out of the centrifuge jar. Place samples in a bath-type sonicator for 20 minutes. After initial reaction has subsided, add peroxide solution to a total of 200 ml and let stand overnight at room temperature. Next day, place on an oscillating hot plate (keep surface <90° C, plastic melts at 125 °C) with caps off to drive off peroxide (2-3 hours). Bubbles of peroxide could be read as particles by the Coulter counter.

Add FDW to samples so they all weigh the same. Centrifuge for the time required to sediment the >0.2 μm fraction. Decant/siphon off the overlying water and discard it. Add 200 ml of new FDW, disperse using a vortex mixer or sonifier, centrifuge again. These two steps remove interstitial salts. The last rinse also removes any residual peroxide. To reduce flocculation of particles, add 50 ml of filtered 0.5% Calgon (preserved with 50 ml of 30% formaldehyde/ 20 liters of solution) and store until ready for wet sieving.

Wet sieve through 63 μm sieve using Calgon solution. Oven-dry the coarse fraction in a pre-weighed beaker. Weigh to get total fraction >63 μm. Sieve dry material through nested sieves as is practical. Weigh each fraction.

Transfer the slurry of fine sediment that passed the 63 μm sieve in 0.5% Calgon to 1000 ml cylinders. Fill to mark. Mix thoroughly. Pipet 20 ml from 20 cm depth immediately after mixing. Transfer this aliquot to a container and save for Coulter counter analysis. Re-mix and pipet another aliquot to a container for weight determination. Let the cylinder stand undisturbed for 15 hours and pipet another aliquot from 5 cm depth to determine the fraction finer than 10.5 phi which is the lower limit measured by the Coulter counter. If the suspension is thin, filter these last two aliquots through pre-weighed nuclepore filters, rinse with FDW, dry and re-weigh. If the suspension is thick, transfer the suspension to a pre- weighed beaker and dry in an oven at 110° C. Calculate the net sediment weight correcting for the weight contributed by Calgon.

We supplemented the Coulter counter analysis with a pipet analysis because the Coulter counter does not measure material finer than 10.5 phi (about .007 mm) and therefore underestimates the clay fraction. We evaluated the magnitude of the underestimation for this data set by measuring the percent finer than 10 phi using the pipet method and recalculating the silt and clay distributions. Using the pipet method for correction, the clay content increases and the silt content decreases by an average of 5.5% (± 2.5%). The Coulter counter results and the results corrected with the pipet method are reported in Appendix Table B. We have plotted the uncorrected Coulter counter data in this report because it is more comparable to hydrophotometer results generated in the USGS Palo Alto laboratory. Triplicate analysis of an internal laboratory standard using the Coulter counter yielded the following mean and standard deviation: 6.0% ± 0.12% sand, 75.7% ± 1.5% silt, and 18.3% ± 1.5% clay.

Clostridium perfringens

Clostridium perfringens is an anaerobic spore-forming bacteria which inhabits the intestines of man and other mammals. Its spore is abundant in sewage, is resistant to most wastewater chlorination procedures, and can survive in the marine environment for long periods of time (Davis and Olivieri, 1984; Bisson and Cabelli, 1980; Hirata and others, 1991). It has been used effectively as a tracer of sewage particles in a number of aquatic environments (Cabelli and others, 1984; Parmenter and Bothner, 1993; Hill and others, 1996; Bothner and others, 1994). Analysis of *Clostridium perfringens* was performed at Biological Analytical Laboratories, North Kingstown, R.I. Spore concentrations were measured using the direct enumeration method, which involves extraction of spores by sonification followed by settling and membrane filtration (Emerson and Cabelli, 1982; Bisson and Cabelli, 1979). The standard deviation among 4 replicates was 24%.

Trace Metals

Samples for all metal analysis (except mercury) were oven dried in filtered air at 65° C, then ground with an agate mortar and pestle. Mercury was determined on wet aliquots that were stored frozen until time of analysis. Analyses were conducted using EPA methods in Table 1 (EPA,19XX) by Quanterra Environmental Services, Arvada, Colorado. All metal concentrations are reported on a dry weight basis. The sediments were leached with hot concentrated nitric and hydrochloric acid. This procedure does not totally dissolve the mineral particles. Inductively coupled plasma atomic emission spectroscopy (ICP-AES) was used for the analysis of Cu, Ni, Zn. Graphite furnace atomic absorption was used for As, Pb, Se, Ag, Cr, Cd. Cold vapor atomic absorption was used for Hg. Analytical error was estimated by analysis of spiked duplicates and averaged 2.6% ± 3.7%. Total organic carbon was determined using coulometry by measuring the difference between total carbon and carbonate carbon. Canadian sediment standards MESS-1, PACS-1 and BCSS-1 were included with the analyses of metals and organic carbon. BCSS-1 was sent as a blind standard.

Organic Compounds

Samples for organic analysis were stored frozen in tightly sealed Teflon containers. They were shipped frozen to Quanterra Environmental Services in June 1996. The samples were promptly analyzed by using the EPA methods referenced in Table 1. In order to obtain sufficient sample volume, it was necessary to composite samples of the 0-1 cm and 1-2 cm depth intervals for cores 3-1 and 8-1. For some analyses, advanced equipment and procedures permitted reasonable estimates of concentration even though they were below the previously established reporting limits. These values are flagged by the qualifier "J" in the tables. The uncertainty in these estimated values is about a factor of 2 according to Lindsay Breyer, Program Manager, Quanterra Environmental Services. The tabulated concentrations of organic compounds are reported on a wet weight basis (water contents are listed) and without blank correction. In the few cases where a signal in the blank was detected, the sample data is flagged with the qualifier "B". The complete data set is presented in the Appendix tables.

AVS and SEM

Acid volatile sulfide (AVS) and simultaneously extracted metals (SEM) on selected samples were determined using the EPA methods (Allen and others, 1991; Boothman and Helmstetter, 1992) The samples were stored frozen until analysis in April, 1996 at the EPA laboratory in Narragansett RI.

Results And Discussion

Organic compounds

The depth profiles of polychlorinated biphenyls (PCBs) provide evidence that the surface sediments at this reference site have received measurable quantities of these compounds (Fig 3). PCBs were commercially manufactured and marketed in the U.S. from 1929 to 1977 and used widely in industry because of their chemical stability, low boiling point, low solubility and high dielectric constant (Weaver, 1984). In both cores analyzed, the concentrations of mono- through deca-chlorobiphenyls in surface sediments (0-3 cm and 0-2 cm) are elevated compared to samples from 20-30 cm in the core where concentrations at or near the analytical detection limit were observed. The concentration gradients are not significantly altered when the data is normalized to account for variability in organic carbon or sediment texture. The average concentration of total PCBs (sum of mono- through deca CB compounds) among the 4 surface sediments analyzed is 2.9 ± 1.0 ppb which is in the range observed at a reference site at 2500 m water depth off New Jersey (~3 ppb and 7.5 ppb, respectively, Takada and others, 1997; Lamoreaux and others 1996).

The average value of PCBs at the reference site is a factor of 8 lower than the ERL (Effects Range - Low) toxicity guideline and a factor of 62 lower than the ERM (Effects Range - Medium; Table 2; Long and others, 1995). The ERL and ERM are guideline concentrations above which toxic effects in marine organisms were observed in approximately 10% and 50%, respectively, of reviewed studies. These guideline concentrations are used by EPA Region 9 to evaluate the results of toxicity tests for sediments proposed for ocean disposal. The ERL and ERM values are determined from a collection of studies involving test organisms collected from shallower marine environments. These values may not be directly applicable to the deep sea environment where, to date, little information on toxicity to these benthic organisms is available. However, these values are relevant for the pre-disposal testing because, for any proposed dredging project, test organisms are simultaneously exposed to the sediments proposed for ocean disposal and the reference sediments in the battery of required bioassays.

The depth profiles of polycyclic aromatic hydrocarbons (PAHs) also suggests an anthropogenic input to this site. The concentrations of pyrene (Fig. 4), fluoranthene,

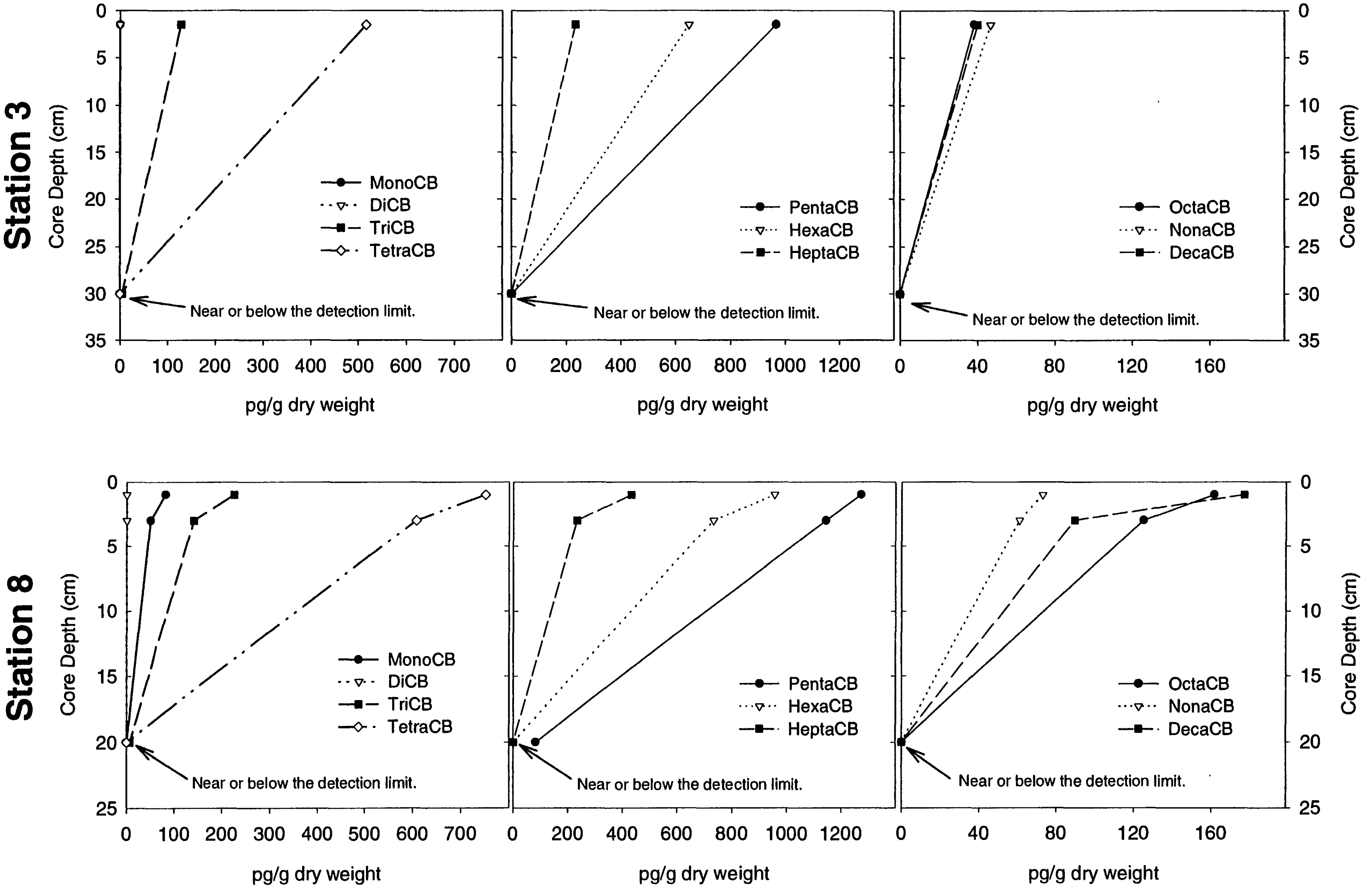


Figure 3. Depth Profiles of Polychlorinated Biphenyls. Di- and Trichlorobiphenyls were blank corrected. Other compounds had no measurable blank.

Table 2a. ERL[1] and ERM[1] guideline values for organic compounds (ppb, dry wt) and percent incidence of biological effects in concentration ranges defined by the two values. (from Long and others, 1995)

	Guidelines		Percent (ratios) incidence of effects[2]		
Chemical	ERL	ERM	<ERL	ERL-ERM	>ERM
Acenaphthene	16	500	20.0 (3/15)	32.4 (11/34)	84.2 (16/19)
Acenaphthylene	44	640	14.3 (1/7)	17.9 (5/28)	100 (9/9)
Anthracene	85.3	1100	25.0 (4/16)	44.2 (19/43)	85.2 (23/27)
Fluorene	19	540	27.3 (3/11)	36.5 (19/52)	86.7 (26/30)
2-Methyl naphthalene	70	670	12.5 (2/16)	73.3 (11/15)	100 (15/15)
Naphthalene	160	2100	16.0 (4/25)	41.0 (16/39)	88.9 (24/27)
Phenanthrene	240	1500	18.5 (5/27)	46.2 (18/39)	90.3 (28/31)
Low-molecular weight PAH	552	3160	13.0 (3/23)	48.1 (13/27)	100 (16/16)
Benz(a)anthracene	261	1600	21.1 (4/19)	43.8 (14/32)	92.6 (25/27)
Benzo(a)pyrene	430	1600	10.3 (3/29)	63.0 (17/27)	80.0 (24/30)
Chrysene	384	2800	19.0 (4/21)	45.0 (18/40)	88.5 (23/26)
Dibenzo(a,h)anthracene	63.4	260	11.5 (3/26)	54.5 (12/22)	66.7 (16/24)
Fluoranthene	600	5100	20.6 (7/34)	63.6 (28/44)	92.3 (36/39)
Pyrene	665	2600	17.2 (5/29)	53.1 (17/32)	87.5 (28/32)
High molecular weight PAH	1700	9600	10.5 (2/19)	40.0 (10/.25)	81.2 (13/16)
Total PAH	4022	44792	14.3 (3/21)	36.1 (13/36)	85.0 (17/20)
p,p′-DDE	2.2	27	5.0 (1/20)	50.0 (10/20)	50.0 (12/24)
Total DDT	1.58	46.1	20.0 (2/10)	75.0 (12/16)	53.6 (15/28)
Total PCB's	22.7	180	18.5 (5/27)	40.8 (20/49)	51.0 (25/49)

[1] ERL = Effects Range Low; ERM = Effects Range Medium (Long and others, 1995)

[2] Number of data entries within each concentration range in which biological effects were observed divided by the total number of entries within each range.

Table 2b. ERL[1] and ERM[1] guideline values for trace metals (ppm, dry wt) and percent incidence of biological effects in concentration ranges defined by the two values. (Long and others, 1995)

	Guidelines		Percent (ratios) incidence of effects[2]		
Chemical	ERL	ERM	<ERL	ERL-ERM	>ERM
Arsenic	8.2	70	5.0 (2/40)	11.1 (8/73)	63.0 (17/27)
Cadmium	1.2	9.6	6.6 (7/106)	36.6 (32/87)	65.7 (44/67)
Chromium	81	370	2.9 (3/102)	21.1 (15/71)	95.0 (19/20)
Copper	34	270	9.4 (6/64)	29.1 (32/110)	83.7 (36/43)
Lead	46.7	218	8.0 (7/87)	35.8 (29/81)	90.2 (37/41)
Mercury	0.15	0.71	8.3 (4/48)	23.5 (16/58)	42.3 (22/52)
Nickel	20.9	51.6	1.9 (1/54)	16.7 (8/48)	16.9 (10/59)
Silver	1.0	3.7	2.6 (1/39)	32.3 (11/34)	92.8 (13/14)
Zinc	150	410	6.1 (6/99)	47.0 (31/66)	69.8 (37/53)

[1] ERL = Effects Range Low; ERM = Effects Range Medium (Long and others, 1995)

[2] Number of data entries within each concentration range in which biological effects were observed divided by the total number of entries within each range.

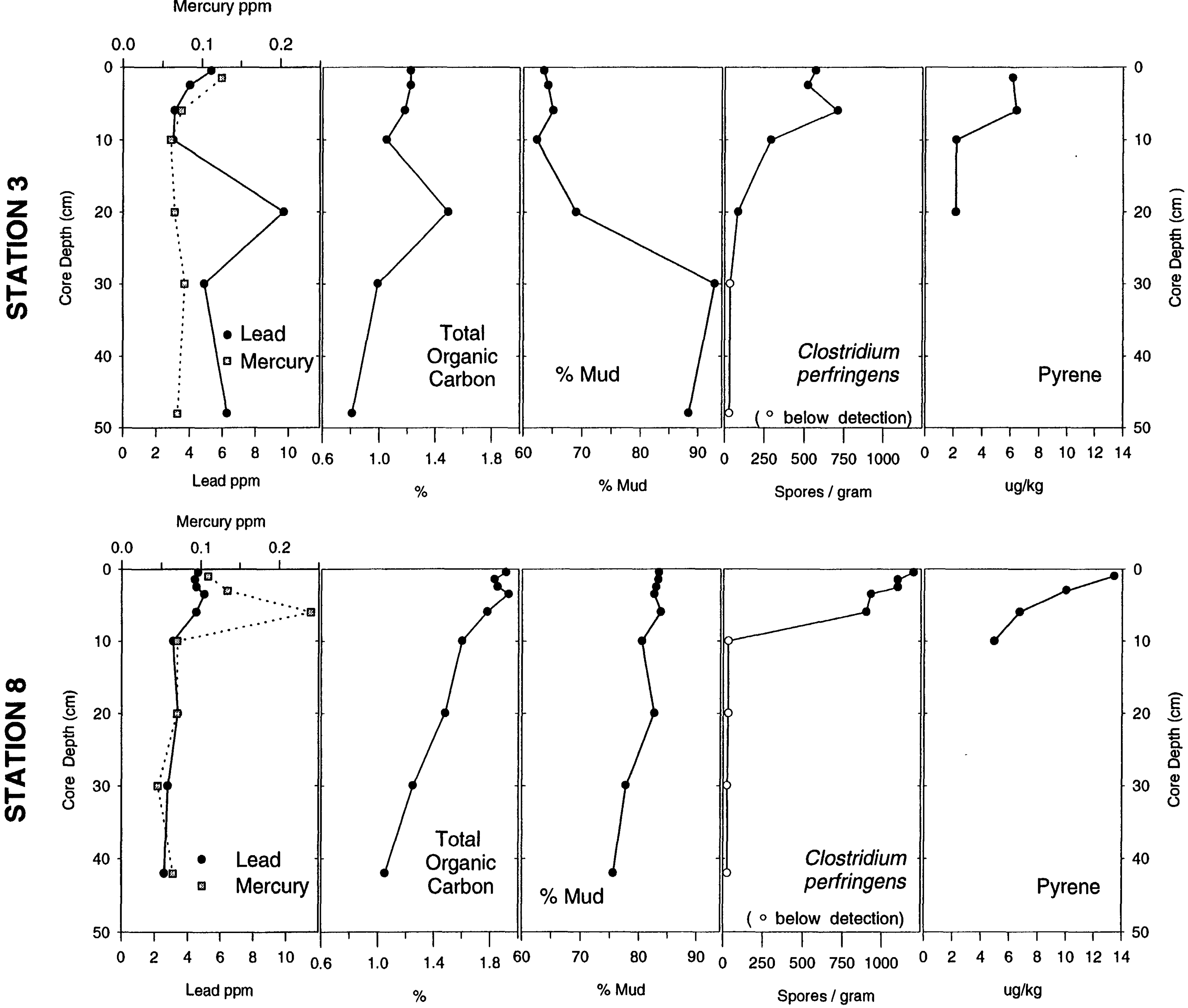


Figure 4. Depth Profiles of Selected Variables in Sediment Cores. (Dry Weight Basis; % Mud = % Silt + % Clay)

benzo(b)fluoranthene, and benzo(g, h, i)perylene (Table 3) decrease by about a factor of 2 between the surface and the deepest horizon analyzed in the cores (11 and 21 cm) from stations 3 and 8. These compounds are thought to be introduced to the environment by combustion of wood (forest or prairie fires), coal, or petroleum products with increased amounts added to the environment during industrial development. The depth profiles are similar to those measured on the Continental Slope off the state of Washington where the enrichments in PAHs are attributed to growth in anthropogenic activity within the Columbia River drainage area rather than to post depositional degradation of compounds introduced at a constant rate (Prahl and Carpenter, 1984). The concentrations of pyrene and fluoranthene estimated at the reference site are about a factor of 3 higher than those measured in surface sediments from the Hatteras Abyssal Plain in the North Atlantic Ocean (4 ppb dry weight) and about a factor of 10 lower than found in sediments from Buzzards Bay, Massachusetts and the Gulf of Maine (100-130 ppb; LaFlamme and Hites, 1978).

Elevated concentrations in surface sediments relative to concentrations deeper in cores were also observed for diesel range organics. The concentrations of this variable were 7.6 and 21 ppm at the surface of cores 3-1 and 8-1 and were lower by a factor of 2 to 3 at a depth of 20-30 cm (Table 3). There are published toxicity guidelines (Table 2A) for only a few of the organic compounds determined in this study. The values reported above detection limits are typically lower than ERL values by a factor of 10 - 50.

Clostridium perfringens

The concentrations of *Clostridium perfringens* in the surface sediments are between 570 and 1200 spores/g, significantly above detection limits (<40 spores/g) at all locations. The concentrations decrease with sediment depth in the two cores analyzed (Fig. 4). Elevated concentrations persist to about 7 cm at the deep station 8 (1166 m) and to at least 21 cm at station 3 (980 m). The source of *Clostridium perfringens* spores to sediments in this reference site is not clear. The source of *Clostridium perfringens* to Boston Harbor and adjacent coastal waters is the discharge of treated sewage at the mouth of Boston Harbor. This discharge accounts for concentrations of >100,000 spores/g in harbor sediments (Durell, 1995) and 1,000 - 11,000 spores/g in Massachusetts Bay (Bothner and others, 1993). Dredged material from any urban

Table 3. Concentration of organic compounds (wet weight basis) for which a value above the detection limit was measured.

Core ID and Depth Interval(cm)	Water	delta-BHC	Benzoic acid	a,a-Dimethyl phenethyl amine	Butanoic acid	Chloroiodo methane	Cholesterol	Cyclic Hydro carbon	Hexane dioic acid, bis(2-ethyl hexyl)^ este	Nonan amide	Octadecan amide	9-Octa decen amide, (Z)-	Oxy genated Hydro carbon	Penten amide, 4-methyl	Saturated Hydro carbon: C10-C20	Siloxane(3)	Sterol
	%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
3-1 0-1 , 3-1 2-3*	40	<0.014	0.044 J	<--	NA	NA	0.4 2	0.21	NA	NA	NA	NA	0.23	NA	0.2	NA	0.37
3-1 5-7	38	0.0067 J	0.066 J	<--	NA	NA	NA	NA	NA	NA	NA	NA	0.15	NA	NA	NA	0.14
3-1 9-11	36	<0.0095	<2.8	<--	0.17 2	NA	NA	NA	0.21 2	NA	NA	NA	0.27	NA	NA	0.16	NA
3-1 19-21	35	<0.0082	<2.5	<--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3-1 29-31	54	0.0092	<2.5	0.043 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.14	NA
3-1 47-49	39																
5-3 0-1	56	<0.025	<5.5	<--	NA	NA	0.49 2	NA	NA	NA	NA	NA	0.34	NA	NA	NA	0.91
8-1 0-1	41	<0.15	<17	<--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
7-2 0-1	67	<0.078	<26	<--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.7	NA
8-1 0-1 , 8-1 1-2*	56	<0.023	<3.4	<--	NA	0.21 2	0.52 2	NA	NA	NA	NA	NA	0.91	NA	NA	NA	0.59
8-1 2-3 , 8-1 3-4*	44	<0.030	0.13 J	<--	NA	0.21 2	0.46 2	NA	NA	NA	NA	NA	0.33	NA	NA	NA	0.19
8-1 5-7	45	0.016	<2.5	<--	NA	NA	NA	NA	NA	NA	NA	0.28 2	NA	NA	NA	NA	NA
8-1 9-11	41	0.005 J	<2.6	<--	NA	NA	NA	NA	NA	NA	NA	0.4 2	NA	2.1 1	NA	NA	NA
8-1 19-21	41	<0.010	<2.4	<--	NA	NA	NA	NA	NA	NA	0.22 2	0.64 2	NA	3.1 1	NA	NA	NA
8-1 29-31	33																
8-1 41-43	32																
10-4 0-1	62	<0.12	<25	<--	NA	NA	NA	NA	NA	2.9 1	3.6 2	11 2	NA	48 1	NA	NA	NA
11-4 0-1	56	<0.088	<8.7	<--	NA	NA	NA	NA	NA	NA	0.51 2	1.6 2	NA	8.1 1	NA	NA	NA
Spikes																	
3-1 9-11 MS			NA	NA													
3-1 9-11 SD			NA	NA													

Core ID and Depth Interval(cm)	Total Mono chloro biphenyls	Total Dichloro biphenyls	2,4,4'-TriCB	3,4,4'-TriCB	Total Trichloro biphenyls	Total Tetrachloro biphenyls	2,3', 4,4',5-Penta CB	2,3,3', 4,4'-Penta CB	Total Penta chloro biphenyls	Total Hexa chloro biphenyls	2,2',3,4, 4',5,5'-HeptaCB	Total Hepta chloro biphenyls	2,2',3,3',4, 4',5,5'-OctaCB	Total Octa chloro biphenyls	2,2',3, 3',4,4', 5,5',6-NonaCB	Total Nona chloro biphenyls	DecaCB
	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g
3-1 0-1,3-1 2-3*	<20	27 B	30	<15	98 B	310	110	61	580	390	64	140	<18	23	28	28	24
3-1 29-31	<13	29 B	<16	<6.4	23 B	<15	<14	<3.7	<18	<15	<9.0	<9.0	<2.6	<2.6	<1.8	<1.8	<8.0
6-1 0-1	27	27 B	29	<12	72 B	200	85	55	400	210	55	78	<14	<14	<20	<20	23
8-1 0-1,8-1 1-2*	36	24 B	38	21	120 B	330	130	77	560	420	85	190	24	71	32	32	78
8-1 2-3,8-1 3-4*	28	25 B	34	<18	100 B	340	130	65	640	410	78	130	22	70	34	34	50
8-1 19-21	<18	35 B	<15	<5.1	25 B	<15	<15	<4.0	48	<15	<8.3	<8.3	<2.2	<2.2	<1.2	<1.2	<5.0
METHOD BLANK	<6.0	35	<18	<3.7	21	<18	<11	<3.7	<19	<13	<5.8	<5.8	<1.7	<1.7	<0.80	<0.80	<6.9

J = Result is detected below reporting limits or is an estimated concentration.
B = Compound is also detected in the blank.
1 = Tentative identification, order of magnitude estimate.
2 = Confident identification, order of magnitude estimate.
(3) = Possible artifact of analysis
q = This sample has GC/FID characteristics for which reliable identification of a product could not be achieved
1(with q) = Sample resembles a hydrocarbon product occurring within the n-alkane range of C12-C28.
x = Target compound's secondary ion confirmation criteria not met, but retention time and peak shape make identification possible.
<-- Less than reportig limit and analyte present in the blank.
NA = Not analyzed
MS = Matrix spike
SD = Spike duplicate
* = Composite sample from 2 depth intervals.
** = Concentrations of a compound for which there were no similar library spectra, and assignment to a particular class of compounds was not possible.

Table 3 Cont. Concentration of organic compounds (wet weight basis) for which a value above the detection limit was measured.

Core ID and Depth Interval(cm)	Unknown **	Vitamin E	Diesel Range Organics	Phen anthrene	Anthracene	Fluor anthene	Pyrene	Benzo(a) anthracene	Chrysene	Benzo(b) fluor anthene	Benzo(a) pyrene	Benzo (g,h,i) perylene	Indeno (1,2,3-cd) pyrene
	mg/kg	mg/kg	mg/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
3-1 0-1 , 3-1 2-3*	0.14	0.29 2	7.6 q1	3 J	<20	3.5 J	3.7 J	<20	<20	3.5 J	<20	2.7 J	<20
3-1 5-7	NA	0.2 2		2.3 J	<20	3.5 J	4 J	<20	<20	3.4 J	2.1 J	2.7 J	<20
3-1 9-11	NA	NA		2 J	<10	1.1 J	1.4 J	<10	<10	1.6 J	<10	1.3 J	<10
3-1 19-21	NA	NA		4.7 J	<10	<10	1.4 J	1 J	<10	1.6 J	<10	<10	<10
3-1 29-31	NA	NA	3 J	2.6 J	<20	<20	<20	<20	<20	<20	<20	<20	<20
3-1 47-49													
5-3 0-1	0.34	0.42 2		<20	<20	2.5 J	2.8 J	<20	<20	2.7 J	<20	2.1 J	<20
6-1 0-1	NA	NA	<44	<20	<20	2.6 J	3.1 J	<20	<20	2 J	<20	<20	<20
7-2 0-1	NA	NA		2.1 J	<20	2.7 J	3.1 J	<20	<20	2.3 J	<20	<20	<20
8-1 0-1 , 8-1 1-2*	0.24	0.49 2	21 q1J	5.7 J	4.9 J	5.3 J	5.9 J	2.4 J	4.4 J	4.9 J	3.3 J	3.5 J	2.4 J
8-1 2-3 , 8-1 3-4*	NA	0.41 2	21 q1	5.9 J	<20	5 J	5.6 J	<20	2.3 J	4.7 J	2.8 J	3.5 J	2.6 J
8-1 5-7	NA	NA		2.5 J	<20	3.2 J	3.7 J	2.5 Jx	3.2 J	5.2 J	2.8 J	3.7 J	2.5 J
8-1 9-11	NA	NA		3.1 J	<20	2.3 J	2.9 J	<20	<20	2.7 J	<20	2.1 J	<20
8-1 19-21	NA	NA	6 q1	2.7 J	<20	<20	<20	<20	<20	<20	<20	<20	<20
8-1 29-31													
8-1 41-43													
10-4 0-1	NA	NA		5 J	<20	3 J	3.2 J	<20	2.1 J	3.1 J	<20	2.2 J	<20
11-4 0-1	NA	NA		7.2 J	<20	3.4 J	4.1 J	<20	2.1 J	3.1 J	<20	2.9 J	<20
Spikes													
3-1 9-11 MS				NA	NA	NA	NA	NA	5	NA	NA	NA	NA
3-1 9-11 SD				NA	NA	NA	NA	NA	4.6	NA	NA	NA	NA

harbor therefore would be a potential source, but no waste or dredge material dumping has occurred in the immediate vicinity of the reference site to our knowledge. Marine mammals, known to migrate through the reference area, may also provide a local source of *Clostridium perfringens* to the environment, but the magnitude of their contribution has not been estimated.

The enriched concentrations of PAHs, PCBs and *Clostridium perfringens* in surficial sediments compared to deeper sediments are consistent with the record of increased industrial discharges present in sediments in varying degrees around the world. The magnitude of enrichment at this reference site is low, however, probably because prevailing winds are onshore at this location (Dorman and Winant, 1995). Enrichments 2-3 orders of magnitude higher have been measured for each of these variables in sediments near urban centers.

Trace Metals

The hot concentrated acid leach of the sediment standards confirmed that most metals were dissolved from the sediment and yields were typically > 70% of the published total metal content (Fig. 5). Exceptions include yields of < 50% for Cr in all standards and of Hg and Se on one standard. These elements may be associated with a mineral phase resistant to the leaching procedure. Agreement with the published values is close enough to justify a comparison between values in the Farallon reference site and metal concentrations in other studies for which the total metal concentration has been reported (Table 4).

Some of the trace elements have high concentrations probably due to the natural mineral assemblage rather than to anthropogenic additions. The average concentrations of Ag, Cd, and Se in surface sediments are between 1.6 and 3.8 times higher than reported for world average shales (Table 4). These three elements, plus Ni, have higher concentrations at the reference site than at offshore locations off Hawaii and New Jersey or at nearshore background stations off the U.S. East Coast (Table 4). There is no evidence from analysis of cores at stations 3 and 8 that the surface concentrations of these four metals are higher than concentrations at the bottom of the cores in sediments deposited prior to industrial influence (Appendix Table B).

The average concentration of each metal in surface sediments from this reference site is

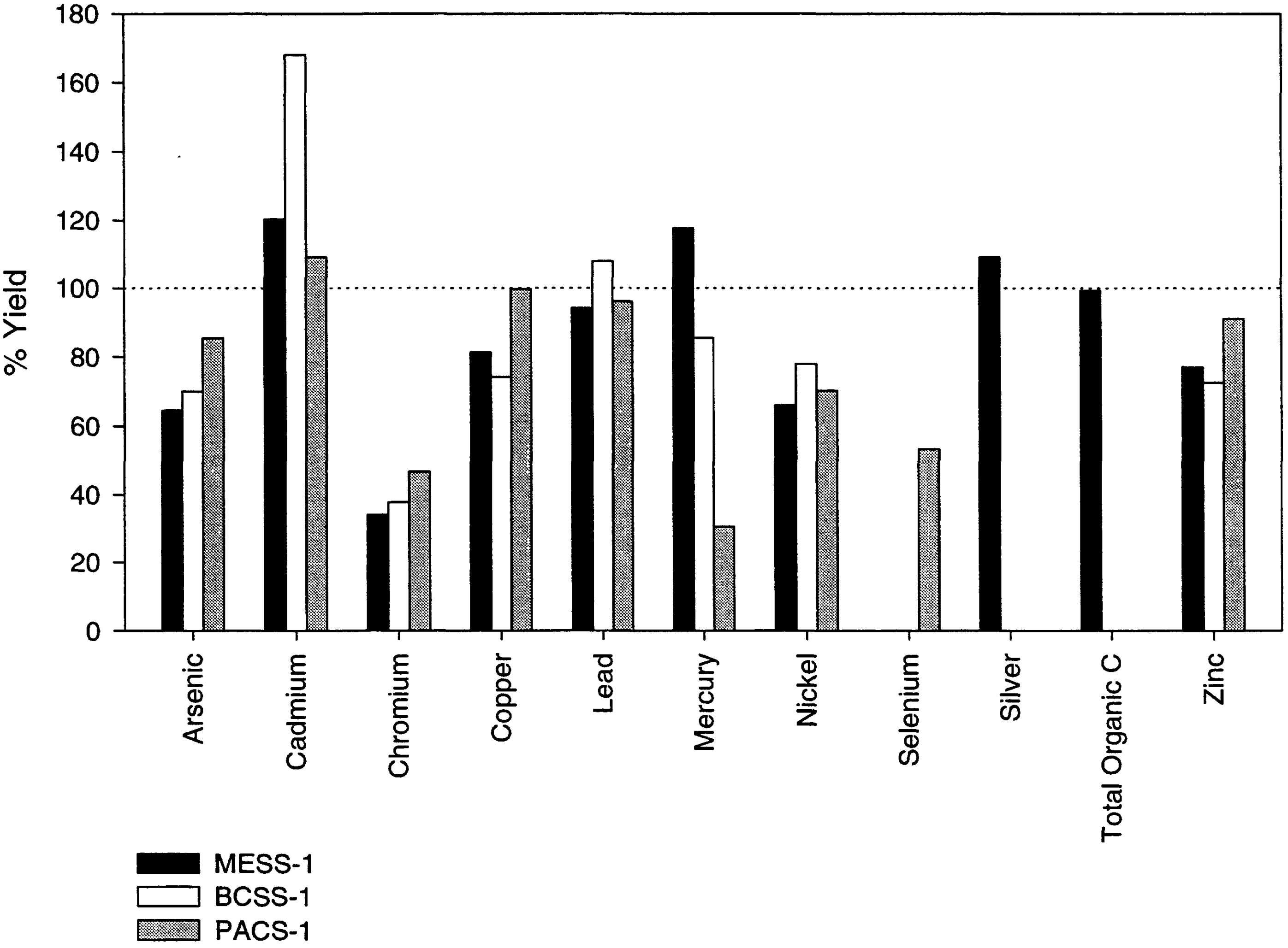


Figure 5. This figure illustrates the % yield by the hot acid leach procedure specified by the EPA method relative to published values for total metal concentrations. Yields less than 60% for Cr and Se may indicate that these elements are bound to a mineral phase resistant to the strong acid leach. The anomalously high yields for Cd in BCSS1 and low yield for Hg in PACS1 have not been confirmed by reanalysis.

Table 4. Average concentrations of metals (ppm dry weight) in surface sediment (0-1 cm, n=7) from the Farallon Island Reference Site compared to ERM[1] values and values in uncontaminated sediments from other areas.

	Arsenic	Cadmium	Chromium	Copper	Mercury[2]	Nickel	Zinc	Lead	Selenium	Silver	Total Organic Carbon %
This Study											
Avg. Conc.	2.2	0.51	58.2	17.2	0.11	50.8	54.9	4.2	0.95	0.38	1.67
Std. Dev.	0.3	0.18	5.9	1.7	0.02	4.8	6.5	0.5	0.23	0.07	0.24
Previous Study[3]	\	0.37	168	24.3	0.08	66.3	\	13.8	\	0.52	\
Previous Study[4]	\	\	140	20	\	70	71	\	\	\	1.01
ERM Values[1]	70	9.6	370	270	0.71	51.8	410	218.	\	3.7	\
AverageCrust[5]	1.8	0.2	100	55	0.08	75	70	12.5	0.05	0.07	\
Average Shale[5]	6	0.3	100	57	0.4	95	80	20	0.6	0.1	\
Hawaii Offshore[6]	1.8	\	23.7	8.7	0.03	13.4	25.3	2.3	\	<0.05	0.31
New Jersey Offshore[7]	\	0.2	69.9	22.8	\	37.1	86.4	19.1	\	0.036	\
U.S. East Coast[8] Coastal Sediment											
Bkg. Mean	5.7	0.13	38	12	0.04	15	58	22	0.3	0.05	\
Std. Dev.	3.3	0.09	24	10	0.03	11	38	14	0.2	0.04	\

[1] Long and others, 1995.

[2] Mercury values for stations 3 and 8 were determined on sample blends from depths of 0-3 and 0-2 cm respectively.

[3] SAIC, 1992 cited in EPA, 1992; area near the reference site, n=5.

[4] Dean and Gardner, 1995, average of surface samples from cores G27 and G28 from in or near the reference site.

[5] Krauskopf, 1967.

[6] Torresan, 199X, in prep. Reference station 102.

[7] Bothner, 199X, in prep. 106-Mile Dumpsite reference station. Alvin Dive 3075.

[8] Strobel and others, 1995, Average among background samples from EMAP, Virginia province; N= 181 to 476 samples.

much lower than the ERM toxic effects guideline described by Long and others, 1995 (Table 2B) except for nickel. The average concentration of nickel is 50.8 ppm, just below the 51.6 ppm ERM value. However, the ERM value is lower than the concentration in average crustal material (75 ppm) and average shale (95 ppm, Table 4) which means that many sediments derived from crustal material have Ni values above this guideline. The ERM guideline for Ni is based on a level at which only 17% of the studies demonstrated toxic effects, but the accuracy of this guideline is reported to be low (Table 2B; Long and others, 1995).

Within the suite of heavy metals analyzed in sediment cores, only Hg and Pb depth profiles suggest an apparent small enrichment in surface sediments relative to deeper sediments (Fig 4). However, this apparent enrichment may be related to correlative changes in % organic carbon rather than to a recent anthropogenic increase in the flux of these metals to the sediments. The ratios of Hg and Pb to organic carbon are constant or, in one case, increase with depth (Fig. 6). Unless the flux of Hg and Pb has increased by the same proportion over time as anthropogenic organic carbon, the uniform ratio of metal to organic carbon that is found with depth suggests that there has not been a recent increase in metal flux. For comparison, in cores of fine sediments on the Continental Shelf south of New England, the Pb to organic carbon ratios are higher at the surface and have been interpreted to reflect the known release of lead to the atmosphere in population centers immediately upwind (Bothner and others, 1981). The concentrations of Pb in surface sediments of the reference site (4.2 ppm ± 0.5 ppm) are lower than observed on the East Coast Continental Shelf or Slope (15-30 ppm, Bothner and others, 1987; Bothner and others, 1981). Prevailing winds at this reference site from the ocean toward the continent (Dorman and Winant, 1995) may explain the low signal of lead and other atmospheric pollutants in the sediments compared to lead concentrations in sediments off the East Coast at even greater distances from shore.

The ratios of Hg and Pb to % mud vary with sediment depth, but in each case, the ratio is higher in surface sediments relative to the deepest sediments recovered in the cores. Without the conflicting trend in the metal/OC ratios, the gradient in the metal/% mud ratios would suggest that Hg and Pb fluxes have increased at these locations, but additional geochemical data (Al and Fe for normalization) and additional core profiles are needed for confirmation.

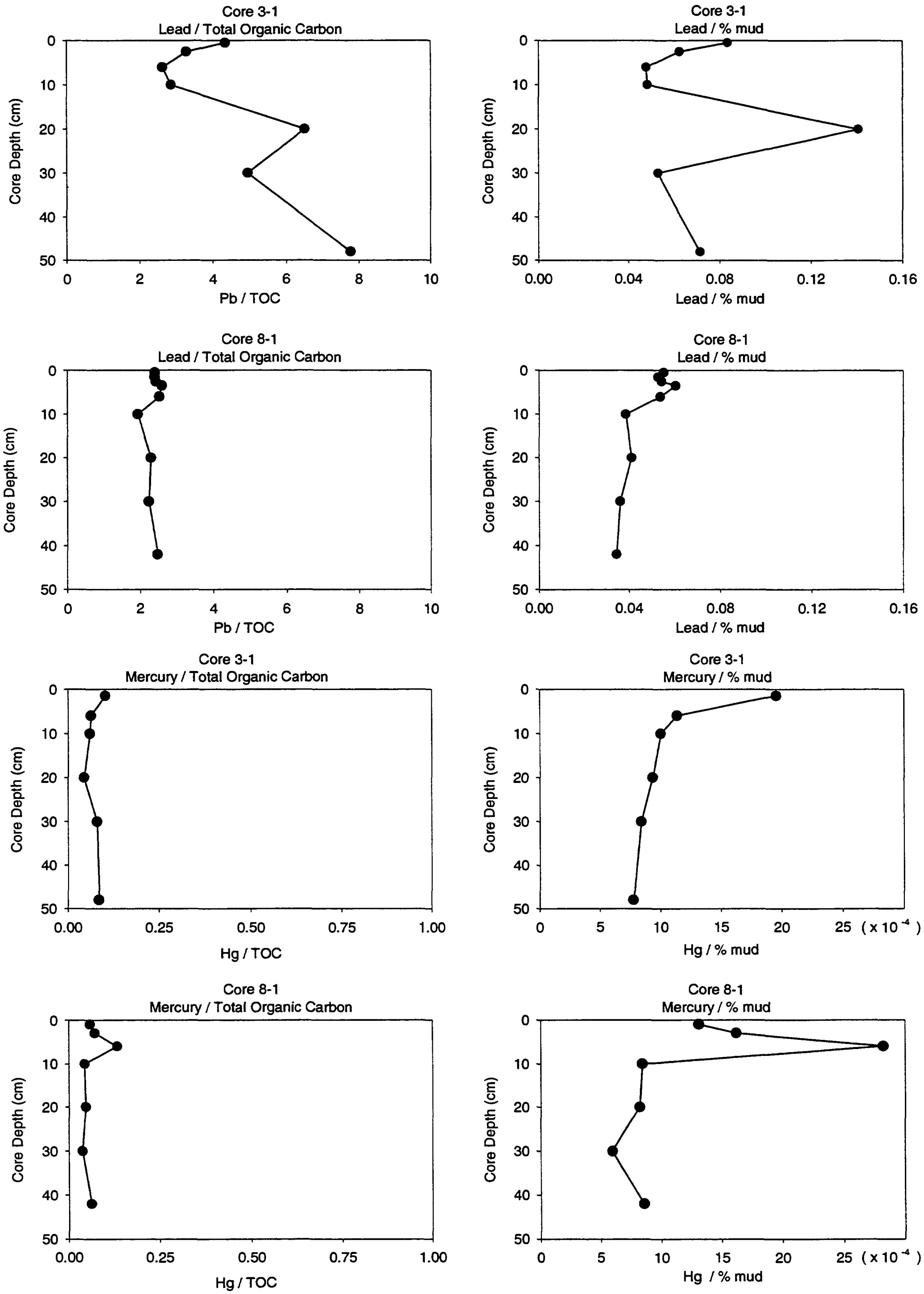


Figure 6. Ratios of lead and mercury to organic carbon and % mud (= % silt + % clay) in sediment from the Reference Site.

Acid Volatile Sulfides, Simultaneously Extracted Metals

In recent years, laboratory and field experiments have shown that the presence of acid-volatile sulfides (AVS) have a significant impact in controlling the bioavailability of heavy metals in marine sediments (for example, see *Environmental Toxicology and Chemistry*, V. 15, No. 12, 1996 for a compilation of 15 papers delineating the relationships between AVS, metals and benthic biological response, and their application to derivation of sediment quality criteria). In sediments where the molar concentration of AVS exceeds that of simultaneously extractable metals (SEM), biologically significant concentrations of dissolved metals are not found in pore waters, i.e. metals are not biologically available and toxic effects due to metals are not observed.

AVS concentrations in the reference site sediment core samples ranged from <0.005 to 0.1 µmole/g dry sediment (Table 5), which are quite low compared to AVS concentrations found in most coastal marine sediments. Other than sandy surficial sediments, uncontaminated coastal marine sediments generally have AVS concentrations of anywhere from 0.5 to 3 µmole AVS/g dry sediment in oxidized surface sediments to 15-500 µmole/g in anoxic subsurface sediment, depending on the depth of sampling and the time of year. Concentration maxima generally occur between 2-10 cm deep, and are closest to the surface and highest in concentration in late summer or early fall. Both electrode response and spiked blank recovery were examined to determine whether analytical problems caused the low values, but no significant problems were evident. Based on the instrumental detection limit and QA sample data, the limit of quantitation was approximately 0.05 µmole AVS/g dry sediment, which is still much lower than concentrations determined in surficial sediments of coastal and estuarine sediments.

The absence of AVS in these sediments can be attributed to the deep-water environment from which they came. AVS production is driven by microbial sulfate reduction requiring: a) reactive iron to form sulfide precipitates; b) sulfate ion to act as an electron acceptor, i.e. to act as an oxidizer; c) organic carbon to metabolize; and d) sulfate reducing bacterial activity. The sediments were 62-84% mud, so they were not likely to be limited by iron availability (iron concentrations in sediments usually correlate with fine-grained sediment composition), and

Table 5. ACID VOLATILE SULFIDE (AVS) AND SIMULTANEOUSLY EXTRACTED METALS (SEM)

Sediment samples

						SEM							
ChemID	Core	Depth (cm)	Rep	AVS (umol/g)	SEM (umol/g)	Zn ug/g	Cu ug/g	Ni ug/g	Pb ug/g	Cd ug/g	Cr ug/g	Mn ug/g	Fe ug/g
25342	3-1	0-1	1	< 0.04	< 0.27	< 1.16	< 7.74	< 5.03	< 8.13	< 1.16	< 3.87	6.19	2881
			2	< 0.03	< 0.22	< 0.94	< 6.32	< 4.11	< 6.64	< 0.94	< 3.16	8.22	2838
25343		2-3	1	< 0.01	0.74	37.02	< 2.92	6.43	< 3.07	< 0.43	< 1.46	13.61	2931
			2	< 0.02	< 0.25	4.19	< 3.65	6.02	< 3.83	< 0.54	< 1.82	13.5	3145
25344		5-7	1	0.10	< 0.24	6.43	< 2.38	5.23	< 2.5	< 0.35	2.26	15.6	3049
			2	0.08	0.30	10.79	1.47	6.37	1.24	0.16	4.7	13.06	2433
25345		9-11	1	0.04	0.29	10.96	< 0.89	6.04	< 0.93	< 0.13	4.16	13.2	2712
			2	0.06	0.34	12.2	1.41	7.27	1.25	0.12	6.38	16.2	2980
25346		19-21	1	0.03	0.67	23.39	4.91	13	1.82	0.36	8.45	26.23	4090
25347	8-1	0-1	1	< 0.0052	0.37	14.04	1.24	7.72	< 1.08	< 0.15	1.81	16.22	2798
25348		1-2	1	0.0054	0.42	14.78	2.23	8.68	2.55	< 0.10	3.47	16.77	2949
25349		2-3	1	< 0.0049	0.43	15.12	1.66	9.52	2.11	< 0.14	4.86	18.27	3145
25350		3-4	1	0.02	0.48	16.66	2.68	10.3	2.53	< 0.10	5.57	19.13	3222
25351		5-7	1	0.01	0.44	15.76	2.9	8.32	1.95	0.13	4.6	18.24	2825
25352		9-11	1	0.06	0.41	15.17	2.59	7.81	0.9	0.12	3.94	17.27	2680

QA summary

Calibration verification				± 15%		16%	10%	7%	17%	15%	9%	6%	8%
Spike recovery				72 - 77 %		91%	84%	84%	92%	87%	96%	85%	71%

because sulfate is a major ion in seawater, sulfate availability should not have been limiting either. Organic carbon concentrations were moderate in the core sediments (0.8 - 1.9%). However, in sediment from 1000 m water depth and deeper, the organic carbon may have already been degraded relative to organic carbon in sediments from shallower waters. Finally, references have shown microbial sulfate reducing activity to be temperature dependent: temperatures of at least 10-15°C seem to be needed for the sulfate reducing bacteria to be active (Jorgensen, 1977, Boothman and Helmstetter, 1992). The annual mean temperature of bottom water in this area is between 3°C and 4°C (Levitus and others, 1994), and so may not have any sulfate-reducing activity to generate AVS.

A possible consequence of the low AVS is that these sediments would have little capacity to sequester or retain additional metal loading if the metals are added in labile chemical forms. The levels of simultaneously extracted metals (SEM) further suggests that these sediments contain no bioavailable "free" metals. Analysis of SEM in these sediment samples show a slight excess of metals above AVS (0.2 - 0.6 μmole/g, Table 5), primarily due to the extremely low AVS rather than elevated metal (SEM) concentrations. In EPA laboratory experiments, however, it has been shown that at least 2-3 μmole/g of "excess" metals are required for any toxic effects to be observed (Berry and others, 1996; Hansen and others, 1996). This results from the metals-binding capacity of other sediment components (e.g. organic matter and iron and manganese oxides in oxic sediments), which prevents significant concentrations of metals in pore waters when SEM exceeds AVS only slightly. Indeed, extracts of pore waters from the reference site sediment samples contained no significant concentrations of zinc or nickel, which, based on their relatively higher sulfide solubilities, would be expected to be present in pore waters in greater concentration than less soluble metals.

Sediment Texture

The sediments in this area of the Continental Slope are fairly uniform in texture (Appendix Table B and Fig. 2). There is only modest variation among the 7 surface samples; the sand fraction averages 28% ± 8% , silt averages 52% ± 6% and the clay fraction averages 20% ± 3.6%. The topography in the study area is complex with two pronounced ridges and valleys

(Fig. 2). The sediments were collected from two east-west trending ridges. Sediment texture of the sea bed surface along both the northern and southern ridge becomes finer with sediment depth except for samples deeper than 1250 m. These deep stations contain the highest content of sand in each east - west transect. The sand sized particles are primarily lithogenic. Foraminifera or other biogenic carbonate particles typically make up less than 0.2% by weight of the sample and do not influence the sand size fraction.

The sediment-depth profiles of texture are slightly different in the two cores. The core from station 3 (980 m) contains about 63% mud (equals silt plus clay) at the surface and becomes finer with depth (Fig.4). The highest mud content (93%) occurs at the 29-31 cm horizon where the water content is also anomalously high. In-filling of an abandoned burrow is a possible explanation of this anomaly. The sediment texture at station 8 (1166 m), in contrast, contains 83% mud at the surface and becomes slightly coarser with depth (Fig.4). The lowest mud content (76%) is found at the bottom of this core. These cores represent areas of considerably different depth and apparently have recorded different temporal trends in sedimentary conditions.

Comparison between the Reference Site and the SF-DODS

The SF-DODS is located about 40 km west of the Farallon Islands in water depths ranging from 2700 m to 3100 m (Fig.1). The site is in a region historically used for ocean disposal (SAIC, 1996). It is located in the southwest corner of a region used as a Chemical Munitions Dumping Area by the U.S. Navy (approximately from 1958 until the late 1960's) and about 15 km WNW of a disposal site used for sealed containers of radioactive wastes (1951-1954). The SF-DODS contains the smaller U.S. Navy ocean dredged material disposal site (ODMDS) where approximately 1.2 million cubic yards of dredged material from the Alameda Naval Base were discharged between May 1993 and December 1993. During the period September through November, 1995, the SF-DODS received about 232,000 cubic yards of dredged material from Oakland Harbor (SAIC, 1996).

In Table 6, the ranges of contaminant concentrations found in the Reference Site are compared to the ranges at the SF-DODS, in dredged sediments from Oakland Harbor, and to ERM guidelines. As expected, contaminant levels at the Reference Site are generally lower than the range measured at the SF-DODS after dumping, with the exception of Cd and Hg. The Oakland Harbor sediments appear to be enriched in As, Cr, Pb, and Hg compared to both the Reference Site and the pre-dumping values at the SF-DODS. In Oakland Harbor, the only metal that exceeds the ERM guideline is Cr for some of the samples (Table 6). At the SF-DODS after dumping, none of the samples exceed this guideline.

The SAIC (1996) report describes the deposition of thin sand-sized mud chips displaced to the NW of the dump site by current flow in a layer generally <0.5 cm thick. A similar distribution was observed following the dumping in 1993. D.C. Rhoads has suggested in an oral presentation (February 6, 1997) that these fine particles have spalled off larger clay clumps as they descend through the water column and are sorted according to grain size, shape, and hydraulic settling velocity. Photographs obtained using the sediment vertical profile system (SVPS, Rhoads and Germano, 1982) in 1993 illustrate the blocky dredged material within the SF-DODS (Fig. 7A) and sand-sized mud chips deposited outside the dump site border (Fig. 7B). Note that the mud chips are bimodal with respect to color and reflectivity (Fig. 7B). The light grey chips may be over-consolidated clay >10,000 years old dredged from the more deeply buried harbor sediment where contamination levels would be low. In contrast, the black mud chips could be organic and sulfide rich material from recent deposits in the harbor with possibly higher contaminant concentrations (D.C. Rhoads, oral presentation, Feb. 6, 1997). A plan view of the sea floor, 2 km west of the dump site perimeter reveals mud chips on the sediment surface along with various examples of benthic animals (Fig. 7C). These three images were collected after the 1993 dumping of dredged material, but similar features and distributions were observed following the 1995 discharge (SAIC, 1996).

Based on chemical analyses of samples composited over the top 10 cm, the post-dumping survey of the SF-DODS in 1995 (SAIC, 1996) concluded that the sediments at and beyond the perimeter of this dump site appear to be uncontaminated by the disposal of dredged material from Oakland Harbor. The 10 cm sampling scheme is intended to sample benthic organisms in

Table 6. Summary comparison of the range of contaminants and other characteristics of sediments at the Reference Site, the SF-DODS before and after dumping, and in sediments dredged from Oakland Harbor in 1995 and dumped at SF-DODS.

CHEMICAL	Surface Samples (0-1cm) at Reference Site (this study)	SF-DODS [1] 1991 (0-10 cm)	SF-DODS [1] 1996 (0-10 cm)	Oakland Harbor [1] (Composits several feet thick)	ERM Guideline[2]
TOC (%)	1.22 - 1.91	3.21 - 3.76	1.6 - 3.2	0.02 - 6.93	
Percent Fines	61 - 83	77 - 96	75 - 97	3 - 91	
Metals (mg/kg dw[*])					
Arsenic	1.8 - 2.4	< 6.62	< 1.4 - 7.5	3.21 - 12.5	70
Cadmium	0.38 - 0.7	< 0.25	0.21 - 0.52	< 0.1 - 0.319	9.6
Chromium	43 - 64	137 - 167	61 - 94	157 - 627	370
Copper	14.5 - 19.8	41 - 62	36 - 57	11.5 - 49	270
Lead	3.3 - 5.3	< 5.25	16 - 29	6.3 - 29.2	218
Mercury	0.092 - 0.134	0.13 - 0.20	< 0.043 - 0.076	< 0.016 - 0.33	0.71
Nickel	47 - 53.9	78 - 115	56 - 80	57.2 - 110	51.6
Selenium	0.64 - 0.98	< 9.37	1.4 - 4.4	< 0.12 - 0.35(?)	
Silver	0.26 - 0.47	< 0.87	0.08 - 0.80	0.023 - 0.364	3.7
Zinc	44.3 - 61.6	108 - 147	68 - 100	42.3 - 128	410
Organics (ug/kg dw)					
Anthracene	<33.3 - 11.1	< 10 - 4.9	< 41 - 110	8.2 - 361	1100
Pyrene	2.2 - 13.4	2.8 - 5.9	< 31 - 34	6.7 - 600	2600

[1] SAIC, 1996 [2] Long and others, 1995 [*] Dry Weight

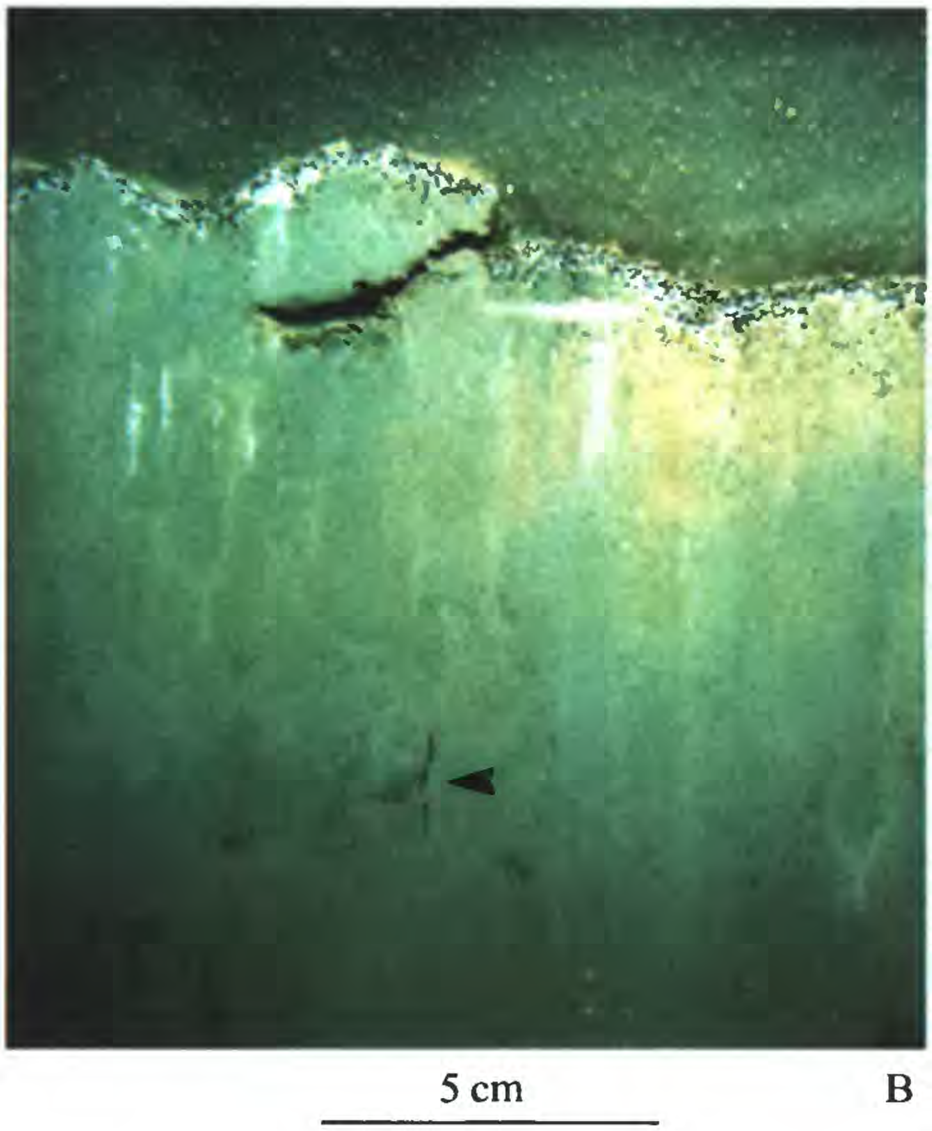
Captions for Figure 7 (on page 32)

Figure 7A. This sediment vertical profile system (SVPS) photograph shows two depositional events recorded at the eastern edge of the SF-DODS (Fig. 1) in September, 1993. An arrow shows the boundary between the first and second event which is marked by a thin (2-3 mm) oxidized layer on dark sediment. This oxidation took place when the dark mud clasts were exposed to the overlying water between events. The second layer was deposited following the oxidation of the first layer and, in turn, is already becoming oxidized. The rough boundary is typical of recently deposited dredge material. No infauna are observed (Station 14 C-2 from PRC, 1995).

Figure 7B. This SVPS photograph shows a continuous layer (0.5 cm thick) of dredge material mud clasts draped over the water sediment interface. The location is 2.9 km east of the designated dredge site perimeter. Note that the mud chips are both light and dark in color. The dark chips could be high in organic carbon and contaminants such as typically found in recently deposited harbor sediments. The light chips may represent over-consolidated clay from deeper in the dredging channel which may have deposited well before anthropogenic influence and contain low organic carbon and contaminant concentrations. (Station 16 A-2, Sept. 1993, PRC, 1995).

Figure 7C. Plan view of the sea floor 2 km west of the dump site perimeter in September 1993. The surface is covered with high (white) and low (blue) reflectance dredge material mud chips. The surface is heavily tracked by epibenthic organisms. Also evident are spiral fecal castings (F) tips of ophiuroid arms (O), anemones (A), sea pens (S), and burrows. (Station 11 Rep D, Sept. 1993, PRC, 1995).

A



B

C

the most active zone (i.e., bioturbation) of the upper surface layer of sediment. We point out, however, that this compositing procedure dilutes the chemical signal from the dredged material at the surface (typically <.5 cm thick) with ambient marine sediments throughout the remaining 9.5 cm interval below, producing at least a 20 fold dilution.

A change in the infaunal successional stages was noted at the time of the post-dumping survey of 1996 relative to an earlier survey in the areas where a thin layer of mud chips were observed. Contaminant concentrations in this layer have not been evaluated. Suggested explanations for changes in the infaunal successional stage at the dump site included accumulation of dredged material (burial), enhanced inputs of labile organic detritus, erosion, or other physical disturbances (SAIC, 1996). Physical features (i.e., large wavelength bedforms) noted during site designation studies suggested that the sea floor in the vicinity of the the SF-DODS may be periodically disturbed by mass transport of sediments (U.S. EPA, 1993; Karl, 1992).

There is reason to expect that the mud chip layer beyond the perimeter of the dump site might have higher contaminant concentrations than the bulk dredged material deposited inside the dump site. Contaminants and organic carbon are typically enriched in the finest sediment fraction relative to the coarse fraction or bulk sample. The process of spalling and selectively transporting the fine fraction may simultaneously transport higher contaminant and organic carbon concentrations while coarser material including disarticulated shells of shallow water bivalves with lower contaminant concentrations settle quickly in the central area of the dump site.

A supplemental sampling and analysis strategy would help determine the potential chemical and ecological impact of a sand-sized mud chip layer dispersed beyond the dump site border. Equipment like the hydraulically-damped gravity corer should be used to collect a 30-50 cm-long core without disturbing the water-sediment interface. Analyses of contaminants in closely spaced depth intervals through the mud chip layer would provide a measure of the concentrations and inventory of contaminants associated with this layer. Chemical profiles in cores from selected locations throughout the dump site would also provide valuable basic information about the rates and extent of sediment mixing, sediment accumulation, and/or erosion. Cores collected at different times from the same locations would reveal the influence of these processes on the long-term changes in contaminant concentrations and inventories.

Conclusions and Recommendations

This report provides data on EPA designated "chemicals of concern" in sediments at the reference site for the SF-DODS. We have found that the analysis of undisturbed sediment cores at various sediment depths improves the sensitivity of detecting contaminant concentrations above background compared to previous analyses of sediments homogenized over the top 10 cm. This study demonstrates that PCB's, PAHs, and *Clostridium perfringens* are slightly enriched in the surface sediments when compared to deeper horizons in sediment cores. The magnitude of chemical enrichment is well below the ERM or ERL guidelines. An overview of results generated during this study is presented in the executive summary.

There are two recommendations for future studies at both the Reference Site and at the SF-DODS:

1. Measure the rates of sediment mixing using depth profiles of radioisotopes such as ^{210}Pb and ^{234}Th. This will provide information on the significance of *in situ* dilution of contaminants added to the sea floor by physical mixing of sediment layers via biological and physical processes.

2. Collect sediment cores without disturbance of the water-sediment interface and analyze different depth horizons. Availability of this data in critical locations will permit a more accurate assessment of the contaminant loads to surface sediments than the present practice of compositing the upper 10 cm of sediment. In addition, analysis of sediment cores will help identify whether the contaminants added with dredged material are mixed, buried, or transported out of the SF-DODS by natural processes. This information is necessary for evaluating the long-term fate and effect of dredged material in the deep sea.

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Appendix Table A. Station Locations and Water Depth

Sediment samples were collected on Cruise E2-94-NC aboard the R.V. Pacific Escort

Core	Date	Time	Latitiude N. Deg.	Latitiude N. Min.	Longitude W. Deg.	Longitude W. Min.	Depth in Meters
3-1	10/31/94	14:09	37	22.9668	123	10.73909	980
5-3	10/31/94	22:08	37	23.2295	123	14.35	1191
6-1	11/01/94	00:05	37	23.96	123	14.99	1302
7-2	11/01/94	05:00	37	25.69	123	15.12	1255
8-1	11/01/94	06:52	37	25.07	123	14.33	1166
10-4	11/01/94	13:43	37	25.0732	123	13.0308	1066
11-4	11/01/94	16:40	37	25.0578	123	11.2971	959

Appendix Table B. Concentration of metals (dry weight basis), Clostridium perfringens, and sediment texture.

Core ID and Depth Interval(cm)	%Sand	Coulter %Silt	Coulter %Clay	Pipet corrected % Silt	Pipet corrected % Clay	C. perf. Spores /g	C. perf. Standard Deviation	Silver mg/kg	Arsenic mg/kg	Cadmium mg/kg	Chromium mg/kg	Mercury mg/kg*	Copper mg/kg	Nickel mg/kg	Zinc mg/kg	Lead mg/kg	Selenium mg/kg	Total Organic Carbon %	Total Cyanide mg/kg
3-1 0-1	36.51	46.81	16.68	40.96	22.53	570	142	0.26	1.8	0.38	43.4		14.5	47	49.4	5.3	0.64	1.22	
3-1 2-3	35.83	48.07	16.11	43.88	20.29	520	184	0.31	1.9	0.53	57.2		15.4	50.2	52.3	4	0.88	1.22	
3-1 0-1 , 3-1 2-3 (1)												0.125							
3-1 5-7	34.91	53.47	11.62	46.30	18.79	710	0	0.28	1.7	0.43	47.4	0.074	15.3	49.4	52	3.1	0.68	1.18	<0.50
3-1 9-11	37.73	48.89	13.38	47.02	15.25	290	37	0.25	1.5	0.42	50.2	0.06	14.3	47.8	50	3	0.78	1.05	<0.50
3-1 19-21	31.06	52.95	15.99	48.22	20.72	83	39	0.43	7.8	0.53	74	0.065	33	80.9	74.4	9.7	2	1.49	<0.50
3-1 29-31	7.14	54.28	38.58	48.19	44.67	<35		0.28	2.3	0.64	58.6	0.078 J	20.8	60.9	59.3	4.9	1.2	0.99	<0.50
3-1 47-49	11.57	67.43	21.00	60.23	28.20	<30		0.14	2.9	0.31	50.2	0.069	25.9	66.3	63.1	6.3	0.47	0.81	
5-3 0-1	29.27	47.67	23.06	45.52	25.21	830	235	0.38	2.1	0.31	46.6	0.105	16.9	53.1	57.1	4.4	0.98	1.55	<0.50
6-1 0-1	39.06	44.80	16.14	41.21	19.73	1100	333	0.47	1.8	0.28	54.6	0.092	16.8	51.1	58.1	4.6	0.98	1.46	<0.50
7-2 0-1	20.43	54.66	24.92	52.26	27.31	680	222	0.41	2	0.35	50	0.115 J	19.8	54.9	61.6	4.2	1.3	1.94	<0.50
8-1 0-1	16.58	61.80	21.62	58.14	25.28	1200	0	0.4	2.7	0.65	63		17.6	51.4	55	4.6	0.98 JG	1.91	
8-1 1-2	16.70	63.64	19.67	58.83	24.47	1100**	263	0.41 G	2.2	0.5 G	63.2		22.4	60.1	65.7	4.4	<1.0 G	1.83	
8-1 0-1 , 8-1 1-2 (1)												0.109							<0.50
8-1 2-3	17.11	58.66	24.23	54.10	28.79	1100	104	0.39	1.9	0.48 G	61.8		19.1	55.5	59.9	4.5	0.6 JG	1.85	
8-1 3-4	17.36	66.05	16.59	62.25	20.39	930	188	0.43	2.4	0.56 G	65.6		20.3	58	61.7	5	0.98 JG	1.93	
8-1 2-3 , 8-1 3-4 (1)												0.134							<0.50
8-1 5-7	16.20	66.84	16.96	61.98	21.82	900	141	0.42	2.3	0.68 G	71.6	0.24	20.2	58.3	64	4.5	<2.5 G	1.78	<0.50
8-1 9-11	19.56	61.10	19.34	55.55	24.89	<31		0.4	2.5	0.69 G	63	0.07	18.9	56.9	61.9	3.1 G	0.88 JG	1.6	<0.50
8-1 19-21	17.35	65.75	16.90	55.72	26.93	<32		0.4	2.5	0.68 G	64.8	0.07	17.4	51.6	56.3	3.4 G	0.82 JG	1.48	<0.50
8-1 29-31	22.26	62.84	14.90	56.00	21.74	<26		0.51	2.6	0.99 G	57.5	0.046 J	18.1	55.7	60.2	2.8 G	1 G	1.25	
8-1 41-43	24.43	68.71	6.86	60.59	14.98	<27		0.38	2.1	0.84 G	52.8	0.065	16.3	51.8	55.8	2.6	0.92 JG	1.05	
10-4 0-1	25.49	52.88	21.62	43.43	31.08	1000	118	0.35	2.4	0.56 G	59.6	0.116	15.2	42.8	44.3	4.1	0.72 JG	1.62	<0.50
11-4 0-1	27.05	56.35	16.60	46.59	26.36	71	0	0.29	2.2	0.7 G	64	0.134	16.5	53.9	55.5	3.3 G	0.76 JG	1.42	<0.50
Standards																			
MESS-1 This Study								0.12	7.1	0.71	24.3		20.3	19.8	147	32	<1.0	2.88	
Published ***								0.11	10.6	0.59	71	0.171	25.1	29.5	191	34.0	0.34	2.9	
Std Dev									1.2	0.1	11	0.014	3.8	2.7	17	6.1	0.06		
BCSS-1 This Study								0.08	7.7	0.42	46.5		13.7	43.1	86.3	24.5	<1.0	2.13	
Published ***									11.1	0.25	123	0.129	18.5	55.3	119	22.7	0.43		
Std Dev									1.4	0.4	14	0.012	2.7	3.6	12	3.4	0.06		
PACS-1 This Study								1.7	180	2.6	52.8		450	31	750	388	0.58 J	3.5	
Published ***									211	2.38	113	4.57	452	44.1	824	404	1.09		
Std Dev									11	0.2	8	0.16	16	2	22	20	0.11		
Spiked Duplicates																			
3-1 47-49								0.62	6	0.68	53.6		50.7	112	108	9.4	2.7		8.2
3-1 47-49								0.62	6	0.67	53.2		50.7	113	109	8.8	2.6		7.5
8-1 41-43								0.84	5.6	1.2	61.4		42.7	104	109	5.4	3.4		
8-1 41-43								0.87	5.6	1.2	61.4		41.5	98.7	103	5.4	3.9		

(1) Composite Sample from 2 depth intervals.
J Result is detected below reporting limit or is an estimated concentration.
G Reporting limit raised due to the matrix of the sample.
* mercury values have been converted to mg/kg dry.
** C. perfringens analysis for this sample was done with 4 replicates. All others used 2 replicates.
*** NRC Canada, 1987

Appendix Table C. Concentrations of furans and dioxins (wet weight basis).

Core ID and Depth Interval (cm)	Lab ID	Tetra chloro dibenzo furans	2,3,7,8- Tetra chloro dibenzo furan	Penta chloro dibenzo furans	1,2,3,7, 8-Penta chloro dibenzo furan	2,3,4,7,8- Penta chloro dibenzo furan	Hexa chloro dibenzo furans	1,2,3, 4,7,8- Hexa chloro dienzo furan	1,2,3,6,7, 8- Hexa chloro dibenzo furan	2,3,4, 6,7,8- Hexa chloro dibenzo furan	1,2,3,7,8,9- Hexa chloro dibenzo furan	Hepta chloro dibenzo furans	1,2,3, 4,6,7, 8-Hepta chloro dibenzo furan	1,2,3,4,7, 8,9- Hepta chloro dibenzo furan	Octa chloro dibenzo furan
		ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
3-1 0-1 , 3-1 2-3 (1)	0487000001SA	<0.40	<0.40	<0.22	<0.22	<0.22	<0.27	<0.27	<0.27	<0.27	<0.27	<0.33	<0.33	<0.33	<0.86
3-1 29-31	0487000002SA	<0.42	<0.42	<0.31	<0.31	<0.31	<0.41	<0.41	<0.41	<0.41	<0.41	<0.53	<0.53	<0.53	<1.2
6-1 0-1	0487000003SA	<0.41	<0.41	<0.36	<0.36	<0.36	<0.32	<0.32	<0.32	<0.32	<0.32	<0.49	<0.49	<0.49	<1.3
8-1 0-1 , 8-1 1-2 (1)	0487000004SA	<0.42	<0.42	<0.27	<0.27	<0.27	<0.30	<0.30	<0.30	<0.30	<0.30	<0.36	<0.36	<0.36	<0.90
8-1 2-3 , 8-1 3-4 (1)	0487000005SA	<0.46	<0.46	<0.26	<0.26	<0.26	<0.32	<0.32	<0.32	<0.32	<0.32	<0.41	<0.41	<0.41	<0.82
8-1 19-21	0487000006SA	<0.50	<0.50	<0.31	<0.31	<0.31	<0.50	<0.50	<0.50	<0.50	<0.50	<0.44	<0.44	<0.44	<1.2
METHOD BLANK	0487000001MB	<0.50	<0.50	<0.26	<0.26	<0.26	<0.31	<0.31	<0.31	<0.31	<0.31	<0.38	<0.38	<0.38	<0.96

Core ID and Depth Interval (cm)	Lab ID	Tetra chloro dibenzo- p- dioxins	2,3,7,8- Tetra chloro dibenzo- p-dioxin	Penta chloro dibenzo -p- dioxins	1,2,3,7,8- Penta chloro dibenzo -p- dioxin	Hexa dichloro dibenzo -p- dioxins	1,2,3,4,7, 8-Hexa chloro dibenzo -p-dioxin	1,2,3, 6,7,8- Hexa chloro dibenzo- p-dioxin	1,2,3, 7,8,9- Hexa chloro dibenzo- p-dioxin	Hepta chloro dibenzo -p- dioxins	1,2,3,4,6,7, 8-Hepta chloro dibenzo-p- dioxin	Octa chloro dibenzo- p-dioxin
		ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
3-1 0-1 , 3-1 2-3 (1)	0487000001SA	<0.14	<0.14	<0.52	<0.52	<0.36	<0.36	<0.36	<0.36	<0.41	<0.41	<0.87
3-1 29-31	0487000002SA	<0.20	<0.20	<0.56	<0.56	<0.58	<0.58	<0.58	<0.58	<0.74	<0.74	<1.1
6-1 0-1	0487000003SA	<0.16	<0.16	<0.63	<0.63	<0.46	<0.46	<0.46	<0.46	<0.58	<0.58	<0.98
8-1 0-1 , 8-1 1-2 (1)	0487000004SA	<0.17	<0.17	<0.72	<0.72	<0.41	<0.41	<0.41	<0.41	<0.43	<0.43	<0.86
8-1 2-3 , 8-1 3-4 (1)	0487000005SA	<0.11	<0.11	<0.61	<0.61	<0.35	<0.35	<0.35	<0.35	<0.42	<0.42	<0.64
8-1 19-21	0487000006SA	<0.15	<0.15	<0.69	<0.69	<0.54	<0.54	<0.54	<0.54	<0.61	<0.61	<3.8
METHOD BLANK	0487000001MB	<0.15	<0.15	<0.49	<0.49	<0.36	<0.36	<0.36	<0.36	<0.40	<0.40	<0.79

(1) = Composite sample from 2 depth intervals.
B = Compound is also detected in the blank.

Appendix Table D. Concentration of polychlorinated biphenyls and organo tin compounds(wet weight basis).

Core ID and Depth Interval (cm)	Lab ID	2-MonoCB	4-Mono CB	Total Mono chloro biphenyls	2,6- DiCB	4,4'- DiCB	Total Dichloro biphenyls	2,4,6-TriCB	2,4,4'-TriCB	3,4,4'-TriCB	Total Trichloro biphenyls	2,2',6,6'-TetraCB	3,3',4,4'-Tetra CB	Total Tetra chloro biphenyls	2,2',4,6,6'-PentaCB	2,3', 4,4',5-Penta CB	2,3,3',4,4'-Penta CB
		pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g
3-1 0-1 , 3-1 2-3 (1)	0487000001SA	<4.9	<5.9	<20	<3.5	<14	27 B	<1.6	30	<15	98 B	<0.86	<12	310	<1.0	110	61
3-1 29-31	0487000002SA	<4.2	<4.0	<13	<2.0	<7.3	29 B	<2.3	<16	<6.4	23 B	<0.74	<4.0	<15	<1.7	<14	<3.7
6-1 0-1	0487000003SA	<4.1	<5.2	27	<3.7	<12	27 B	<2.5	29	<12	72 B	<0.53	<9.5	200	<2.6	85	55
8-1 0-1 , 8-1 1-2 (1)	0487000004SA	<4.4	<6.8	36	<3.6	<15	24 B	<1.8	38	21	120 B	<0.31	<15	330	<0.85	130	77
8-1 2-3 , 8-1 3-4 (1)	0487000005SA	<5.7	<5.2	28	<3.2	<14	25 B	<1.8	34	<18	100 B	<1.2	<14	340	<0.87	130	65
8-1 19-21	0487000006SA	<3.4	<5.3	<18	<2.2	<8.4	35 B	<1.6	<15	<5.1	25 B	<1.2	<1.5	<15	<0.96	<15	<4.0
METHOD BLANK	0487000001MB	<3.3	<6.0	<6.0	<2.1	<7.5	35	<2.8	<18	<3.7	21	<1.1	<2.5	<18	<1.8	<11	<3.7

Core ID and Depth Interval (cm)	Lab ID	3,3',4,4',5-Penta CB	Total Penta chloro biphenyls	2,2',4,4',6,6'-HexaCB	3,3',4,4',5,5'-Hexa CB	Total Hexa chloro biphenyls	2,2',3,4',5,6,6'-Hepta CB	2,2',3,4,4',5,5'-Hepta CB	2,3,3',4,4',5,5'-Hepta CB	Total Hepta chloro biphenyls	2,2',3,3',5,5',6,6'-OctaCB	2,2',3,3',4,4',5,5'-OctaCB	Total Octa chloro biphenyls	2,2',3,3',4,5,5',6,6'-NonaCB	2,2',3,3',4,4',5,5',6-NonaCB	Total Nona chloro biphenyls	DecaCB
		pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g
3-1 0-1 , 3-1 2-3 (1)	0487000001SA	<2.9	580	<0.81	<2.1	390	<1.5	64	<1.4	140	<5.6	<18	23	<3.8	28	28	24
3-1 29-31	0487000002SA	<3.2	<18	<0.58	<1.4	<15	<0.83	<9.0	<1.8	<9.0	<0.85	<2.6	<2.6	<1.1	<1.8	<1.8	<8.0
6-1 0-1	0487000003SA	<3.1	400	<0.87	<1.1	210	<0.49	55	<1.6	78	<3.1	<14	<14	<3.7	<20	<20	23
8-1 0-1 , 8-1 1-2 (1)	0487000004SA	<2.9	560	<0.57	<1.5	420	<0.47	85	<1.5	190	<7.0	24	71	<9.2	32	32	78
8-1 2-3 , 8-1 3-4 (1)	0487000005SA	<2.1	640	<1.1	<1.0	410	<0.49	78	<1.6	130	<6.1	22	70	<5.9	34	34	50
8-1 19-21	0487000006SA	<6.6	48	<0.87	<2.3	<15	<1.3	<8.3	<0.90	<8.3	<0.69	<2.2	<2.2	<0.67	<1.2	<1.2	<5.0
METHOD BLANK	0487000001MB	<1.4	<19	<1.1	<2.0	<13	<1.3	<5.8	<2.4	<5.8	<1.0	<1.7	<1.7	<0.46	<0.80	<0.80	<6.9

Core ID and Depth Interval (cm)	Lab ID	Monobutyl tin	Dibutyl tin	Tributyl tin	Tetrabutyl tin
		ug/Kg	ug/Kg	ug/Kg	ug/Kg
3-1 0-1 , 3-1 2-3 (1)	0487000001SA	<1.0	<1.0	<1.0	<1.0
3-1 29-31	0487000002SA	<1.0	<1.0	<1.0	<1.0
6-1 0-1	0487000003SA	<1.0	<1.0	<1.0	<1.0
8-1 0-1 , 8-1 1-2 (1)	0487000004SA	<1.0	<1.0	<1.0	<1.0
8-1 2-3 , 8-1 3-4 (1)	0487000005SA	<1.0	<1.0	<1.0	<1.0
8-1 19-21	0487000006SA	<1.0	<1.0	<1.0	<1.0

(1) = Composite sample from 2 depth intervals.
B = Compound is also detected in the blank.

Appendix Table E. Concentrations of all other organic compounds (wet weight basis) determined on sediment samples from the EPA reference site on the Continental Slope near the Farallon Islands.

Core ID and Depth Interval (cm)	Lab ID	Aldrin	alpha-BHC	beta-BHC	delta- BHC	gamma-BHC	gamma-Chlordane	alpha-Chlordane	4,4'-DDD	4,4'-DDE	4,4'-DDT	Dieldrin	Endrin	Endrin aldehyde	Endo sulfan I	Endo sulfan II	Endo sulfan sulfate	Hepta chlor	Hepta chlor epoxide	Toxa phene	Aroclor-1016
		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
3-1 0-1 , 3-1 2-3 *	0486900001SA	<0.014	<0.014	<0.014	<0.014	<0.014	<0.014	<0.014	<0.029	<0.029	<0.029	<0.029	<0.029	<0.029	<0.014	<0.029	<0.029	<0.014	<0.014	<0.29	<0.14
3-1 5-7	0486900002SA	<0.0092	<0.0092	<0.0092	0.0067 J	<0.0092	<0.0092	<0.0092	<0.018	<0.018	<0.018	<0.018	<0.018	<0.018	<0.0092	<0.018	<0.018	<0.0092	<0.0092	<0.18	<0.092
3-1 9-11	0486900003SA	<0.0095	<0.0095	<0.0095	<0.0095	<0.0095	<0.0095	<0.0095	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.0095	<0.019	<0.019	<0.0095	<0.0095	<0.19	<0.095
3-1 19-21	0486900004SA	<0.0082	<0.0082	<0.0082	<0.0082	<0.0082	<0.0082	<0.0082	<0.016	<0.016	<0.016	<0.016	<0.016	<0.016	<0.0082	<0.016	<0.016	<0.0082	<0.0082	<0.16	<0.082
3-1 29-31	0486900005SA	<0.0092	<0.0092	<0.0092	0.0092	<0.0092	<0.0092	<0.0092	<0.018	<0.018	<0.018	<0.018	<0.018	<0.018	<0.0092	<0.018	<0.018	<0.0092	<0.0092	<0.18	<0.092
3-1 47-49	0488900006SA																				
5-3 0-1	0486900007SA	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.025	<0.050	<0.050	<0.025	<0.025	<0.50	<0.25
6-1 0-1	0486900008SA	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.15	<0.30	<0.30	<0.15	<0.15	<3.0	<1.5
7-2 0-1	0486900009SA	<0.078	<0.078	<0.078	<0.078	<0.078	<0.078	<0.078	<0.16	<0.16	<0.16	<0.16	<0.16	<0.16	<0.078	<0.16	<0.16	<0.078	<0.078	<1.6	<0.78
8-1 0-1 , 8-1 1-2 *	0486900010SA	<0.023	<0.023	<0.023	<0.023	<0.023	<0.023	<0.023	<0.046	<0.046	<0.046	<0.046	<0.046	<0.046	<0.023	<0.046	<0.046	<0.023	<0.023	<0.46	<0.23
8-1 2-3 , 8-1 3-4 *	0486900011SA	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.060	<0.060	<0.060	<0.060	<0.060	<0.060	<0.030	<0.060	<0.060	<0.030	<0.030	<0.60	<0.30
8-1 5-7	0486900012SA	<0.0092	<0.0092	<0.0092	0.016	<0.0092	<0.0092	<0.0092	<0.018	<0.018	<0.018	<0.018	<0.018	<0.018	<0.0092	<0.018	<0.018	<0.0092	<0.0092	<0.18	<0.092
8-1 9-11	0486900013SA	<0.0098	<0.0098	<0.0098	0.005 J	<0.0098	<0.0098	<0.0098	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.0098	<0.020	<0.020	<0.0098	<0.0098	<0.20	<0.098
8-1 19-21	0486900014SA	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.010	<0.020	<0.020	<0.010	<0.010	<0.20	<0.10
8-1 29-31	0486900015SA																				
8-1 41-43	0486900016SA																				
10-4 0-1	0486900017SA	<0.12	<0.12	<0.12	<0.12	<0.12	<0.12	<0.12	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.12	<0.25	<0.25	<0.12	<0.12	<2.5	<1.2
11-4 0-1	0486900018SA	<0.088	<0.088	<0.088	<0.088	<0.088	<0.088	<0.088	<0.18	<0.18	<0.18	<0.18	<0.18	<0.18	<0.088	<0.18	<0.18	<0.088	<0.088	<1.8	<0.88
Spikes																					
3-1 9-11 MS	0486900003MS																				
3-1 9-11 SD	0486900003SD																				

J = Result is detected below reporting limits or is an estimated concentration.
1 = Tentative Identification, order of magnitude estimate.
2 = Confident Identification, order of magnitude estimate.
3 = Possible artifact of analysis
q = this sample has GC/FID characteristics for which reliable identification of a product could not be achieved.
1(with q) = Sample resembles a hydrocarbon product occurring within the n-alkane range of C12-C28.
x = Target compound's secondary ion confirmation criteria not met, but retention time and peak shape make identification possible.
<-- Less than reportig limit and analyte present in the blank.
NA = Not analyzed
MS = Matrix spike
SD = Spike duplicate
* = Composite sample from 2 depth intervals.
** Concentrations of a compound for which there were no similar library spectra, and assignment to a particular class of compounds was not possible.

Appendix Table E Continued. Concentrations of all other organic compounds (wet weight basis) determined on sediment samples from the EPA reference site on the Continental Slope near the Farallon Islands.

Core ID and Depth Interval (cm)	Aroclor-1221	Aroclor-1232	Aroclor-1242	Aroclor-1248	Aroclor-1254	Aroclor-1260	Methoxy chlor	Phenol	bis (2-Chloro ethyl) ether	2-Chloro phenol	1,3-Di chloro benzene
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
3-1 0-1 , 3-1 2-3 *	<0.14	<0.14	<0.14	<0.14	<0.29	<0.29	<0.14	<0.50	<0.50	<0.50	<0.50
3-1 5-7	<0.092	<0.092	<0.092	<0.092	<0.18	<0.18	<0.092	<0.52	<0.52	<0.52	<0.52
3-1 9-11	<0.095	<0.095	<0.095	<0.095	<0.19	<0.19	<0.095	<0.57	<0.57	<0.57	<0.57
3-1 19-21	<0.082	<0.082	<0.082	<0.082	<0.16	<0.18	<0.082	<0.50	<0.50	<0.50	<0.50
3-1 29-31	<0.092	<0.092	<0.092	<0.092	<0.18	<0.18	<0.092	<0.50	<0.50	<0.50	<0.50
3-1 47-49											
5-3 0-1	<0.25	<0.25	<0.25	<0.25	<0.50	<0.50	<0.25	<1.1	<1.1	<1.1	<1.1
6-1 0-1	<1.5	<1.5	<1.5	<1.5	<3.0	<3.0	<1.5	<3.5	<3.5	<3.5	<3.5
7-2 0-1	<0.78	<0.78	<0.78	<0.78	<1.8	<1.6	<0.78	<5.1	<5.1	<5.1	<5.1
8-1 0-1 , 8-1 1-2 *	<0.23	<0.23	<0.23	<0.23	<0.46	<0.46	<0.23	<0.68	<0.68	<0.68	<0.68
8-1 2-3 , 8-1 3-4 *	<0.30	<0.30	<0.30	<0.30	<0.60	<0.60	<0.30	<0.34	<0.34	<0.34	<0.34
8-1 5-7	<0.092	<0.092	<0.092	<0.092	<0.18	<0.18	<0.092	<0.50	<0.50	<0.50	<0.50
8-1 9-11	<0.098	<0.098	<0.098	<0.098	<0.20	<0.20	<0.098	<0.51	<0.51	<0.51	<0.51
8-1 19-21	<0.10	<0.10	<0.10	<0.10	<0.20	<0.20	<0.10	<0.48	<0.48	<0.48	<0.48
8-1 29-31											
8-1 41-43											
10-4 0-1	<1.2	<1.2	<1.2	<1.2	<2.5	<2.5	<1.2	<5.0	<5.0	<5.0	<5.0
11-4 0-1	<0.88	<0.88	<0.88	<0.88	<1.8	<1.8	<0.88	<1.7	<1.7	<1.7	<1.7
Spikes											
3-1 9-11 MS								4.1	NA	4.3	NA
3-1 9-11 SD								4.7	NA	5	NA

Core ID and Depth Interval (cm)	1,4-Di chloro benzene	1,2-Di chloro benzene	bis(2-Chloro isopropyl) ether	N-Nitroso-di-n- propyl amine	Hexa chloro ethane	Nitro benzene	Iso phorone	2-Nitro phenol	2,4-Di methyl phenol	bis(2-Chloro ethoxy) methane	2,4-Di chloro phenol
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
3-1 0-1 , 3-1 2-3 *	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
3-1 5-7	<0.52	<0.52	<0.52	<0.52	<0.52	<0.52	<0.52	<0.52	<0.52	<0.52	<0.52
3-1 9-11	<0.57	<0.57	<0.57	<0.57	<0.57	<0.57	<0.57	<0.57	<0.57	<0.57	<0.57
3-1 19-21	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
3-1 29-31	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
3-1 47-49											
5-3 0-1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1
6-1 0-1	<3.5	<3.5	<3.5	<3.5	<3.5	<3.5	<3.5	<3.5	<3.5	<3.5	<3.5
7-2 0-1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1
8-1 0-1 , 8-1 1-2 *	<0.68	<0.68	<0.68	<0.68	<0.68	<0.68	<0.68	<0.68	<0.68	<0.68	<0.68
8-1 2-3 , 8-1 3-4 *	<0.34	<0.34	<0.34	<0.34	<0.34	<0.34	<0.34	<0.34	<0.34	<0.34	<0.34
8-1 5-7	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
8-1 9-11	<0.51	<0.51	<0.51	<0.51	<0.51	<0.51	<0.51	<0.51	<0.51	<0.51	<0.51
8-1 19-21	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48
8-1 29-31											
8-1 41-43											
10-4 0-1	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
11-4 0-1	<1.7	<1.7	<1.7	<1.7	<1.7	<1.7	<1.7	<1.7	<1.7	<1.7	<1.7
Spikes											
3-1 9-11 MS	2	NA	NA	2.2	NA	NA	NA	NA	NA	NA	NA
3-1 9-11 SD	2.4	NA	NA	2.6	NA	NA	NA	NA	NA	NA	NA

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q = this sample has GC/FID characteristics for which reliable identification of a product could not be achieved.
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<-- Less than reportig limit and analyte present in the blank.
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MS = Matrix spike
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* = Composite sample from 2 depth intervals.
** Concentrations of a compound for which there were no similar library spectra, and assignment to a particular class of compounds was not possible.

Appendix Table E Continued. Concentrations of all other organic compounds (wet weight basis) determined on sediment samples from the EPA reference site on the Continental Slope near the Farallon Islands.

Core ID and Depth Interval (cm)	1,2,4-Tri chloro benzene	Hexa chloro butadiene	4-Chloro-3-methyl phenol	2,4,6-Tri chloro phenol	2,4,5-Tri chloro phenol	2-Chloro naphthalene	Dimethyl phthalate	2,4-Di nitro phenol	4-Nitro phenol	2,4-Di nitro toluene	2,6-Di nitro toluene	Diethyl phthalate	4-Chloro phenyl phenyl ether	4,6-Di nitro-2-methyl phenol	4-Bromo phenyl phenyl ether	Hexa chloro benzene	Penta chloro phenol	Di-n- butyl phthalate	Butyl benzyl phthalate	3,3'-Di chloro benzidine	bis(2- Ethyl hexyl) phthalate	Di-n- octyl phthalate
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
3-1 0-1 , 3-1 2-3 *	<0.50	<0.50	<0.50	<0.50	<1.5	<0.50	<0.50	<1.5	<2.5	<0.50	<0.50	<0.50	<0.50	<1.5	<0.50	<0.50	<1.5	<0.50	<0.50	<1.0	<0.50	<0.50
3-1 5-7	<0.52	<0.52	<0.52	<0.52	<1.5	<0.52	<0.52	<1.5	<2.6	<0.52	<0.52	<0.52	<0.52	<1.5	<0.52	<0.52	<1.5	<0.52	<0.52	<1.0	<0.52	<0.52
3-1 9-11	<0.57	<0.57	<0.57	<0.57	<1.7	<0.57	<0.57	<1.7	<2.8	<0.57	<0.57	<0.57	<0.57	<1.7	<0.57	<0.57	<1.7	<0.57	<0.57	<1.1	<0.57	<0.57
3-1 19-21	<0.50	<0.50	<0.50	<0.50	<1.5	<0.50	<0.50	<1.5	<2.5	<0.50	<0.50	<0.50	<0.50	<1.5	<0.50	<0.50	<1.5	<0.50	<0.50	<0.99	<0.50	<0.50
3-1 29-31	<0.50	<0.50	<0.50	<0.50	<1.5	<0.50	<0.50	<1.5	<2.5	<0.50	<0.50	<0.50	<0.50	<1.5	<0.50	<0.50	<1.5	<0.50	<0.50	<1.0	<0.50	<0.50
3-1 47-49																						
5-3 0-1	<1.1	<1.1	<1.1	<1.1	<3.3	<1.1	<1.1	<3.3	<5.5	<1.1	<1.1	<1.1	<1.1	<3.3	<1.1	<1.1	<3.3	<1.1	<1.1	<2.2	<1.1	<1.1
6-1 0-1	<3.5	<3.5	<3.5	<3.5	<10	<3.5	<3.5	<10	<17	<3.5	<3.5	<3.5	<3.5	<10	<3.5	<3.5	<10	<3.5	<3.5	<6.9	<3.5	<3.5
7-2 0-1	<5.1	<5.1	<5.1	<5.1	<15	<5.1	<5.1	<15	<26	<5.1	<5.1	<5.1	<5.1	<15	<5.1	<5.1	<15	<5.1	<5.1	<10	<5.1	<5.1
8-1 0-1 , 8-1 1-2 *	<0.68	<0.68	<0.68	<0.68	<2.0	<0.68	<0.68	<2.0	<3.4	<0.68	<0.68	<0.68	<0.68	<2.0	<0.68	<0.68	<2.0	<0.68	<0.68	<1.4	<0.68	<0.68
8-1 2-3 , 8-1 3-4 *	<0.34	<0.34	<0.34	<0.34	<1.0	<0.34	<0.34	<1.0	<1.7	<0.34	<0.34	<0.34	<0.34	<1.0	<0.34	<0.34	<1.0	<0.34	<0.34	<0.69	<0.34	<0.34
8-1 5-7	<0.50	<0.50	<0.50	<0.50	<1.5	<0.50	<0.50	<1.5	<2.5	<0.50	<0.50	<0.50	<0.50	<1.5	<0.50	<0.50	<1.5	<0.50	<0.50	<1.0	<0.50	<0.50
8-1 9-11	<0.51	<0.51	<0.51	<0.51	<1.5	<0.51	<0.51	<1.5	<2.6	<0.51	<0.51	<0.51	<0.51	<1.5	<0.51	<0.51	<1.5	<0.51	<0.51	<1.0	<0.51	<0.51
8-1 19-21	<0.48	<0.48	<0.48	<0.48	<1.5	<0.48	<0.48	<1.5	<2.4	<0.48	<0.48	<0.48	<0.48	<1.5	<0.48	<0.48	<1.5	<0.48	<0.48	<0.97	<0.48	<0.48
8-1 29-31																						
8-1 41-43																						
10-4 0-1	<5.0	<5.0	<5.0	<5.0	<15	<5.0	<5.0	<15	<25	<5.0	<5.0	<5.0	<5.0	<15	<5.0	<5.0	<15	<5.0	<5.0	<10	<5.0	<5.0
11-4 0-1	<1.7	<1.7	<1.7	<1.7	<5.2	<1.7	<1.7	<5.2	<8.7	<1.7	<1.7	<1.7	<1.7	<5.2	<1.7	<1.7	<5.2	<1.7	<1.7	<3.5	<1.7	<1.7
Spikes																						
3-1 9-11 MS	2.2	NA	4.5	NA	NA	NA	NA	NA	6	2.7	NA	NA	NA	NA	NA	NA	4.8	NA	NA	NA	NA	NA
3-1 9-11 SD	2.6	NA	4.9	NA	NA	NA	NA	NA	7	3.2	NA	NA	NA	NA	NA	NA	5.2	NA	NA	NA	NA	NA

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2 = Confident identification, order of magnitude estimate.
3 = Possible artifact of analysis
q = this sample has GC/FID characteristics for which reliabla identification of a product could not be achieved.
1(with q) = Sample resembles a hydrocarbon product occurring within the n-alkane range of C12-C28.
x = Target compound's secondary ion confirmation criteria not met, but retention time and peak shape make identification possible.
<-- Less than reportig limit and analyte present in the blank.
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MS = Matrix spike
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* = Composite sample from 2 depth intervals.
** Concentrations of a compound for which there were no similar library spectra, and assignment to a particular class of compounds was not possible.

Appendix Table E Continued. Concentrations of all other organic compounds (wet weight basis) determined on sediment samples from the EPA reference site on the Continental Slope near the Farallon Islands.

Core ID and Depth Interval (cm)	Aceto phenone	Aniline	4-Aminobi phenyl	Benzidine	Benzoic acid	Benzyl alcohol	4- Chloro aniline	Dibenz (a,j) acridine	Dibenzo furan	p-Di methyl amino azo benzene	7,12-Di methyl benz(a)-^ anth racene	a,a-Di methyl phenethyl amine	Diphenyl amine	1,2- Diphenyl hydrazine	Ethyl methane sulfonate	Methyl methane sulfonate	2-Methyl naph thalene	1- Naphthyl amine	2- Naphthyl amine	2-Nitro aniline	3-Nitro aniline	4-Nitro aniline
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
3-1 0-1 , 3-1 2-3 *	<2.5	<2.5	<2.5	<5.6	0.044 J	<1.0	<1.0	<--	<0.50	<2.5	<2.5	<--	<2.5	<2.5	<2.5	<2.5	<0.50	<2.5	<2.5	<2.5	<2.5	<2.5
3-1 5-7	<2.6	<2.6	<2.6	<5.8	0.066 J	<1.0	<1.0	<--	<0.52	<2.6	<2.6	<--	<2.6	<2.6	<2.6	<2.6	<0.52	<2.6	<2.6	<2.6	<2.6	<2.6
3-1 9-11	<2.8	<2.8	<2.8	<6.4	<2.8	<1.1	<1.1	<--	<0.57	<2.8	<2.8	<--	<2.8	<2.8	<2.8	<2.8	<0.57	<2.8	<2.8	<2.8	<2.8	<2.8
3-1 19-21	<2.5	<2.5	<2.5	<5.5	<2.5	<0.99	<0.99	<--	<0.50	<2.5	<2.5	<--	<2.5	<2.5	<2.5	<2.5	<0.50	<2.5	<2.5	<2.5	<2.5	<2.5
3-1 29-31	<2.5	<2.5	<2.5	<5.7	<2.5	<1.0	<1.0	<--	<0.50	<2.5	<2.5	0.043 J	<2.5	<2.5	<2.5	<2.5	<0.50	<2.5	<2.5	<2.5	<2.5	<2.5
3-1 47-49																						
5-3 0-1	<5.5	<5.5	<5.5	<12	<5.5	<2.2	<2.2	<--	<1.1	<5.5	<5.5	<--	<5.5	<5.5	<5.5	<5.5	<1.1	<5.5	<5.5	<5.5	<5.5	<5.5
6-1 0-1	<17	<17	<17	<39	<17	<6.9	<6.9	<--	<3.5	<17	<17	<--	<17	<17	<17	<17	<3.5	<17	<17	<17	<17	<17
7-2 0-1	<26	<26	<26	<57	<26	<10	<10	<--	<5.1	<26	<26	<--	<26	<26	<26	<26	<5.1	<26	<26	<26	<26	<26
8-1 0-1 , 8-1 1-2 *	<3.4	<3.4	<3.4	<7.6	<3.4	<1.4	<1.4	<--	<0.68	<3.4	<3.4	<--	<3.4	<3.4	<3.4	<3.4	<0.68	<3.4	<3.4	<3.4	<3.4	<3.4
8-1 2-3 , 8-1 3-4 *	<1.7	<1.7	<1.7	<3.9	0.13 J	<0.69	<0.69	<--	<0.34	<1.7	<1.7	<--	<1.7	<1.7	<1.7	<1.7	<0.34	<1.7	<1.7	<1.7	<1.7	<1.7
8-1 5-7	<2.5	<2.5	<2.5	<5.7	<2.5	<1.0	<1.0	<--	<0.50	<2.5	<2.5	<--	<2.5	<2.5	<2.5	<2.5	<0.50	<2.5	<2.5	<2.5	<2.5	<2.5
8-1 9-11	<2.6	<2.6	<2.6	<5.7	<2.6	<1.0	<1.0	<--	<0.51	<2.6	<2.6	<--	<2.6	<2.6	<2.6	<2.6	<0.51	<2.6	<2.6	<2.6	<2.6	<2.6
8-1 19-21	<2.4	<2.4	<2.4	<5.4	<2.4	<0.97	<0.97	<--	<0.48	<2.4	<2.4	<--	<2.4	<2.4	<2.4	<2.4	<0.48	<2.4	<2.4	<2.4	<2.4	<2.4
8-1 29-31																						
8-1 41-43																						
10-4 0-1	<25	<25	<25	<56	<25	<10	<10	<--	<5.0	<25	<25	<--	<25	<25	<25	<25	<5.0	<25	<25	<25	<25	<25
11-4 0-1	<8.7	<8.7	<8.7	<19	<8.7	<3.5	<3.5	<--	<1.7	<8.7	<8.7	<--	<8.7	<8.7	<8.7	<8.7	<1.7	<8.7	<8.7	<8.7	<8.7	<8.7
Spikes																						
3-1 9-11 MS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3-1 9-11 SD	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

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3 = *Possible artifact of analysis*
q = this sample has GC/FID characteristics for which reliable identification of a product could not be achieved.
1(with q) = Sample resembles a hydrocarbon product occurring within the n-alkane range of C12-C28.
x = Target compound's secondary ion confirmation criteria not met, but retention time and peak shape make Identification possible.
<-- Less than reportig limit and analyte present in the blank.
NA = Not analyzed
MS = Matrix spike
SD = *Spike duplicate*
* = Composite sample from 2 depth intervals.
** Concentrations of a compound for which there were no similar library spectra, and assignment to a particular class of compounds was not possible.

Appendix Table E Continued. Concentrations of all other organic compounds (wet weight basis) determined on sediment samples from the EPA reference site on the Continental Slope near the Farallon Islands.

Core ID and Depth Interval (cm)	Penta chloro benzene	Penta chloro nitro benzene	Phen acetin	2-Picoline	Pronamide	1,2,4,5-Tetra chloro benzene	2,6-Di chloro phenol	2-Methyl phenol	4-Methyl phenol	2,3,4,6-Tetra chloro phenol	N-Nitroso -di-n- butyl amine	N-Nitroso dimethyl amine	N-Nitroso piperidine	1-Chloro naph thalene	3-Methylch ol anthrene	N-Nitroso diphenyl amine	Hexa chloro cyclo penta diene	Butanoic acid	Chloroiodo methane	Cholesterol	Cyclic Hydro carbon
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
3-1 0-1 , 3-1 2-3 *	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<0.50	<0.50	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<0.50	<0.50	NA	NA	0.4 2	0.21
3-1 5-7	<2.6	<2.6	<2.6	<2.6	<2.6	<2.6	<2.6	<0.52	<0.52	<2.6	<2.6	<2.6	<2.6	<2.6	<2.6	<0.52	<0.52	NA	NA	NA	NA
3-1 9-11	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<0.57	<0.57	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<0.57	<0.57	0.17 2	NA	NA	NA
3-1 19-21	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<0.50	<0.50	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<0.50	<0.50	NA	NA	NA	NA
3-1 29-31	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<0.50	<0.50	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<0.50	<0.50	NA	NA	NA	NA
3-1 47-49																					
5-3 0-1	<5.5	<5.5	<5.5	<5.5	<5.5	<5.5	<5.5	<1.1	<1.1	<5.5	<5.5	<5.5	<5.5	<5.5	<5.5	<1.1	<1.1	NA	NA	0.49 2	NA
6-1 0-1	<17	<17	<17	<17	<17	<17	<17	<3.5	<3.5	<17	<17	<17	<17	<17	<17	<3.5	<3.5	NA	NA	NA	NA
7-2 0-1	<26	<26	<26	<26	<26	<26	<26	<5.1	<5.1	<26	<26	<26	<26	<26	<26	<5.1	<5.1	NA	NA	NA	NA
6-1 0-1 , 8-1 1-2 *	<3.4	<3.4	<3.4	<3.4	<3.4	<3.4	<3.4	<0.68	<0.68	<3.4	<3.4	<3.4	<3.4	<3.4	<3.4	<0.68	<0.68	NA	0.21 2	0.52 2	NA
8-1 2-3 , 8-1 3-4 *	<1.7	<1.7	<1.7	<1.7	<1.7	<1.7	<1.7	<0.34	<0.34	<1.7	<1.7	<1.7	<1.7	<1.7	<1.7	<0.34	<0.34	NA	0.21 2	0.46 2	NA
8-1 5-7	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<0.50	<0.50	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<0.50	<0.50	NA	NA	NA	NA
8-1 9-11	<2.6	<2.6	<2.6	<2.6	<2.6	<2.6	<2.6	<0.51	<0.51	<2.6	<2.6	<2.6	<2.6	<2.6	<2.6	<0.51	<0.51	NA	NA	NA	NA
6-1 19-21	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<0.48	<0.48	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<0.48	<0.48	NA	NA	NA	NA
8-1 29-31																					
8-1 41-43																					
10-4 0-1	<25	<25	<25	<25	<25	<25	<25	<5.0	<5.0	<25	<25	<25	<25	<25	<25	<5.0	<5.0	NA	NA	NA	NA
11-4 0-1	<6.7	<8.7	<8.7	<8.7	<8.7	<8.7	<8.7	<1.7	<1.7	<8.7	<8.7	<8.7	<8.7	<8.7	<8.7	<1.7	<1.7	NA	NA	NA	NA
Spikes																					
3-1 9-11 MS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA				
3-1 9-11 SD	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA				

J = Result is detected below reporting limits or is an estimated concentration.
1 = Tentative Identification, order of magnitude estimate.
2 = Confident Identification, order of magnitude estimate.
3 = Possible artifact of analysis
q = this sample has GC/FID characteristics for which reliable identification of a product could not be achieved.
1(with q) = Sample resembles a hydrocarbon product occurring within the n-alkane range of C12-C28.
x = Target compound's secondary ion confirmation criteria not met, but retention time and peak shape make Identification possible.
<-- Less than reportig limit and analyte present in the blank.
NA = Not analyzed
MS = Matrix spike
SD = Spike duplicate
* = *Composite sample from 2 depth intervals.*
** Concentrations of a compound for which there were no similar library spectra, and assignment to a particular class of compounds was not possible.

Appendix Table E Continued. Concentrations of all other organic compounds (wet weight basis) determined on sediment samples from the EPA reference site on the Continental Slope near the Farallon Islands.

Core ID and Depth Interval (cm)	Hex anedioic acid, bis(2-ethylhex yl)^este	Nonanamide	Octa decanamide	9- Octa decenamide,(Z)-	Oxygen ated Hydro carbon	Pentan amide, 4-methyl	Saturated Hydro carbon: C10-C20	Siloxane(3)	Sterol	unknown**	Vitamin E	Diesel Range Organics
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
3-1 0-1 , 3-1 2-3 *	NA	NA	NA	NA	0.23	NA	0.2	NA	0.37	0.14	0.29 2	7.6 q1
3-1 5-7	NA	NA	NA	NA	0.15	NA	NA	NA	0.14	NA	0.2 2	
3-1 9-11	0.21 2	NA	NA	NA	0.27	NA	NA	0.16	NA	NA	NA	
3-1 19-21	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
3-1 29-31	NA	NA	NA	NA	NA	NA	NA	0.14	NA	NA	NA	3 J
3-1 47-49												
5-3 0-1	NA	NA	NA	NA	0.34	NA	NA	NA	0.91	0.34	0.42 2	
6-1 0-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	<44
7-2 0-1	NA	NA	NA	NA	NA	NA	NA	1.7	NA	NA	NA	
8-1 0-1 , 6-1 1-2 *	NA	NA	NA	NA	0.91	NA	NA	NA	0.59	0.24	0.49 2	21 q1J
8-1 2-3 , 8-1 3-4 *	NA	NA	NA	NA	0.33	NA	NA	NA	0.19	NA	0.41 2	21 q1
8-1 5-7	NA	NA	NA	0.28 2	NA	NA	NA	NA	NA	NA	NA	
8-1 9-11	NA	NA	NA	0.4 2	NA	2.1 1	NA	NA	NA	NA	NA	
8-1 19-21	NA	NA	0.22 2	0.64 2	NA	3.1 1	NA	NA	NA	NA	NA	6 q1
8-1 29-31												
8-1 41-43												
10-4 0-1	NA	2.9 1	3.6 2	11 2	NA	48 1	NA	NA	NA	NA	NA	
11-4 0-1	NA	NA	0.51 2	1.6 2	NA	8.1 1	NA	NA	NA	NA	NA	
Spikes												
3-1 9-11 MS												
3-1 9-11 SD												

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3 = Possible artifact of analysis
q = this sample has GC/FID characteristics for which reliable identification of a product could not be achieved.
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x = Target compound's secondary Ion confirmation criteria not met, but retention time and peak shape make Identification possible.
<-- Less than reportig limit and analyte present in the blank.
NA = Not analyzed
MS = Matrix spike
SD = Spike duplicate
* = Composite sample from 2 depth intervals.
** Concentrations of a compound for which there were no similar library spectra, and assignment to a particular class of compounds was not possible.

Appendix Table E Continued. Concentrations of all other organic compounds (wet weight basis) determined on sediment samples from the EPA reference site on the Continental Slope near the Farallon Islands.

Core ID and Depth Interval (cm)	Naphthalene	Acenaph thylene	Acenaph thene	Fluorene	Phen anthrene	Anthracene	Fluor anthene	Pyrene	Benzo(a) anthracene	Chrysene	Benzo(b) fluor anthene	Benzo (k)fluor anthene	Benzo(a) pyrene	Dibenz (a,h) anth racene	Benzo (g,h,i) perylene	Indeno (1,2,3-cd) pyrene	Water
	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	%
3-1 0-1 , 3-1 2-3 *	<20	<20	<20	<20	3 J	<20	3.5 J	3.7 J	<20	<20	3.5 J	<20	<20	<20	2.7 J	<20	40
3-1 5-7	<20	<20	<20	<20	2.3 J	<20	3.5 J	4 J	<20	<20	3.4 J	<20	2.1 J	<20	2.7 J	<20	38
3-1 9-11	<10	<10	<10	<10	2 J	<10	1.1 J	1.4 J	<10	<10	1.6 J	<10	<10	<10	1.3 J	<10	36
3-1 19-21	<10	<10	<10	<10	4.7 J	<10	<10	1.4 J	1 J	<10	1.6 J	<10	<10	<10	<10	<10	35
3-1 29-31	<20	<20	<20	<20	2.6 J	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	54
3-1 47-49																	39
5-3 0-1	<20	<20	<20	<20	<20	<20	2.5 J	2.6 J	<20	<20	2.7 J	<20	<20	<20	2.1 J	<20	56
6-1 0-1	<20	<20	<20	<20	<20	<20	2.6 J	3.1 J	<20	<20	2 J	<20	<20	<20	<20	<20	41
7-2 0-1	<20	<20	<20	<20	2.1 J	<20	2.7 J	3.1 J	<20	<20	2.3 J	<20	<20	<20	<20	<20	67
8-1 0-1 , 8-1 1-2 *	<20	<20	<20	<20	5.7 J	4.9 J	5.3 J	5.9 J	2.4 J	4.4 J	4.9 J	<20	3.3 J	<20	3.5 J	2.4 J	56
8-1 2-3 , 8-1 3-4 *	<20	<20	<20	<20	5.9 J	<20	5 J	5.6 J	<20	2.3 J	4.7 J	<20	2.8 J	<20	3.5 J	2.6 J	44
8-1 5-7	<20	<20	<20	<20	2.5 J	<20	3.2 J	3.7 J	2.5 Jx	3.2 J	5.2 J	<20	2.8 J	<20	3.7 J	2.5 J	45
8-1 9-11	<20	<20	<20	<20	3.1 J	<20	2.3 J	2.9 J	<20	<20	2.7 J	<20	<20	<20	2.1 J	<20	41
8-1 19-21	<20	<20	<20	<20	2.7 J	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	41
8-1 29-31																	33
8-1 41-43																	32
10-4 0-1	<20	<20	<20	<20	5 J	<20	3 J	3.2 J	<20	2.1 J	3.1 J	<20	<20	<20	2.2 J	<20	62
11-4 0-1	<20	<20	<20	<20	7.2 J	<20	3.4 J	4.1 J	<20	2.1 J	3.1 J	<20	<20	<20	2.9 J	<20	56
Spikes																	
3-1 9-11 MS	3.9	NA	NA	4	NA	NA	NA	NA	NA	5	NA	NA	NA	NA	NA	NA	
3-1 9-11 SD	8.3	NA	NA	3.8	NA	NA	NA	NA	NA	4.6	NA	NA	NA	NA	NA	NA	

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SD = Spike duplicate
* = Composite sample from 2 depth intervals.
** Concentrations of a compound for which there were no similar library spectra, and assignment to a particular class of compounds was not possible.

Appendix Table F. Concentration (% dry weight basis) of organic carbon, carbonate carbon, total carbon, hydrogen and nitrogen.

Core ID and Depth Interval(cm)	Lab ID	Organic C	Carbonate C	Carbon	Hydrogen	Nitrogen
3-1 0-1	48774-01	1.22	0.11	1.33	0.67	0.16
3-1 2-3	48774-10	1.22	0.10	1.32	0.56	0.17
3-1 5-7	48774-02	1.18	0.06	1.24	0.52	0.15
3-1 9-11	48774-03	1.05	0.04	1.09	0.58	0.13
3-1 19-21	48774-04	1.49	0.33	1.82	0.80	0.15
3-1 29-31	48774-05	0.99	0.02	1.01	0.65	0.12
3-1 47-49	48774-06	0.81	0.21	1.02	0.62	0.09
5-3 0-1	48774-07	1.55	0.15	1.70	0.69	0.20
6-1 0-1	48774-08	1.46	0.11	1.57	0.75	0.17
7-2 0-1	48774-09	1.94	0.18	2.12	0.82	0.25
8-1 0-1	48774-11	1.91	0.18	2.09	0.80	0.24
8-1 1-2	48774-23	1.83	0.21	2.04	0.80	0.24
8-1 2-3	48774-12	1.85	0.17	2.02	0.78	0.25
8-1 3-4	48774-24	1.93	0.18	2.11	0.79	0.24
8-1 5-7	48774-13	1.78	0.14	1.92	0.76	0.22
8-1 9-11	48774-14	1.60	0.11	1.71	0.69	0.19
8-1 19-21	48774-15	1.48	0.09	1.57	0.69	0.19
8-1 29-31	48774-16	1.25	0.03	1.28	0.60	0.15
8-1 41-43	48774-17	1.05	0.02	1.07	0.56	0.14
10-4 0-1	48774-18	1.62	0.16	1.78	0.74	0.20
11-4 0-1	48774-19	1.42	0.10	1.52	0.68	0.17
Standards						
MESS-1	48774-20	2.88	<0.02	2.88	0.72	0.19
BCSS-1*	48774-21	2.13	0.06	2.19	0.70	0.21
PACS-1	48774-22	3.50	0.10	3.60	1.00	0.30

*BCSS-1 was submitted as a blind standard.