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Final Reports of Principal Investigators

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Bronson, M. T. 1988. Trace contaminants in the greater St. George Basin: a statistical review. U.S. Dep. Commer., NOAA, OCSEAP Final Rep. 69: 101–203.

Bronson, M. T. 1989. Mercury in Alaska marine surface sediments: a review of the regional data. U.S. Dep. Commer., NOAA, OCSEAP Final Rep. 69: 205–225.

Robertson, D. E., and K. H. Abel. 1979. Natural distribution and environmental background of trace heavy metals in Alaskan shelf and estuarine areas. U.S. Dep. Commer., NOAA, OCSEAP Final Rep. 69: 227–419.

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Anchorage, Alaska

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The content of these reports has not been altered from that submitted by the Principal Investigators. In some instances, grammatical, spelling, and punctuation errors have been corrected to improve readability; some figures and tables have been enhanced to improve clarity in reproduction.

Outer Continental Shelf Environmental Assessment Program

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TRACE CONTAMINANTS IN SURFACE SEDIMENT OF THE NORTHERN BERING SEA: A STATISTICAL REVIEW

by

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ABSTRACT

Data are presented for concentrations of nine trace elements and three hydrocarbon measures in surface sediment of the northern Bering Sea from past research reports. Further graphs, maps, and analyses are based on the original data compiled in an appendix.

Statistical summaries indicate means and confidence intervals for twelve normally distributed samples. Contour maps illustrate geographic variation within samples from six investigations. Correlation analyses also indicate the extent to which normalizing variables account for variation in six of the contaminants.

Statistical tests reveal that cadmium, copper, and mercury concentrations in the area near Nome differ significantly between investigations, but zinc does not. Arsenic, barium, and chromium levels differ between the Nome area and the remainder of Norton Basin.

The original research reports themselves are catagorized on the basis of sponsoring program, quantity of raw data, and sampled material.

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INTRODUCTION

As the northern Bering Sea is leased for mineral extraction, the monitoring of marine pollution will take on increasing importance. Those charged with detecting pollution from the proposed development will find that some past research will be valuable for measuring later changes in contaminant levels in the area. This report compiles the results of research on trace elements and organic contaminants in surface sediment of the northern Bering Sea and draws contrasts between areas and among investigations.

METHODS

I tabulated the numerical values in reports of trace elements and organic contaminants in surface sediment of the American Bering Sea north of 63 degrees latitude. The area conforms to the Norton Basin lease planning area and includes Norton Sound and Norton Basin, as well as the continental shelf west to the international boundary and north to the Bering Strait. I did not consider data from sea-floor sediment deeper than 10 cm.

All the chemical concentrations and ancillary information reflected in the figures and summary tables of this review can be found in tables in Appendix B. The data in the tables of the appendix were extracted, without corrections, from tables in the original published research reports.

I wrote the appendix tables as Lotus 1-2-3 spreadsheets, selecting the variables of interest from the original reports. For statistics and frequency histograms, the data matrix of each spreadsheet was imported to Complete Statistical System (CSS), a commercial application for use on IBM personal computers.

Frequency distributions, shown as histograms, were drawn with CSS-Intergraph. In the graphs, the Y axes denote the number of sediment specimen sites. The X axes' labels denote the upper boundaries of the frequency intervals.

For statistical analyses, chemical concentrations below the lower detection limit were assigned the value of the lower detection limit. For example, I omitted the less-than sign from a datum such as <.005 ppm, and used .005 for subsequent calculations. This practice results in an estimate of the mean biased toward larger values and an estimate of the dispersion biased toward smaller values. These biases are strongest for contaminants whose concentrations are low and therefore close to the lower detection limit. This alternative, however, avoids a high frequency of occurrence in the "zero ppm" class, thereby making samples much more tractable for statistical comparisons.

I tested each analyte in each table for normality of its frequency distribution. Each of these statistical samples was subjected to t-tests for skewness and kurtosis. Those

data found with dispersions significantly different from a normal distribution were transformed logarithmically to create a sample distribution closer to normal and more amenable to parametric treatment. Confidence intervals were calculated only for arithmetic or log-transformed distributions whose skewness and kurtosis were not significantly different from a normal distribution at the .05 level of probability. The 95% confidence limits were defined as plus or minus two standard errors of the mean.

Concentrations are expressed in parts per million on a dry weight basis unless otherwise noted.

All the data reviewed here were taken at face value from original reports. I made no assumptions regarding the appropriateness of collecting, storage, or laboratory methods. I did not evaluate the accuracy of the data and did not select data on the basis of quality.

RESULTS

Arsenic

Rusanowski, et al (1988) reported arsenic concentrations in surface sediment near Nome greater than concentrations reported for Norton Sound in general by Robertson and Abel (1979). Table 1 shows the geometric mean of arsenic closer to Nome, calculated from transformations of the values provided by Rusanowski, et al (1988). The

Table 1. Means of trace element concentrations (ppm dry weight) in surface sediment near Nome, using tabular data in Rusanowski, et al (1988) which fit a normal distribution. The geometric means are calculated from sample distributions made normal by log transformation. Each element is represented by 22 samples, except nickel with 19 samples, collected in 1985, 1986, and 1987 near the Bima dredge.

Element	Arith. mean	Geom. mean	95% conf. limits low	high
As		31.84	19.81	51.18
Cd		1.76	1.15	2.69
Cr		15.95	12.13	20.97
Cu		18.45	12.85	26.51
Hg		0.0167	0.0093	0.0298
Ni	39.09		29.20	48.98
Pb		8.83	5.76	13.54
Zn	65.62		54.42	76.82

original values are transformed lognormally because they differed significantly from a normal distribution. A two-tailed t-test for a difference in the means, using degrees of freedom modified for variances which are unknown and unequal, is significant ($t'=4.19$, $df=25$, $P<.005$). The arithmetic mean arsenic concentration of Robertson and Abel's six specimen means is 10.88 ppm dry weight, with a 95% confidence interval from 7.012 to 14.755 ppm. The sampling locations of Robertson and Abel (1979) are shown in Figure 1.

Such comparisons of the values of Robertson and Abel (1979) to other reports are questionable, however. Parametric methods require assumptions about the dispersion of the sample frequency distributions. Robertson and Abel (1979) report means rather than individual determinations, and they give no indication of the sample sizes or frequency distributions within each grab specimen. For this report, I assumed that the specimen means that Robertson and Abel (1979) reported were arithmetic means of normally distributed data.

The sampling locations reported by Robertson and Abel (1979) for Norton Sound are illustrated in Figure 1. The frequency histograms of arsenic concentrations near Nome reported by Rusanowski, et al (1988) are shown in Figures 2 and 3, for arithmetic and log-transformed values respectively. The sampling locations described by Rusanowski, et al (1988) are shown in Figure 28.

In the case of arsenic, as for all other analytes which they report, Rusanowski, et al (1986, 1987, 1988) and Northern Technical Services (NORTEC) (1985) do not specify the depth of the sediment grabs. For this report, therefore, I assumed that the grab technique itself did not result in sampling of analyte statistical populations which were different than those of the other investigators.

Barium

Barium concentrations in the northern Bering Sea differ little between the studies of Robertson and Abel (1979) and Larsen, et al (1980). The concentrations all fall within a range of less than one order of magnitude, as shown in Figures 1 and 4. The arithmetic mean of barium based on Robertson and Abel's six cores is 484.3 ppm dry weight, with a 95% confidence interval from 229.1 to 739.5 ppm.

Both of these investigations indicate barium concentrations about two times greater than the concentrations reported by Sharma (1979) from the same region.

Nevertheless. the geographic variation of Larsen's barium concentrations (Fig. 4) follow a pattern not unlike that of Sharma (1979: Fig. 10-32). No tabular data are offered in either report to allow a test of the significance of this difference.

Cadmium

For the area near Nome, Sharma (1974) reported cadmium concentrations greater than those reported by Rusanowski, et al (1988). Figure 5 shows geographic distribution of the cadmium levels of Sharma (1974) and Figures 6,7, and 8 show frequency distributions of Sharma's data. Figures 6, 9 and 10 show frequency distributions of Rusanowski's data.

Because Sharma's data are not normally distributed, they are compared to Rusanowski's data using a non-parametric method. A Kolmogorov-Smirnov test (Table 2) indicates that the underlying statistical populations of cadmium are independent, and that the two investigators did not measure the same thing.

Rusanowski's cadmium levels are summarized by their geometric mean and confidence limit in Table 1.

Nearly half of the variation in Rusanowski's cadmium levels is explained by variation in the percentage of solids in the grab samples, as shown in Table 3. A relationship between grain size and concentration is expected for many trace chemicals in sediment.

Chromium

The Norton Sound sample of Robertson and Abel (1979) reflects chromium concentrations significantly greater than those sampled at Nome by Rusanowksi, et al (1988), according to a two-tailed t-test on log-transformed data ($t=5.75$, $df=26$, $P<.0005$).

The arithmetic mean and confidence interval of chromium levels in Norton Basin are 79.67 ppm dry weight, and 60.49 to 98.87 ppm, respectively, based on the six specimens of Robertson and Abel (1979). See Figure 1 for grab locations.

The geometric mean and confidence interval of chromium levels at Nome are shown in Table 1 (Rusanowski, et al 1988). These chromium values are somewhat affected by percentage solids, as determined from correlation analysis (Table 3). See Figures 11 and 12 for frequency histograms of the sample.

Copper

Rusanowski's copper levels are significantly greater than those of Sharma (1974), according to a Kolmogorov-Smirnov test (Table 2). Geographic distribution in the copper concentrations measured by Sharma (1974) is shown in Figure 13. The sample frequency histograms are shown in Figures 14, 15, 16 and 17. The difference between the two samples is displayed in Figure 18.

Sharma's copper concentrations are affected by organic carbon in the grab samples, as shown in Table 3. However, none of Sharma's three metals are significantly affected by grain size. Moreover, none conforms to a normal

Table 2. Kolmogorov-Smirnov tests of metals concentrations (ppm dry weight) in northern Bering Sea surface sediment, at .05 level of significance.

The null hypotheses are that sample pairs are drawn from the same statistical populations. Statistical significance is the result of large sample differences in either the "location" or "shape" of the frequency distributions, or both.

Element	Name of sample	N	Arith. mean	SD	Significant difference
Cd	Rusanowski (1988)	22	3.650	7.868	Signif.
	Sharma (1974)	19	5.492	2.679	
Cu	Rusanowski (1988)	22	23.98	14.08	Signif.
	Sharma (1974)	19	15.37	11.45	
Hg	Nelson near Nome	28	.0320	.0246	Signif.
	Rusanowski near Nome	22	.0351	.0401	
Hg	Nelson not near Nome	94	.0371	.0335	NS
	Nelson near Nome	28	.0320	.0246	
Zn	Rusanowski (1988)	22	65.62	25.66	NS
	Sharma (1974)	19	84.00	84.16	

Table 3. The proportion of variation in Norton Basin sediment trace contaminant concentrations (ppm dry weight) explained by normalizing variables. The proportion of explained variation is the adjusted R-squared for correlation coefficients found significant at the .05 level.

Data report and normalizer		Analyte	Adjusted R-squared
Rusanowski, et al (1988)	% solids	Cd, ppm	.472
		Cr, ppm	.255
		Cu, ppm	.281
		Hg, ppm	.338
		Zn, ppm	.257
Sharma (1974)	% wt. non-carbonate carbon	Cu, ppm	.387
		Zn, ppm	.527
Kaplan, et al (1979)	% organic carbon	Aliphatic hydrocarbons	.113

distribution even after correcting for the affect of organic carbon.

Lead

Lead concentrations in surface sediment near Nome are reported by Rusanowski, et al (1988) and are summarized in Table 1. Frequency histograms of the sample distribution, as arithmetic and as log-transformed values, are shown in Figures 19 and 20.

Sharma (1974) reported that lead was not detectable.

Mercury

Nelson, et al (1972) and Rusanowski, et al (1988) sampled mercury populations near Nome which differed greatly in their variances but little in their means. The subset of 28 values of Nelson, et al (1972) near Nome has a geometric mean of .0274 ppm with a 95% confidence interval of .0223 to .0338 ppm. A two-tailed t-test, using log-transformed values and degrees of freedom modified for unequal variances, showed no significant difference in the means of Nelson's and Rusanowski's mercury concentrations near Nome ($t'=1.65$, $df=16$). However, F-tests based on log-transformed values indicate a significant difference between the variances ($F=6.09$; $P<.001$). Similarly, a Kolmogorov-Smirnov test on untransformed values shows that the two samples were from statistical populations characterized by distinctly different dispersions (Table 2).

Figures 21-25 show the frequency distributions of the two samples from the area near Nome. Table 1 summarizes Rusanowski's mercury concentrations.

Offshore Nome

The highest mercury levels in the Nome area appear near Penny River. Geographic distribution in the subset of the concentrations measured by Nelson, et al (1972) near Nome is shown in Figure 26. Figures 27 and 28 give close views of the Penny River area and the mercury samples of Nelson, et al (1972) and Rusanowski, et al (1988), respectively.

For purposes of detecting changes in mercury concentrations, Nelson's sample has more statistical power. Statistical power is the probability of rejecting a hypothesis of no difference when there is a true difference. Statistical power is calculated as 1 minus beta, the probability of rejecting an alternative hypothesis of a difference when the hypothesis is true. Applying such a calculation, it is found that Nelson's log-transformed sample can detect differences in means equal to its standard deviation of 0.54 ppm approximately 95% of the time, using a two-tailed t-test. However, Rusanowski's standard deviation

is large enough that the sample size would have to exceed 100 to detect that difference at that high rate.

Nelson basin-wide

Views of Nelson's sampling locations and mercury concentrations over the northern Bering Sea are shown in Figures 29 and 30. The extensive sampling by Nelson, et al (1972) yielded mercury exceeding 0.10 ppm dry weight only at two points, a station near Penny River and a station 40 km north of the Yukon River delta.

The frequency distribution of Nelson's samples are shown in Figures 31 and 32. Log normal transformation of the original ppm values resulted in a distribution not significantly different from normal. The geometric mean and its 95% confidence interval calculated for this regional sample are .0269 ppm, and .0234 to .0308 ppm, respectively.

Nelson's sampling shows no significant difference between mercury levels near Nome and mercury levels in the remainder of the northern Bering Sea study area (Table 2).

These mercury data are discussed further by Nelson, et al (1975, 1977) and Patry, et al (1977).

Nickel

Rusanowski's research reports are the only published source of raw data on nickel concentrations in the region (Rusanowski, et al, 1986, 1987, 1988). Summary statistics for nickel are presented in Table 1. Figures 33 and 34 show the frequency histograms.

Zinc

No significant difference in the zinc concentrations sampled near Nome by Sharma (1974) and Rusanowski, et al (1988) is indicated by a Kolmogorov-Smirnov test (Table 2). Such pairs of samples which do not lead to a rejection of the null hypothesis of no difference may be combined as a single sample for analytical purposes.

Frequency histograms for both samples are presented in Figures 35-39. Rusanowski's data are summarized in Table 1.

More than half of the variation in the zinc sampled by Sharma (1974) is explained by differences in organic carbon concentrations in the grab samples (Table 3). Zinc concentrations vary widely among locations near Nome, but show no regular pattern (Figure 40).

Acid-extractable concentrations

Burrell (1977, 1978) reported acid-extractable concentrations of six elements in surface sediment of Norton Sound. His data reflect trace contaminants from the soluble fraction of the sediment, unlike the other studies which examine the whole-rock fraction. Burrell's concentrations

are therefore not directly comparable to those of the other studies.

The sampling stations of Burrell (1977, 1978) are mapped in Figure 41. The geographic variations in the concentrations of three trace elements are depicted in Figures 42-44. Cadmium concentrations reported by Burrell (1977, 1978) are as high as the lower detection limit at only one station. Thus, cadmium is not mapped here.

Hydrocarbons

Published tabular data on trace levels of hydrocarbons in the northern Bering Sea are available from Kaplan, et al (1979, 1980), Kaplan and Venkatesan (1981), and Venkatesan, et al (1981).

Geographic variation of total n-alkanes, the odd-to-even ratio of n-alkanes, and the ratio of aliphatics plus aromatics to total organic carbon is shown in Figures 45-47. These variables are common indexes of hydrocarbon levels.

Table 4 displays statistical summaries of three major hydrocarbon indexes and a normalizing variable. Geometric means and confidence intervals are calculated after log transformation.

The concentration of aliphatic hydrocarbons in surface sediment is significantly affected by the percentage of organic carbon based on a regression analysis (P=.034). The adjusted R-squared shows that only 11% of the the variation is explained by percentage organic carbon, a minor affect (Table 3).

The frequency histograms of the major hydrocarbon variables are illustrated in Figures 48-57.

Table 4. Geometric means of hydrocarbon concentrations in northern Bering Sea surface sediment, based on data in Kaplan, et al (1979, 1980). The geometric means and their confidence intervals are calculated from distributions made normal by log transformation.

Analyte	N	Geom. mean	95% conf. limits low	high
% organic carbon	48	.5635	.4745	.6692
aliphatics, ppm	49	3.771	2.861	4.973
aromatics, ppm	48	2.088	1.624	2.684
n-alkanes, ppm	37	41.86	12.08	145.1

Two patterns emerge from these comparisons.

First, the independent investigations sometimes reported different mean levels for the same analytes from the same areas. Statistically significant differences between studies were found for the frequency distributions of cadmium, copper and mercury within the area near Nome. Although the mean levels of mercury near Nome estimated by two studies cannot be considered different, the variances were different, indicating that two independent mercury populations were investigated there. For the region as a whole, mean barium concentrations differed between one pair of studies and a third investigation.

In addition, arsenic and chromium levels differed between areas sampled by independent investigations.

Such discrepencies may represent real variation in the concentrations of analytes in sediment, or they may be the result of methodological differences between research programs which are not apparent in the reports.

The second conclusion is that the samples vary in their suitability for detecting trends.

For example, some research efforts in the northern Bering Sea have resulted in extensive contour mapping of trace metals. Such work is reported by Larson, et al (1980), Nelson, et al (1975), Nelson (1977), and Sharma (1978). In these reports, the original individual data are reduced to isolines to depict continuous geographic trends in chemical concentrations across the region. However, these reports preclude statistical treatment.

Sample data from other reports, although unreduced and allowing some statistical analysis, cannot be treated by parametric methods simply because their frequency distributions are not normal and cannot be made normal by transformation. For example, the concentrations of Sharma (1974) cannot provide the variance estimates necessary for calculating the precision of the analyte means.

Some of the data, however, are amenable to more rigorous comparisons. For example, confidence intervals and multivariate relationships can be calculated for mercury, hydrocarbon indexes, and all the elements measured by Rusanowski, et al (1988) because the samples do not differ significantly from normal frequency distributions. In addition, samples of large size or narrow dispersions, or both, offer the greatest power in detecting differences. Samples with these characteristics provide the strongest basis for measuring variation among investigations, among study areas, and over time.

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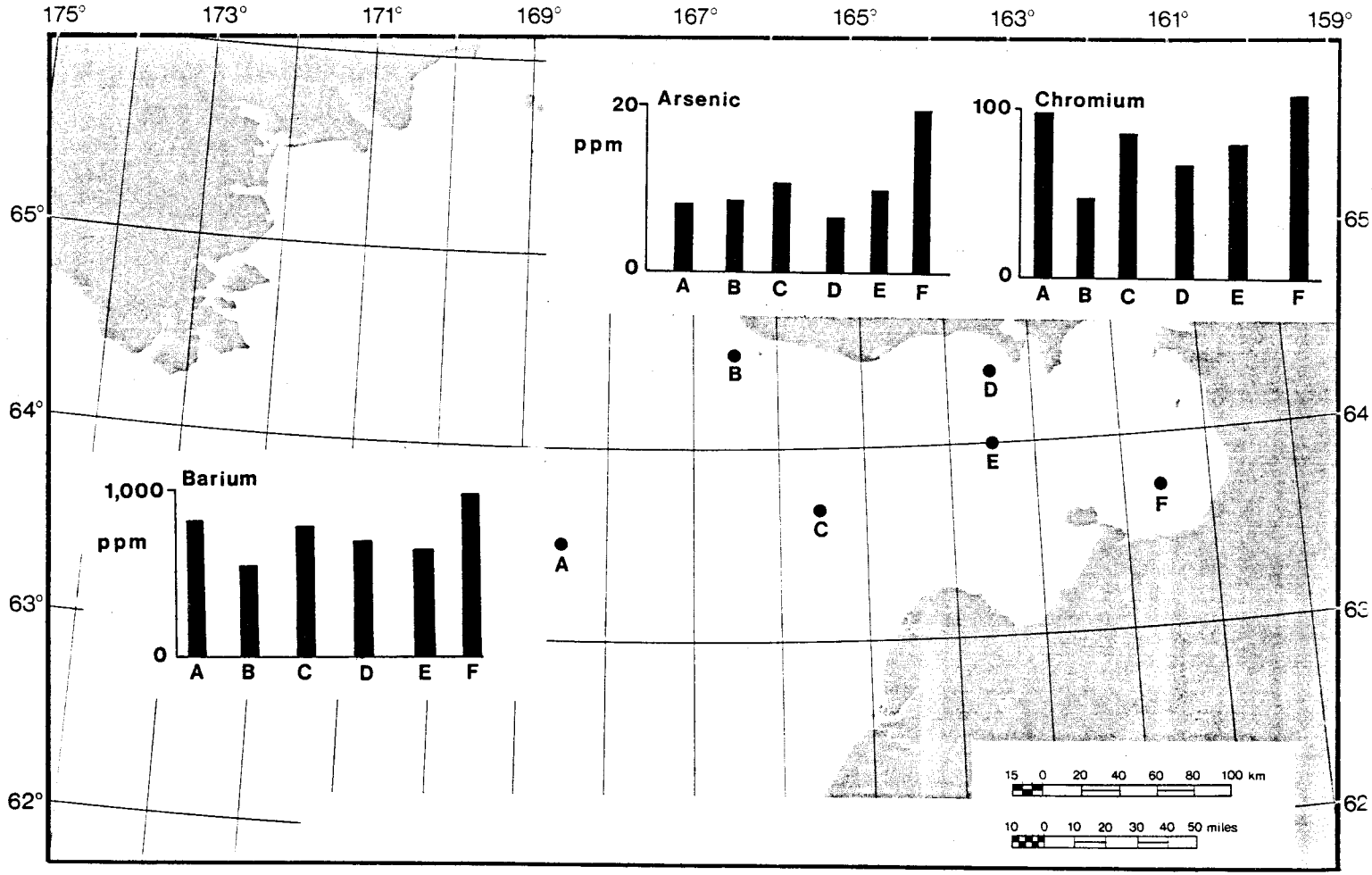

Fig. 1. Mean concentrations of arsenic, barium, and chromium in surface sediment 0-2cm at six HAPS core stations, 1976, in ppm, dry weight. Adapted from Robertson and Abel (1979: Table C.4 and C.5).

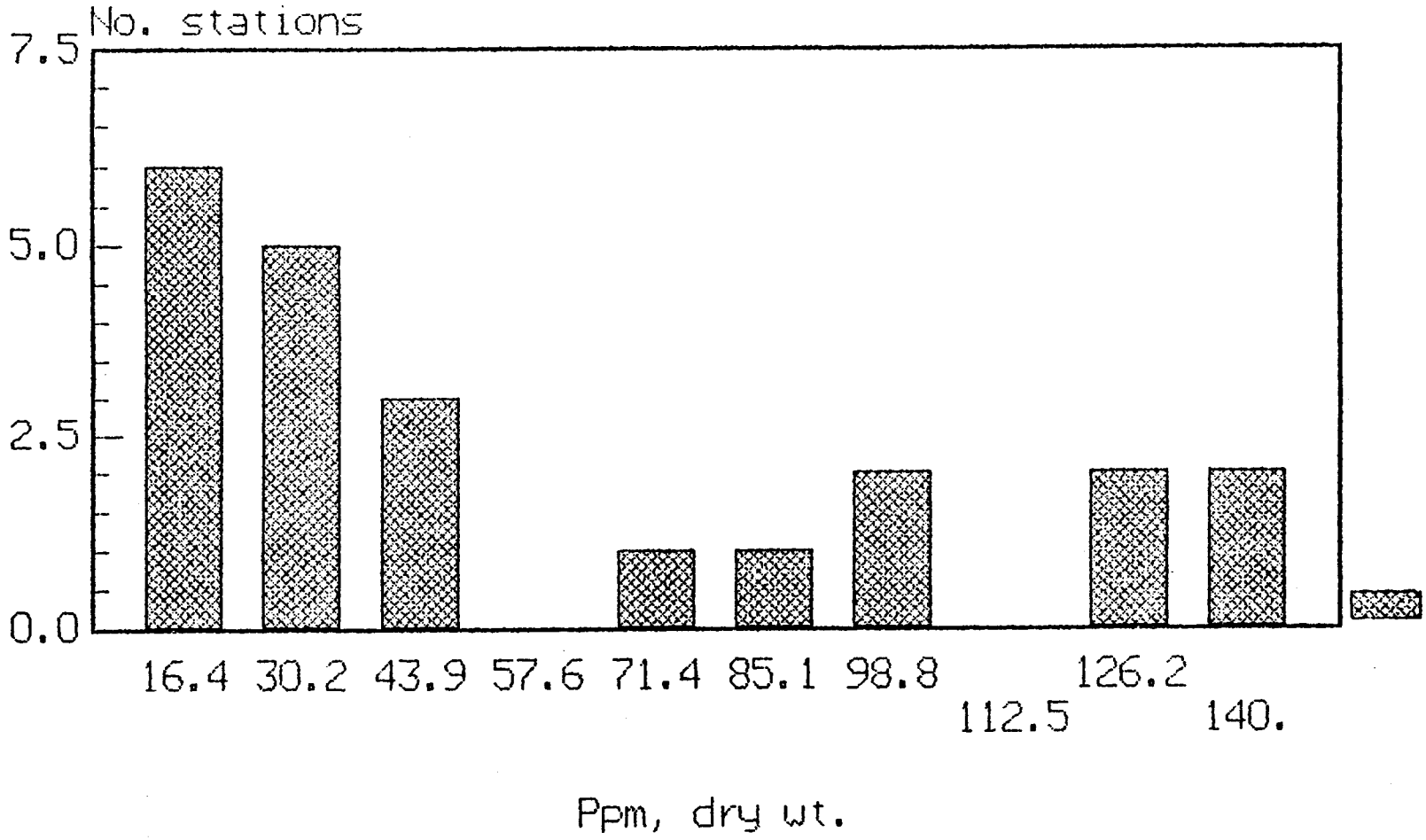

Fig. 2. Arsenic in surface sediment at 22 stations near Nome. Based on Rusanowski, et al (1988).

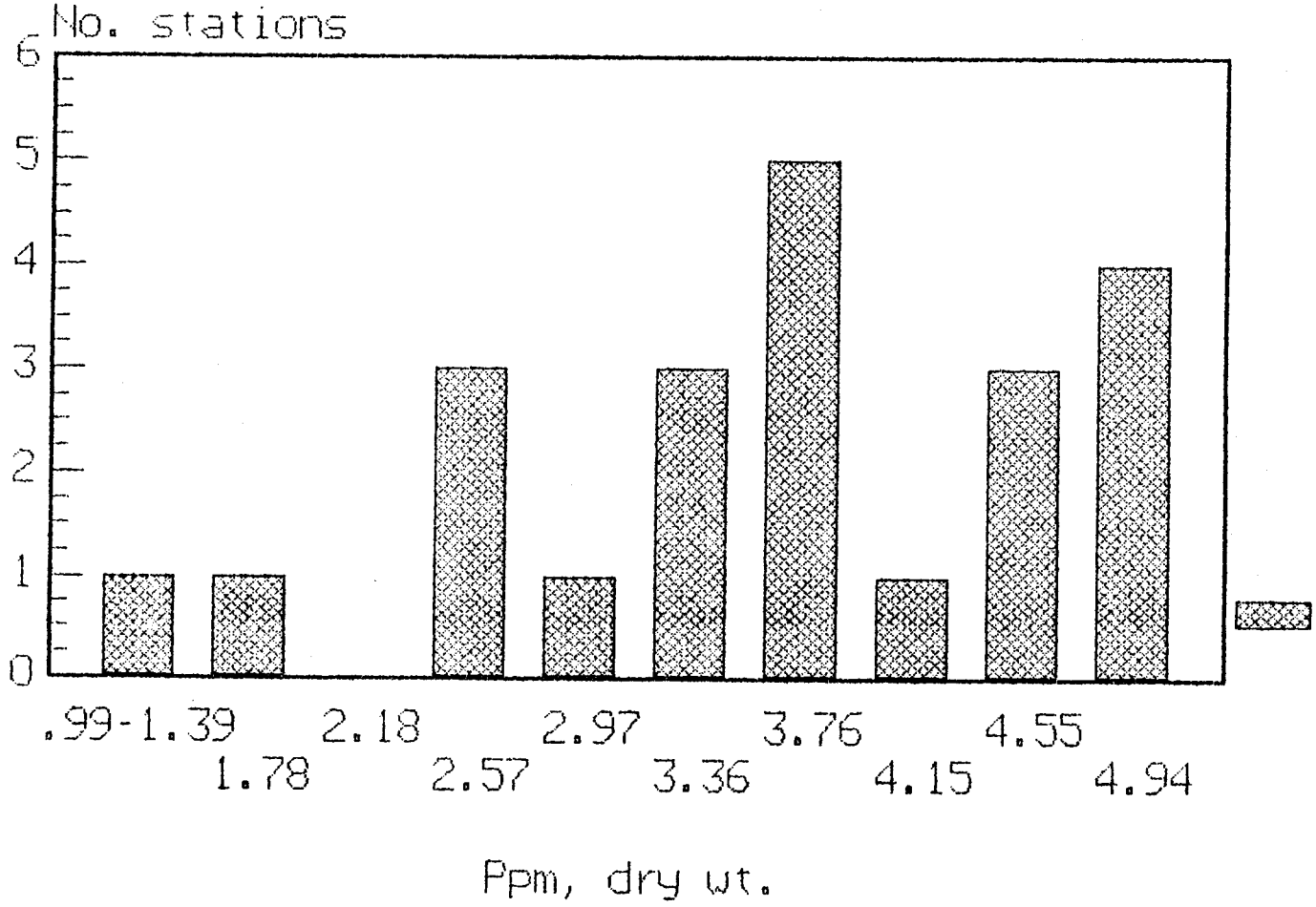

Fig. 3. Log normal of arsenic in surface sediment at 22 stations near Nome. Based on Rusanowski, et al (1988).

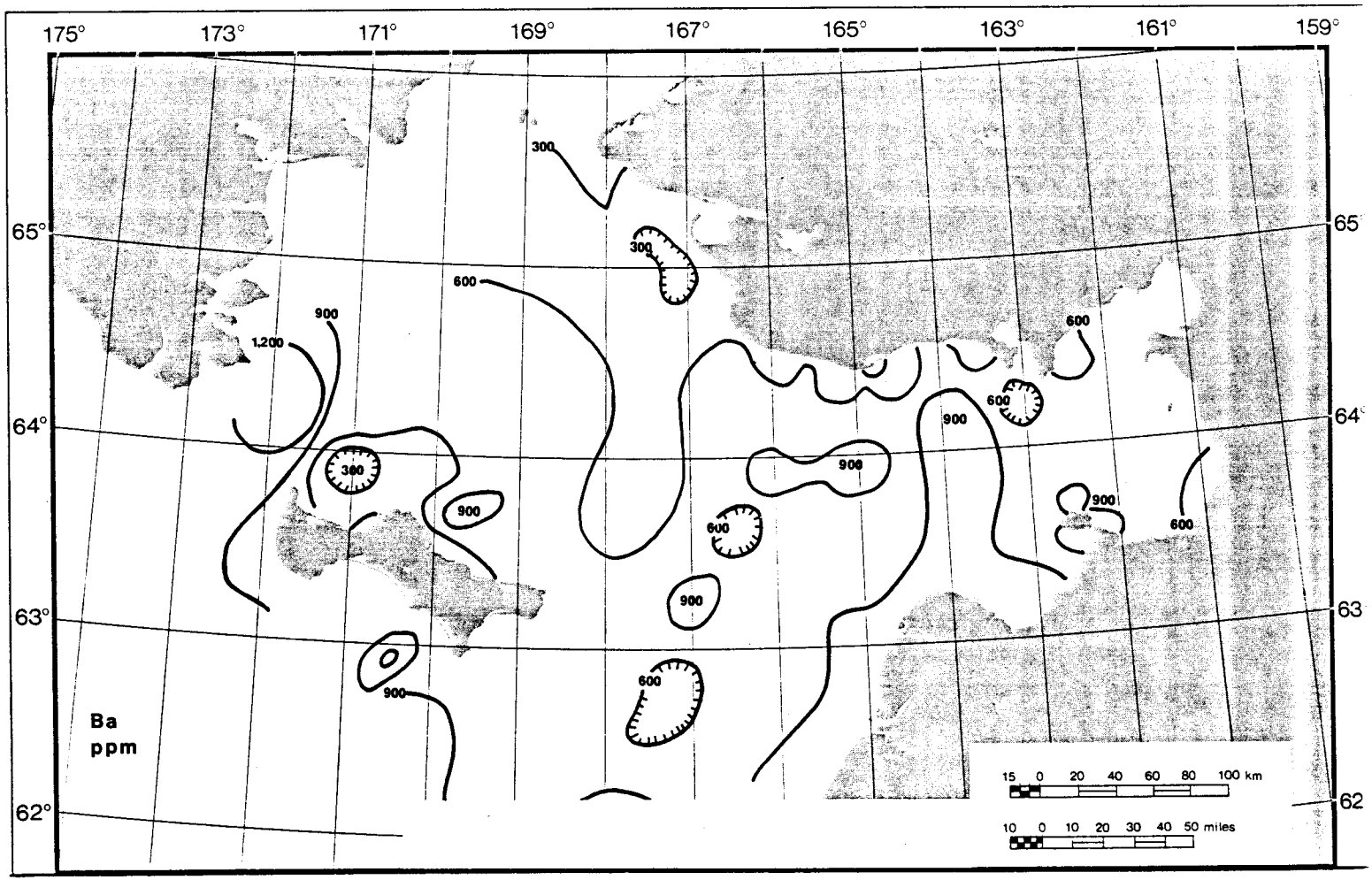

Fig. 4. Barium concentration in surface sediment, 0-10cm, based on 180 van Veen and Soutar van Veen grabs, in ppm dry weight. Adapted from Larsen, et al (1980: Fig. 29).

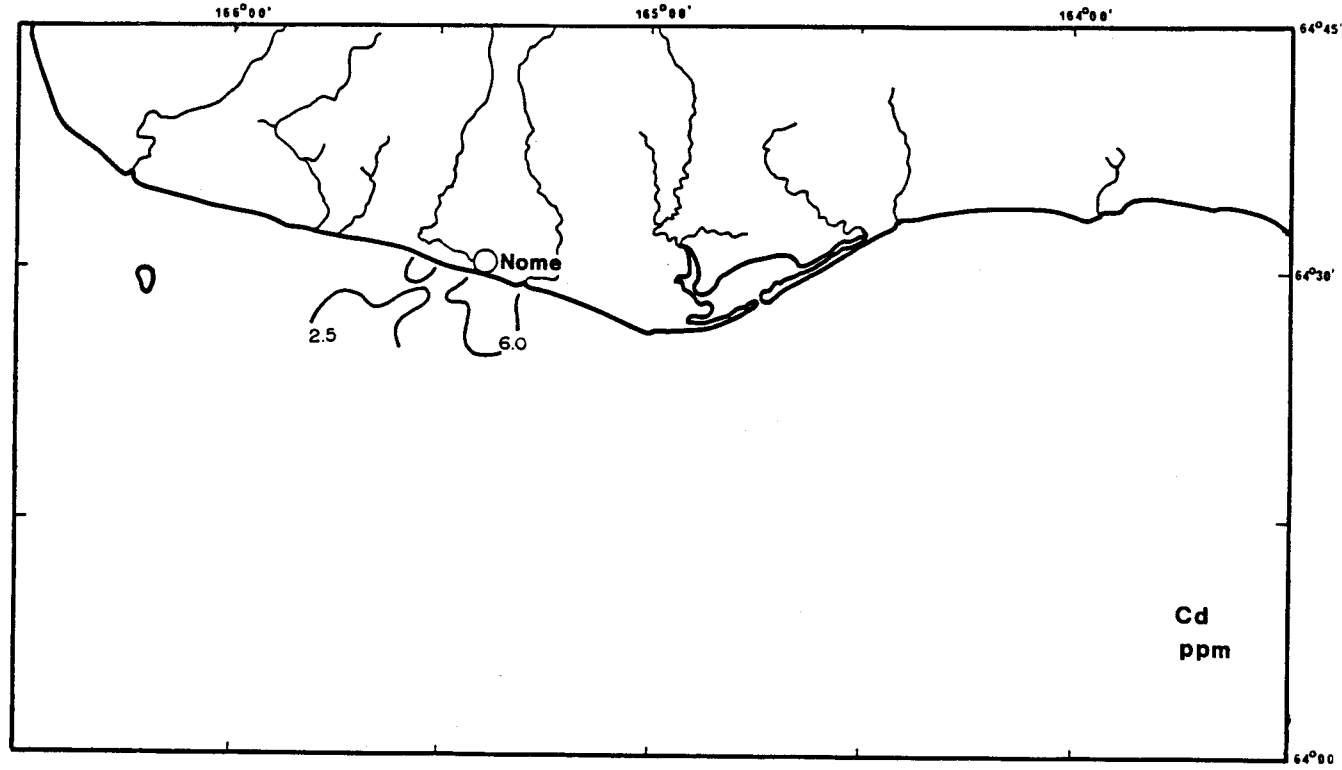

Fig. 5. Isolines of cadmium concentration in surface sediments based on 19 van Veen grabs. Drawn from Sharma (1974:139).

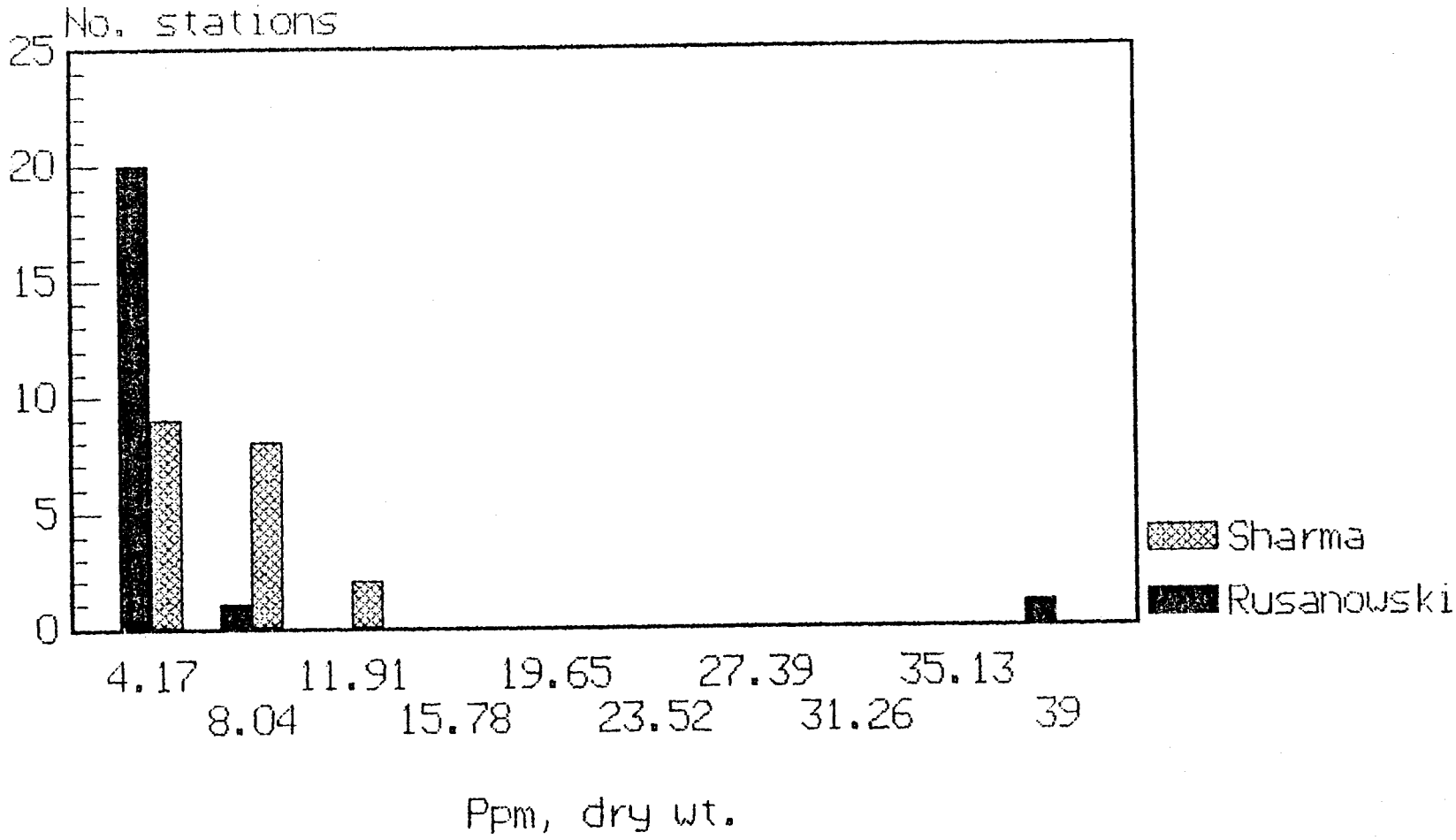

Fig. 6. Cadmium in surface sediment near Nome, based on 22 samples of Rusanowski, et al (1988) and 19 samples of Sharma (1974).

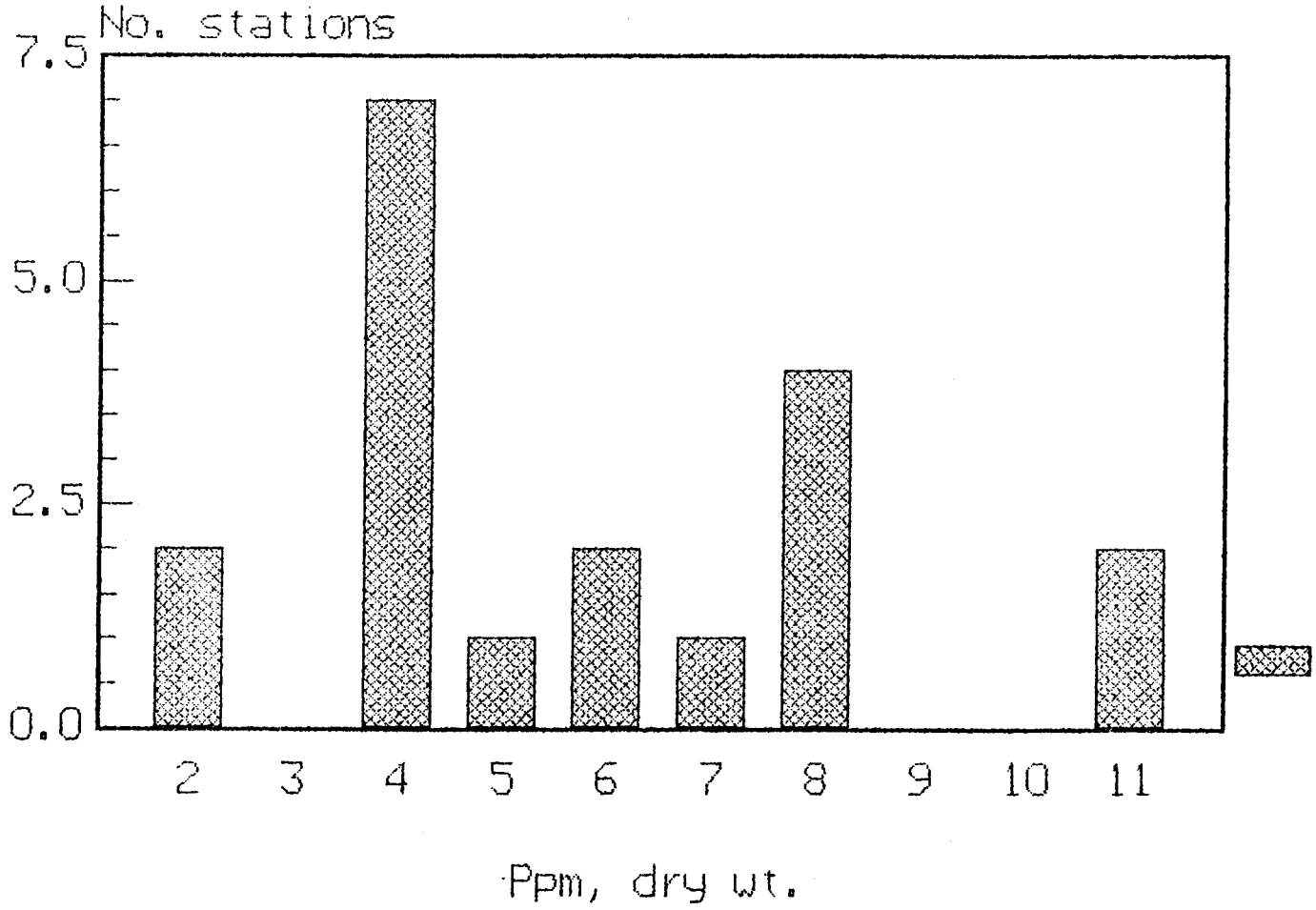

Fig. 7. Cadmium in surface sediment at 19 stations near Nome. Based on Sharma (1974).

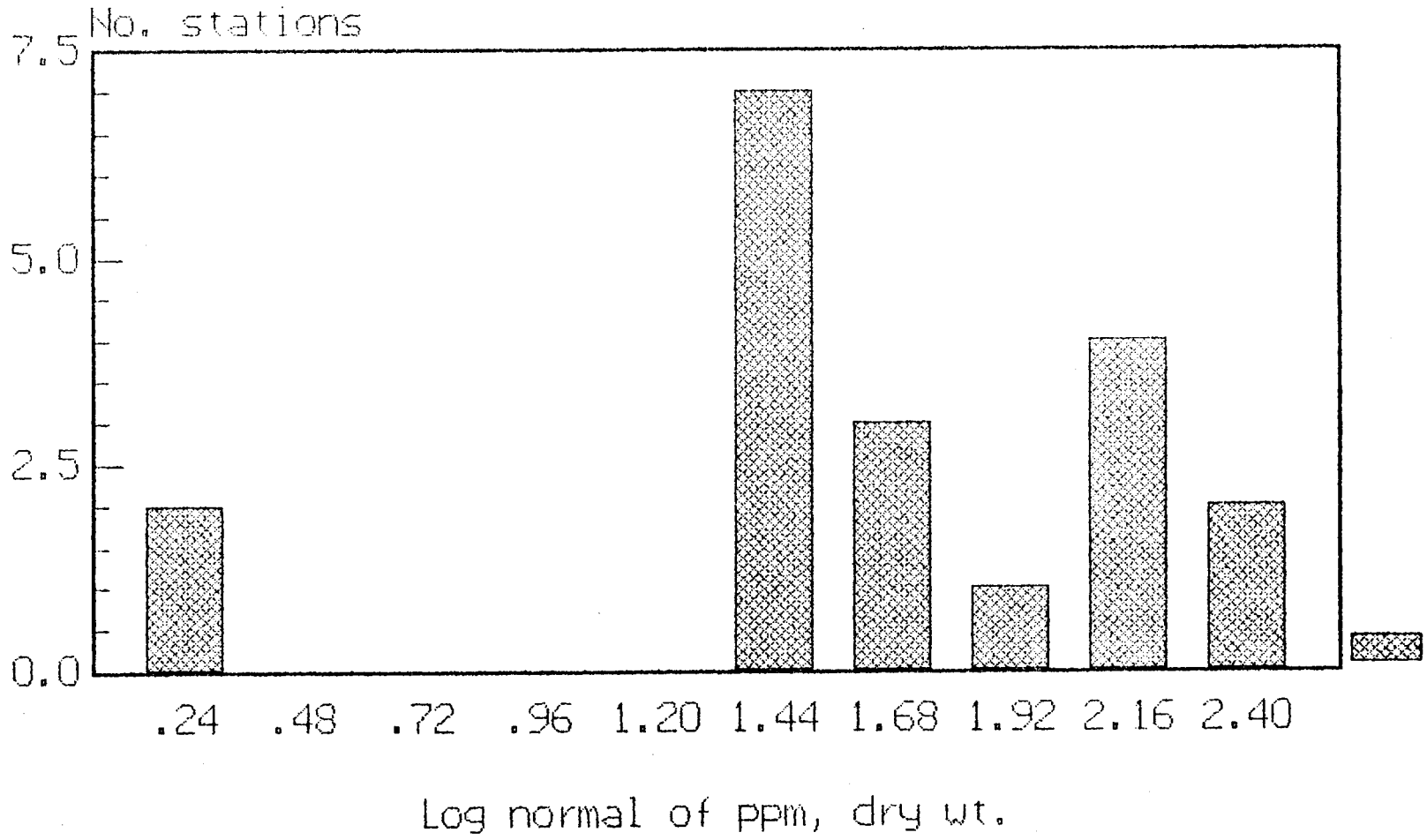

Fig. 8. Log normal of ppm of cadmium in surface sediment at 19 stations near Nome. Based on Sharma (1974).

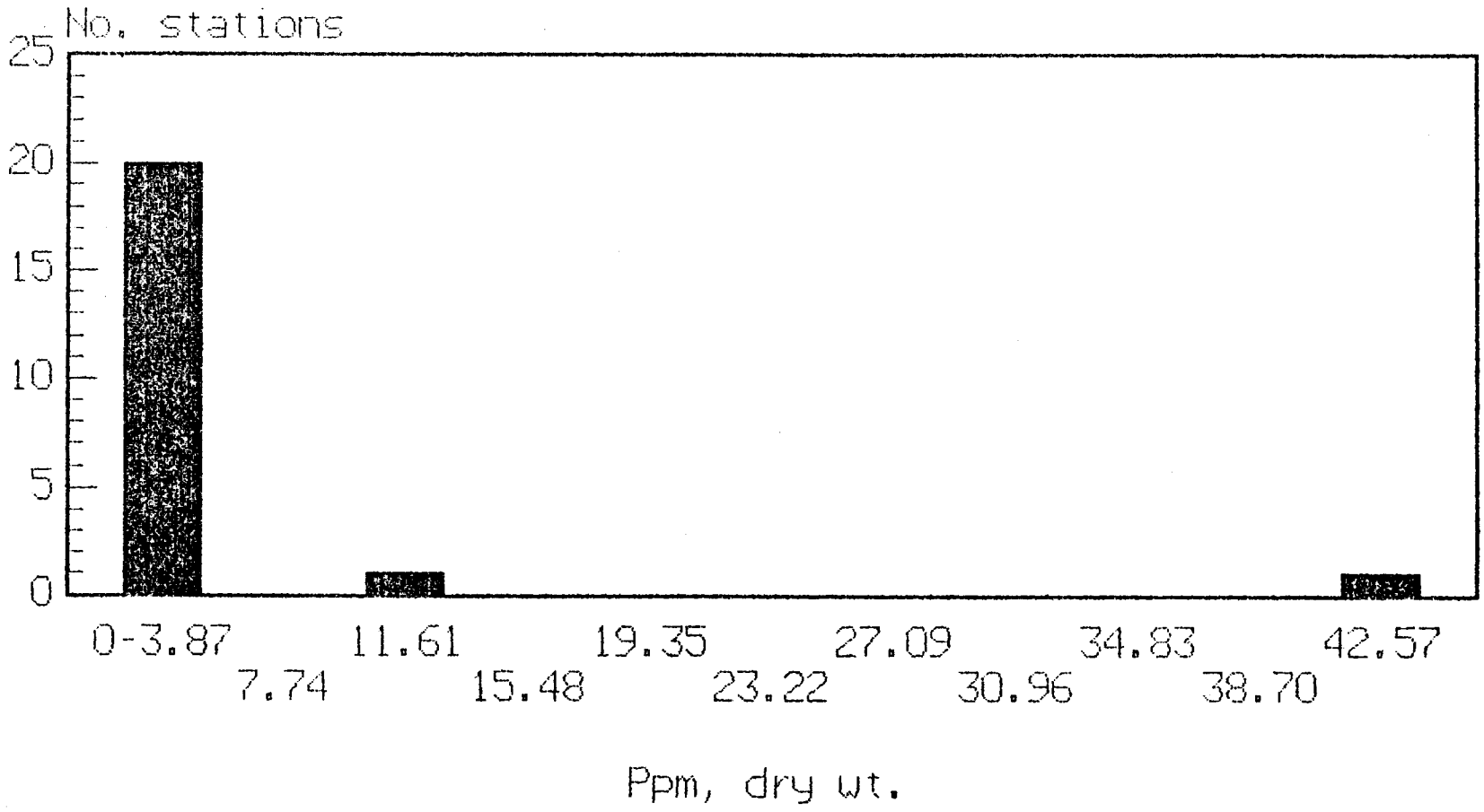

Fig. 9. Cadmium in surface sediment at 22 stations near Nome. Drawn from Rusanowski, et al (1988).

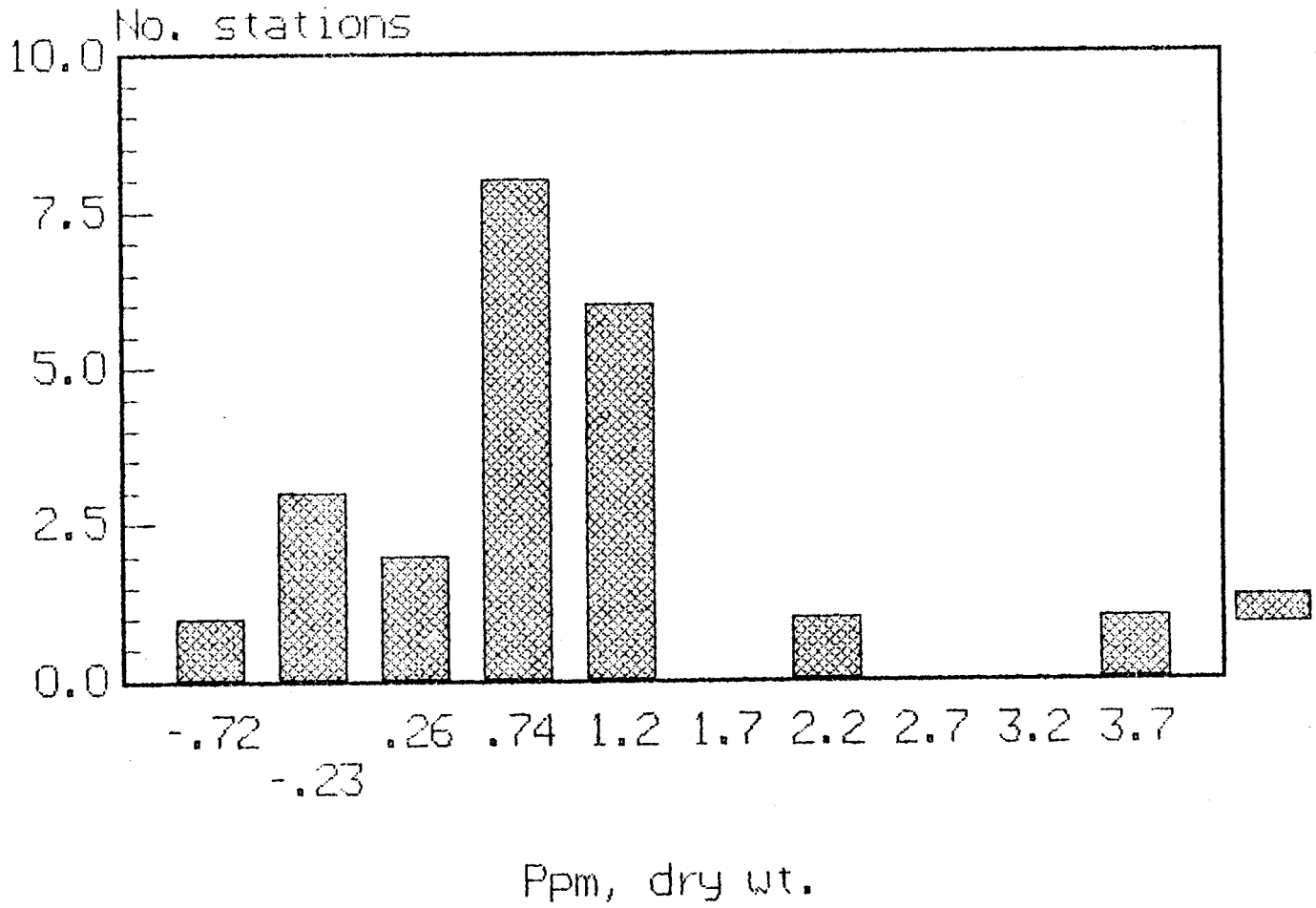

Fig. 10. Log normal of cadmium in surface sediment at 22 stations near Nome. Based on Rusanowski, et al (1988).

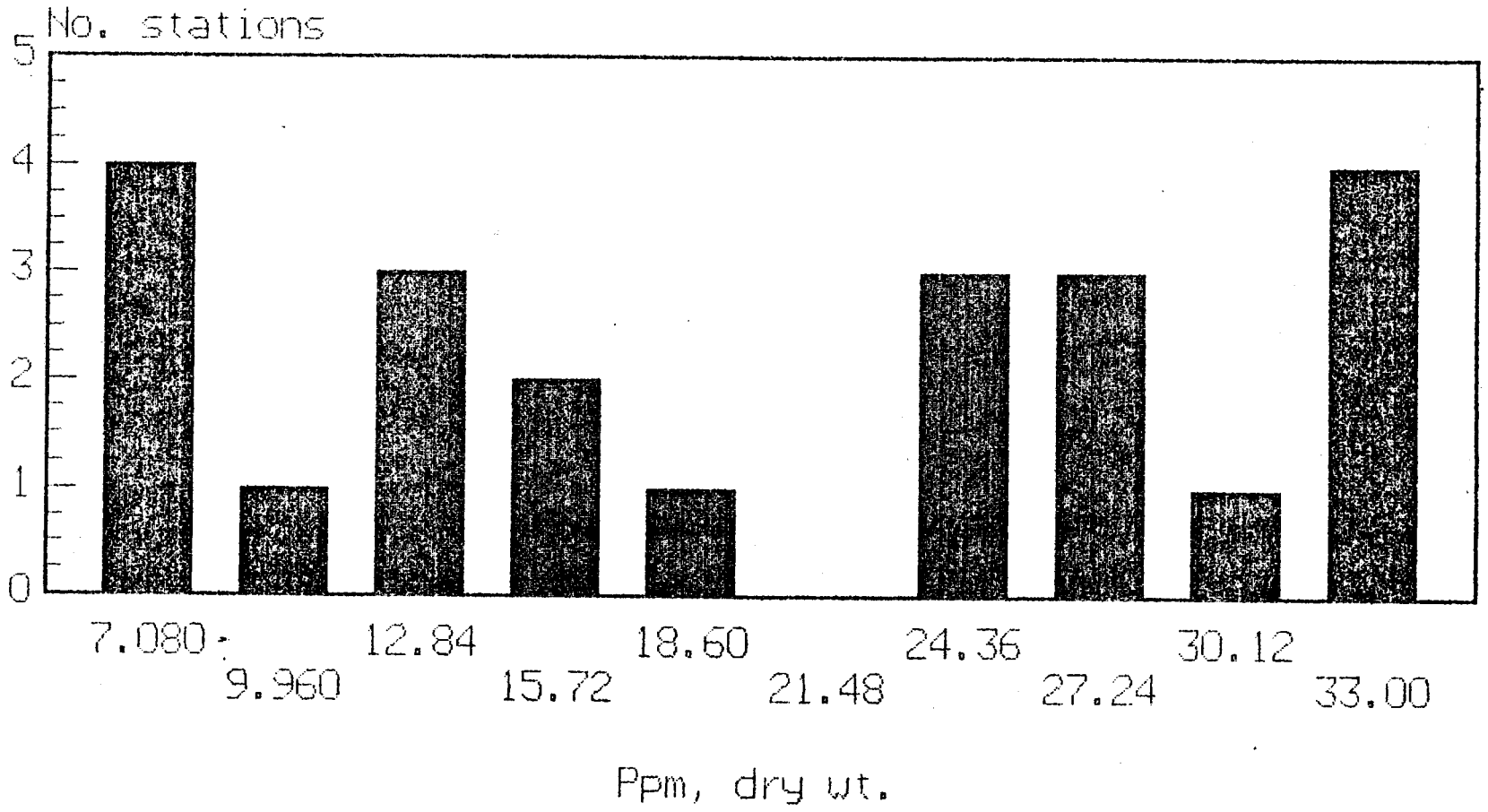

Fig. 11. Chromium in surface sediment at 22 stations near Nome. Drawn from Rusanowski, et al (1988).

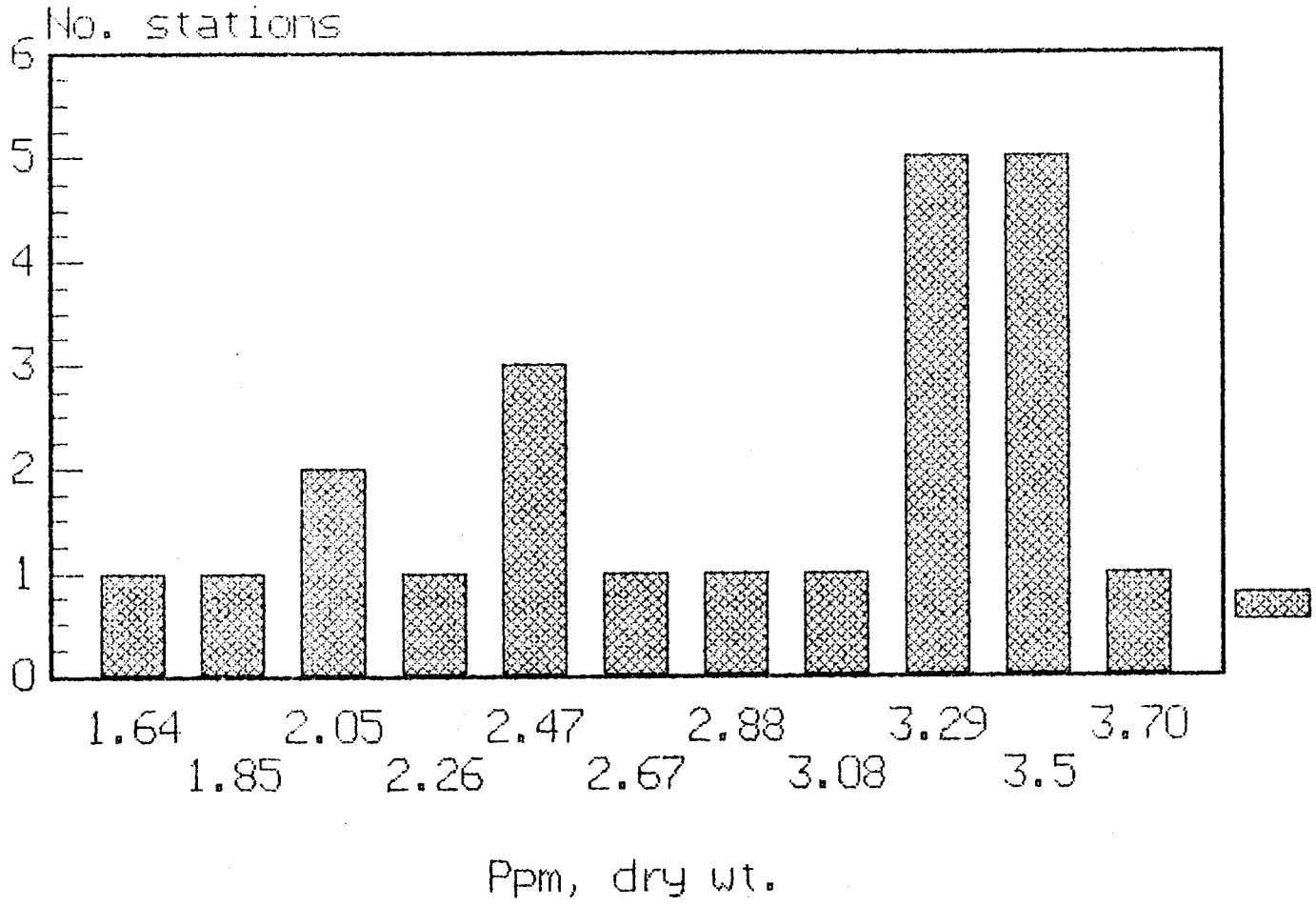

Fig. 12. Log normal of chromium in surface sediment at 22 stations near Nome. Based on Rusanowski, et al (1988).

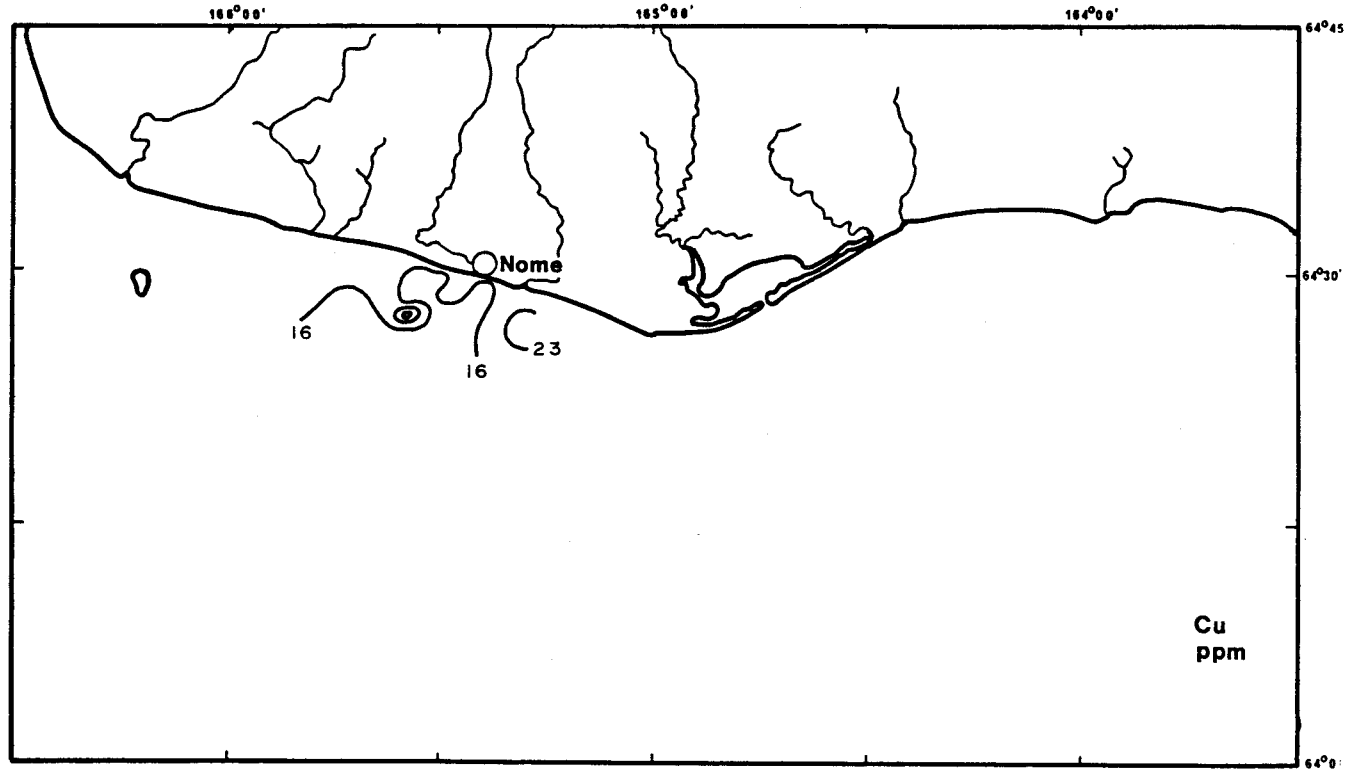

Fig. 13. Isolines of copper concentration in surface sediments based on 19 van Veen grabs. Drawn from Sharma (1974:139).

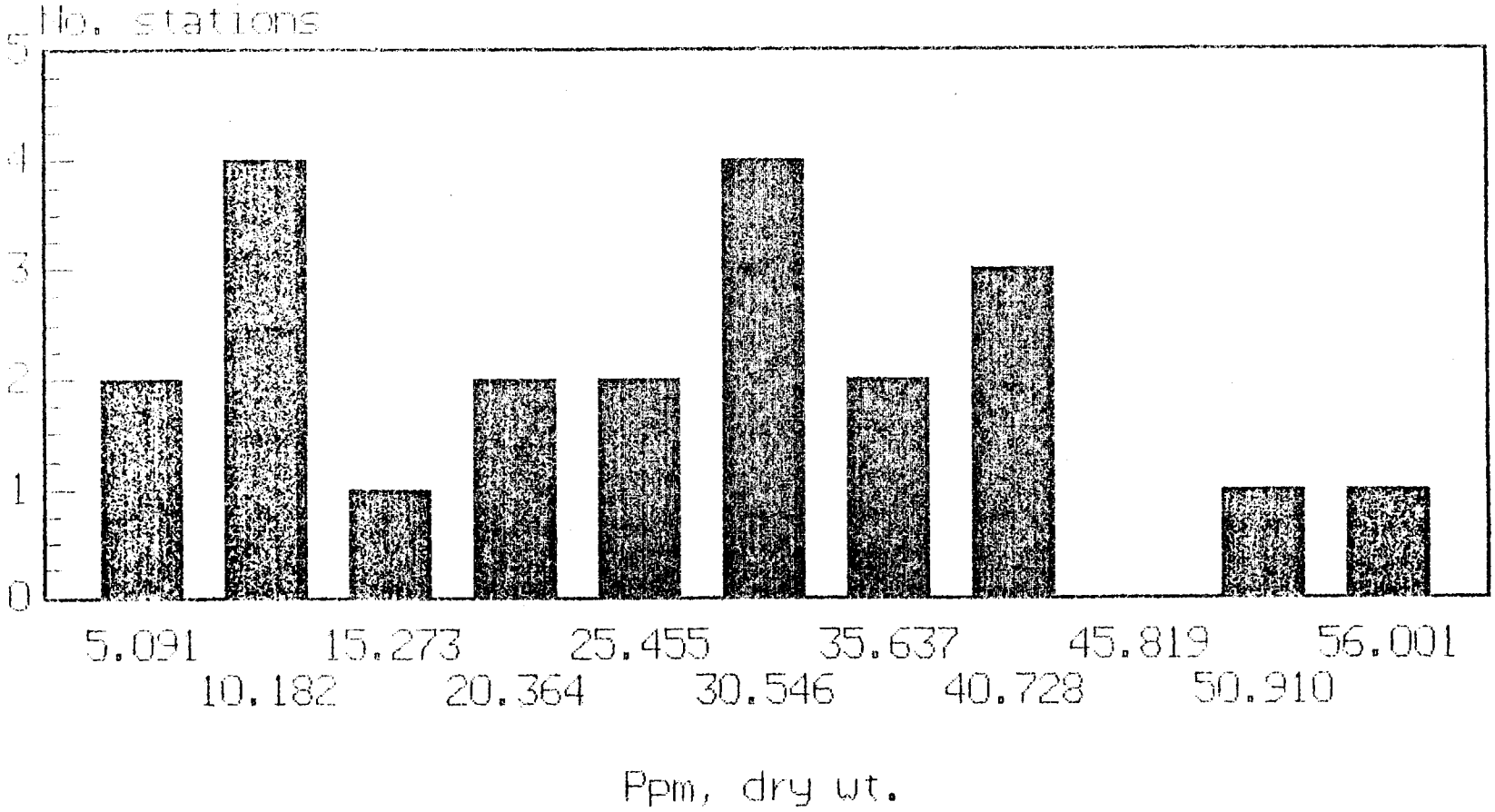

Fig. 14. Copper in surface sediment at 22 stations near Nome. Drawn from Rusanowski, et al (1988).

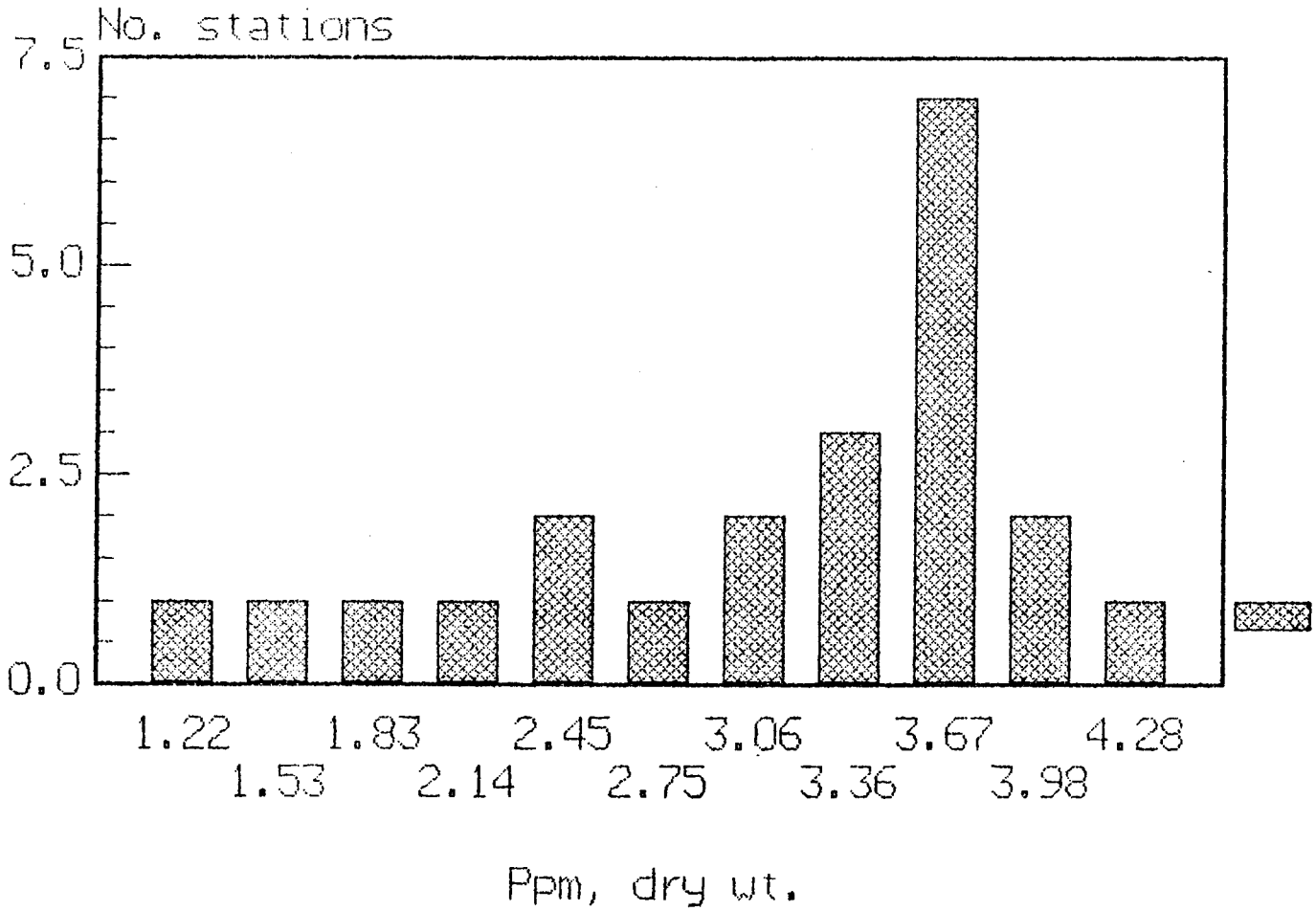

Fig. 15. Log normal of copper in surface sediment at 22 stations near Nome. Based on Rusanowski, et al (1988).

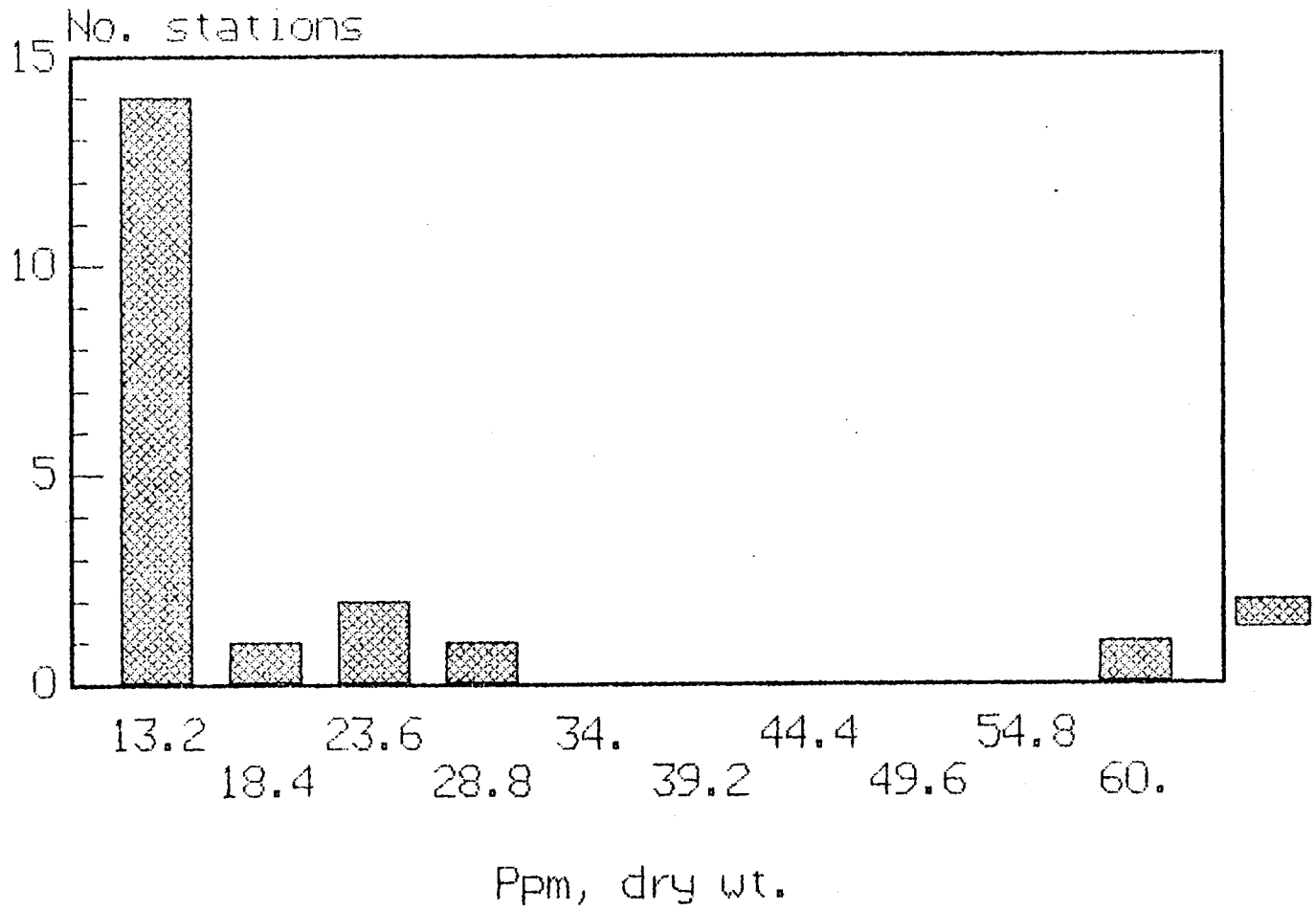

Fig. 16. Copper in surface sediment at 19 stations near Nome. Based on Sharma (1974).

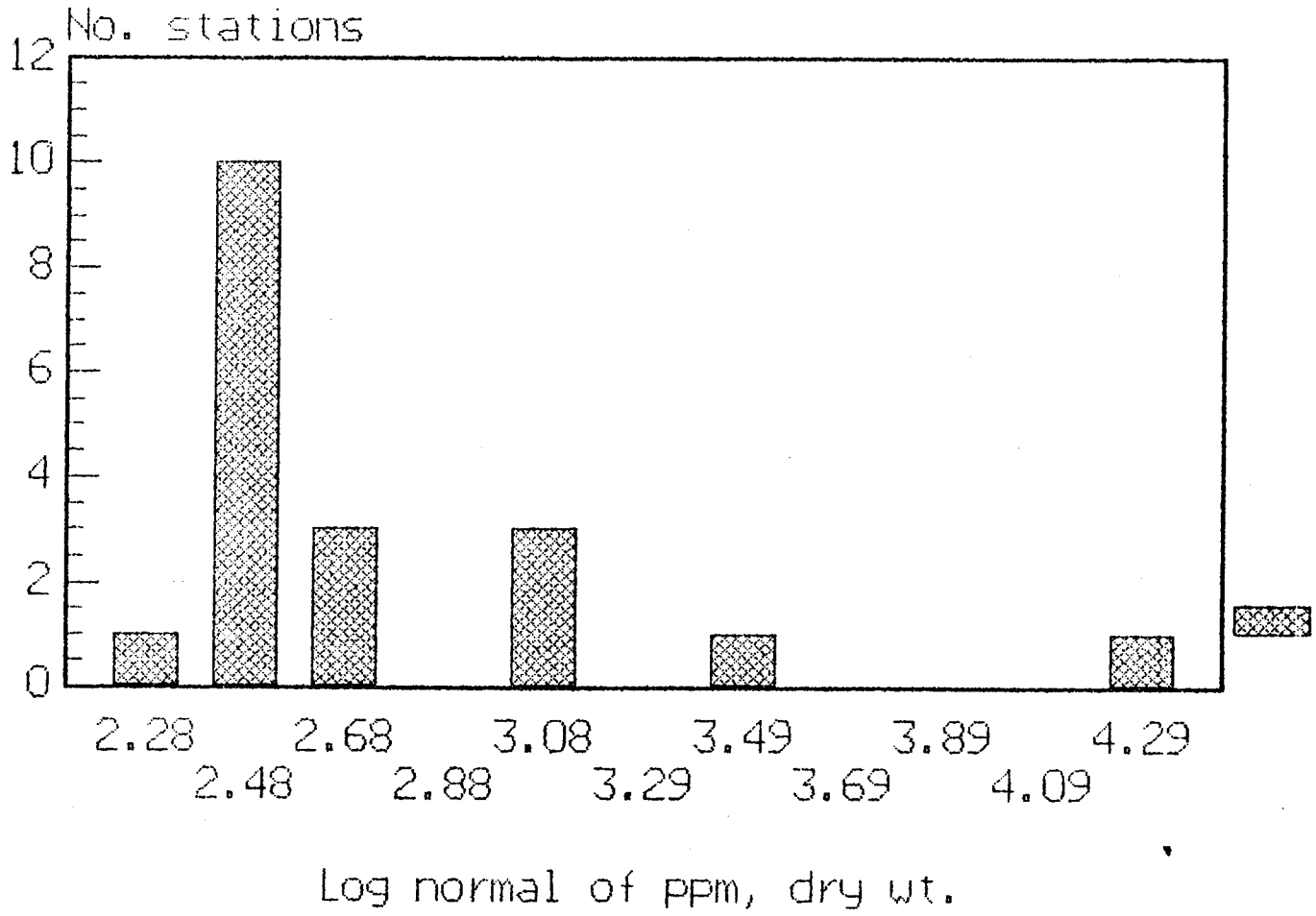

Fig. 17. Log normal of ppm of copper in surface sediment at 19 stations near Nome. Based on Sharma (1974).

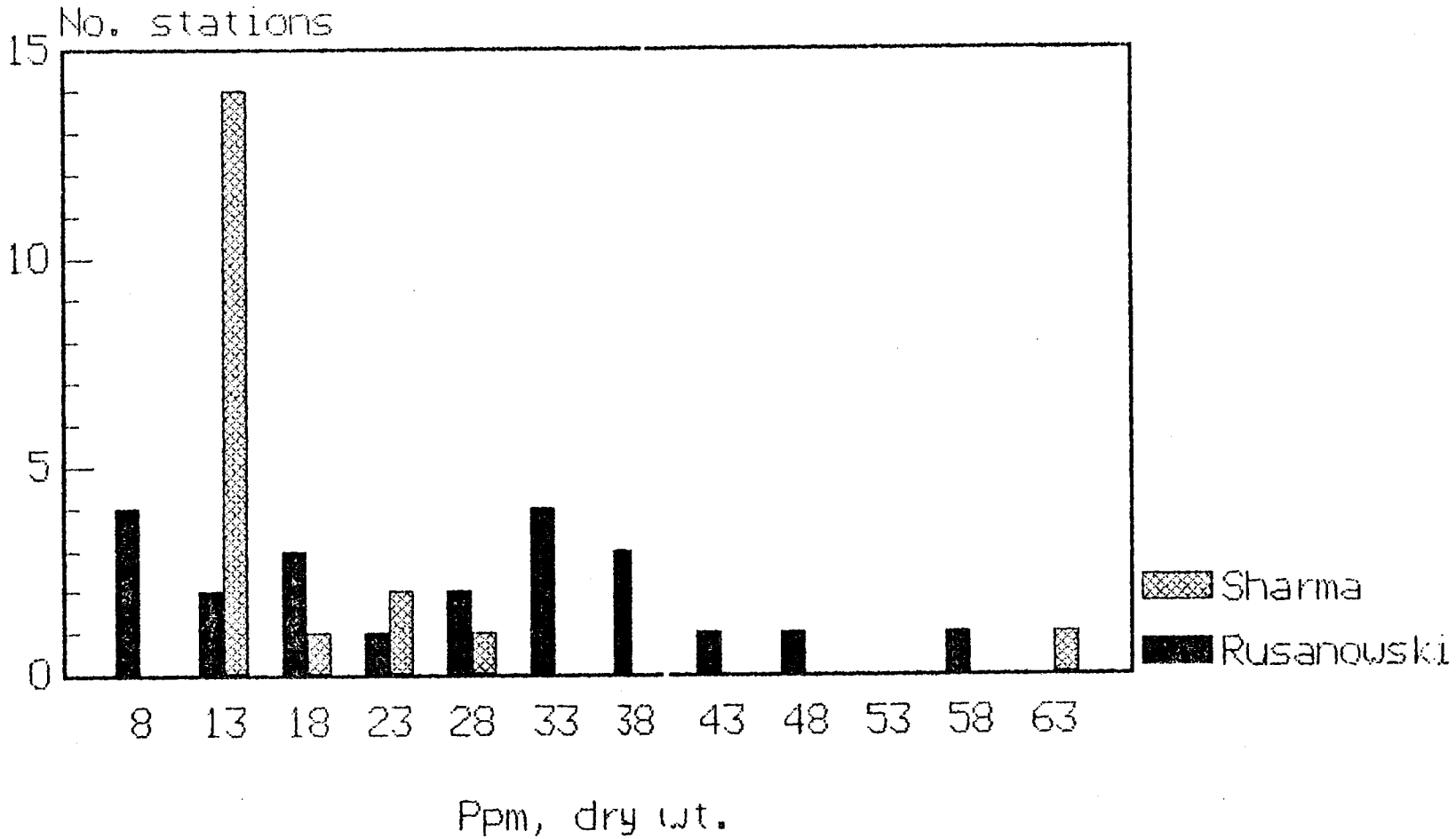

Fig. 18. Copper in surface sediment near Nome, based on 22 samples of Rusanowski, et al (1988) and 19 samples of Sharma (1974).

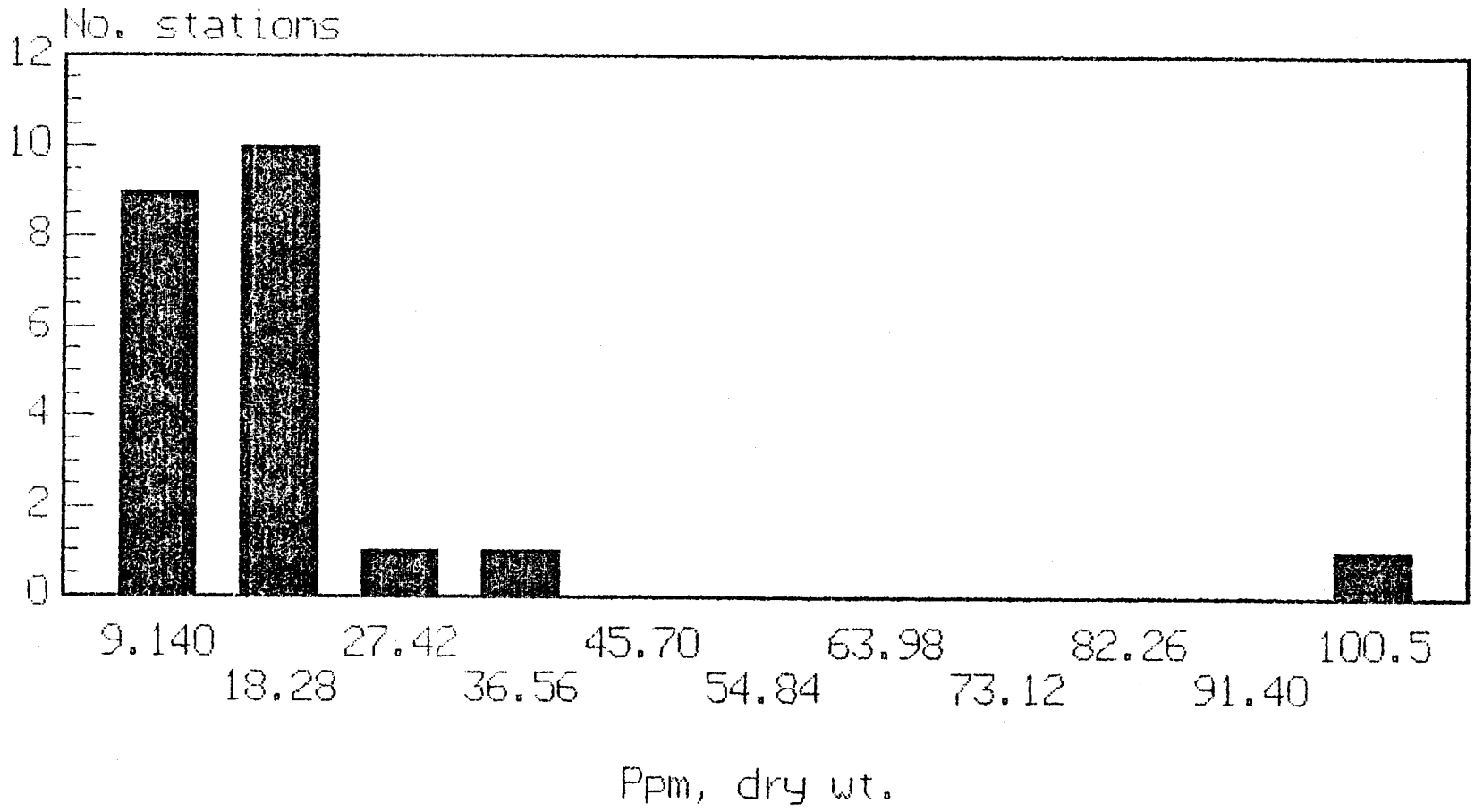

Fig. 19. Lead in surface sediment at 22 stations near Nome. Drawn from Rusanowski, et al (1988).

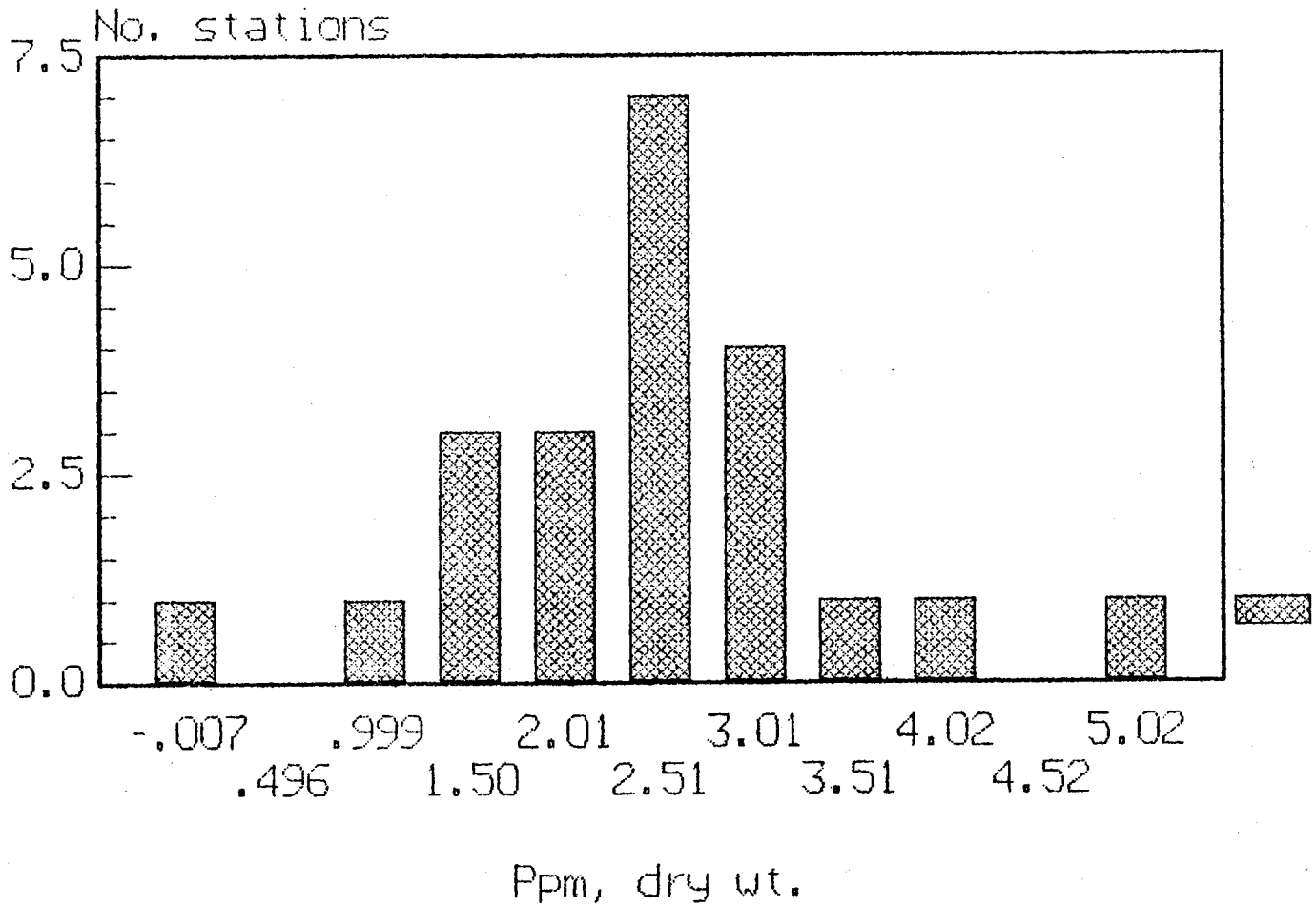

Fig. 20. Log normal of lead in surface sediment at 22 stations near Nome. Based on Rusanowski, et al (1988).

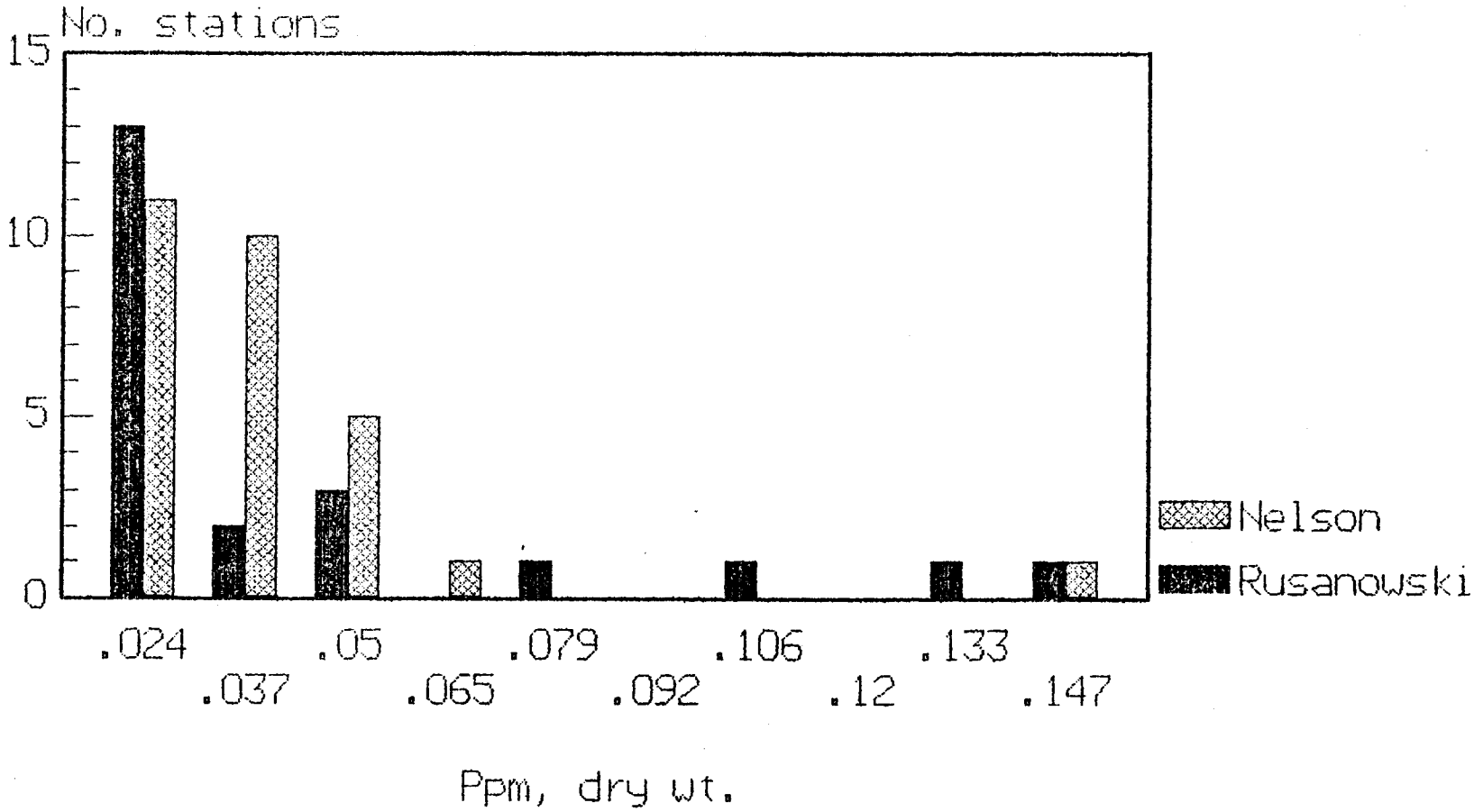

Fig. 21. Mercury in surface sediment near Nome, based on 28 samples of Nelson, et al (1972) and 22 samples of Rusanowski, et al (1988).

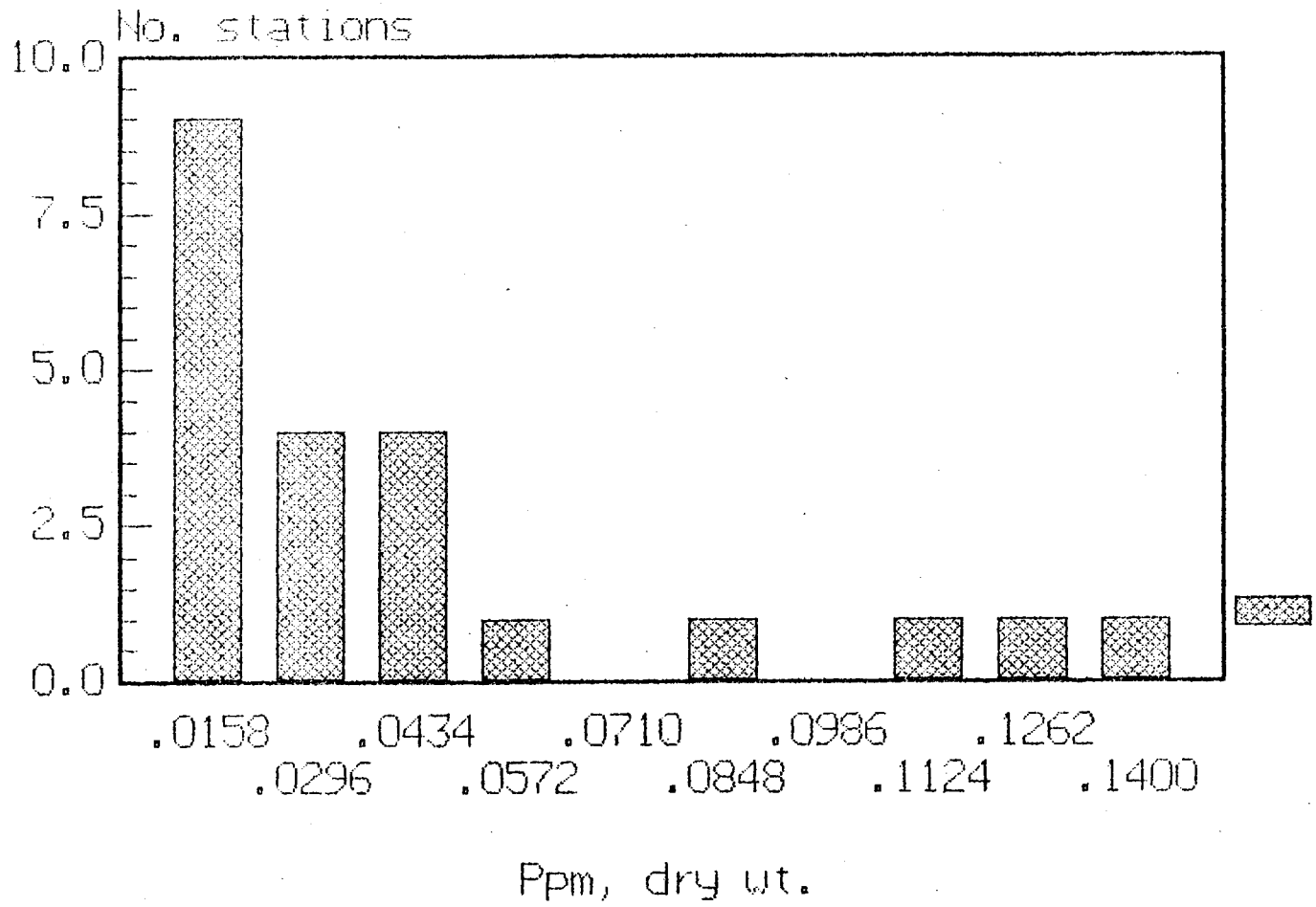

Fig. 22. Mercury concentration in surface sediment at 22 stations near Nome. Based on Rusanowski, et al (1988).

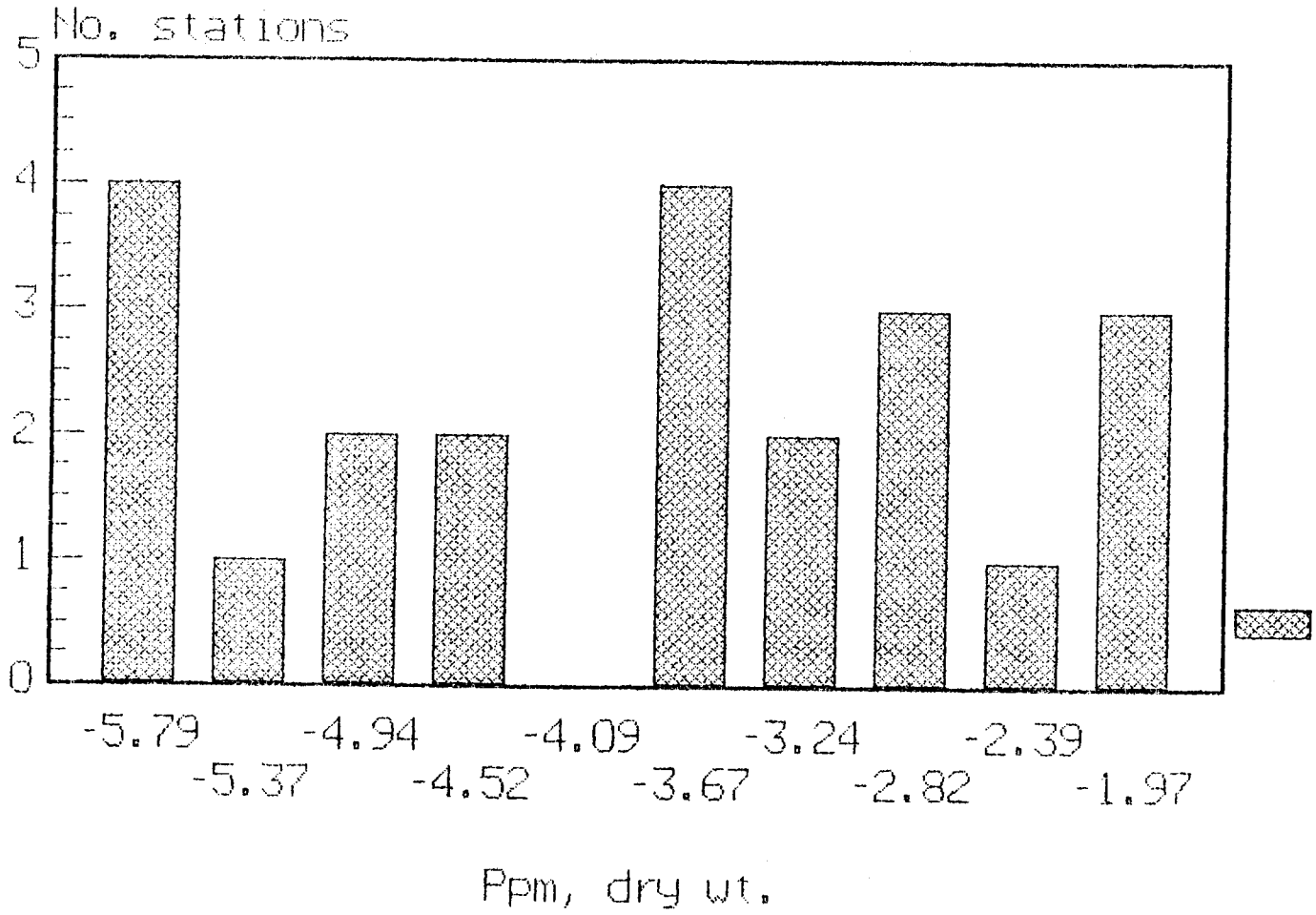

Fig. 23. Log normal of mercury in surface sediment at 22 stations near Nome. Based on Rusanowski, et al (1988).

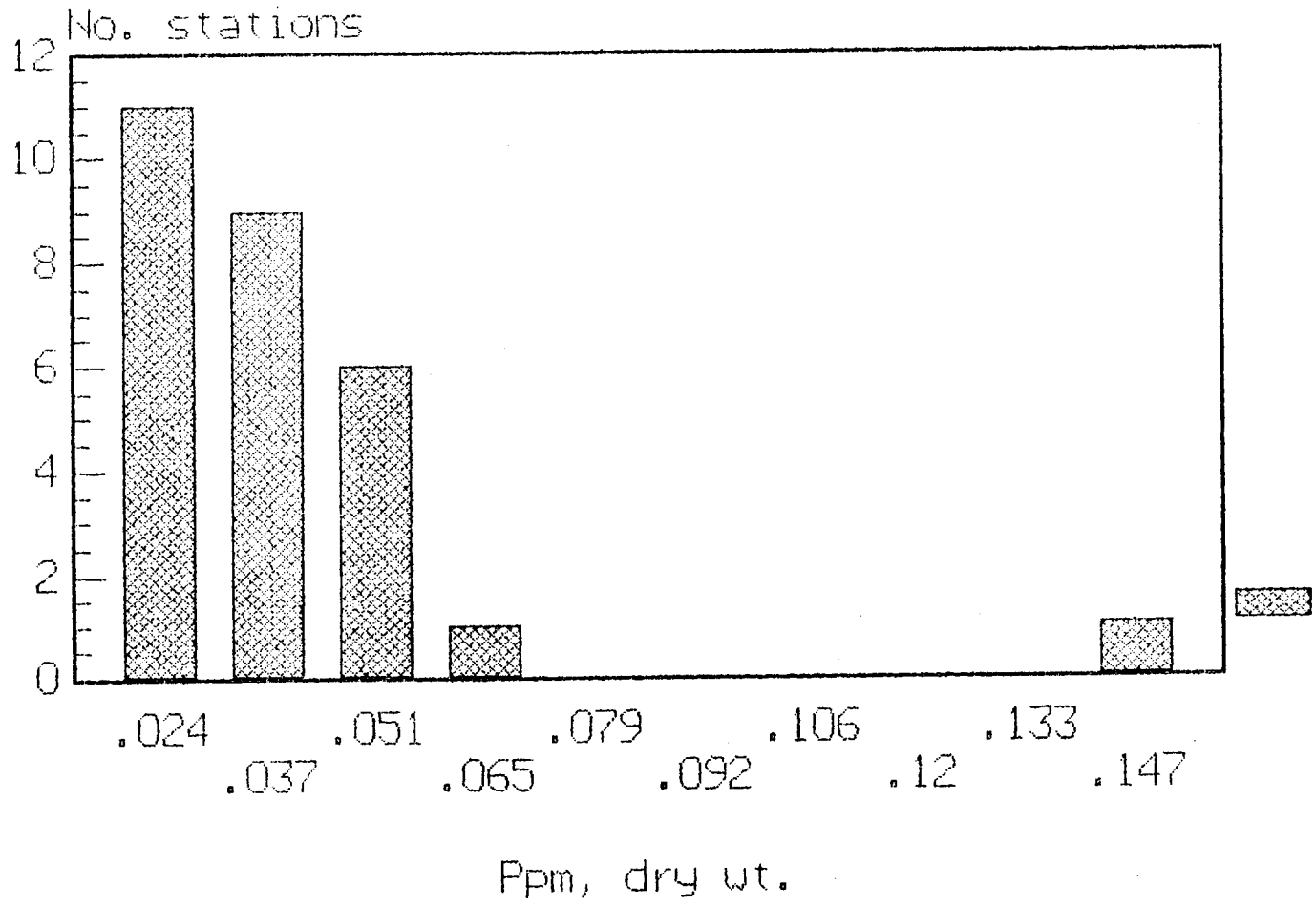

Fig. 24. Mercury concentration in surface sediment at 28 stations near Nome. Based on Nelson, et al (1972).

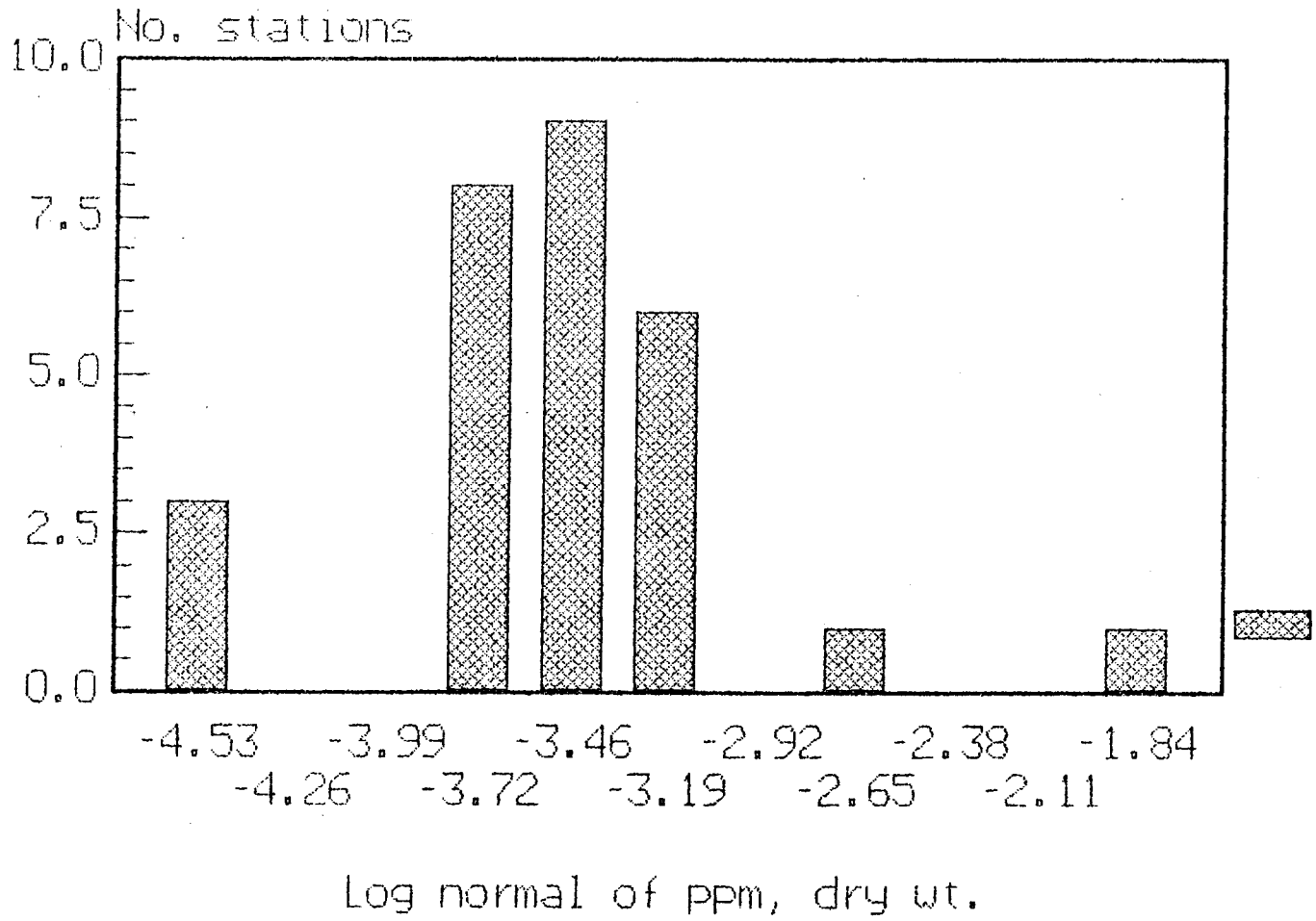

Fig. 25. Log normal of mercury in surface sediment at 28 stations near Nome. Based on Nelson, et al (1972).

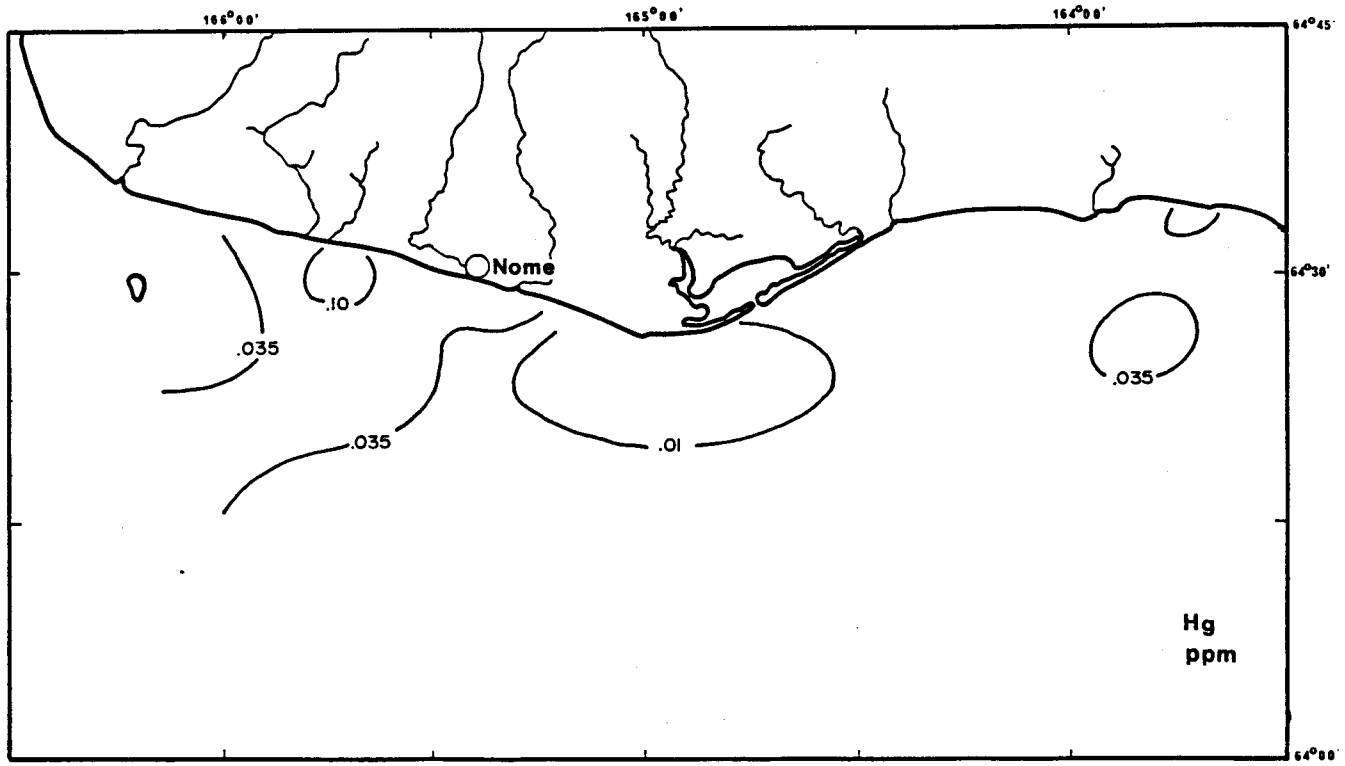

Fig. 26. Isolines of mercury concentration in surface sediments, 0-10 cm, based on 28 van Veen grab and box core samples, in ppm dry weight. Drawn from Nelson, et al (1972: Appendix I).

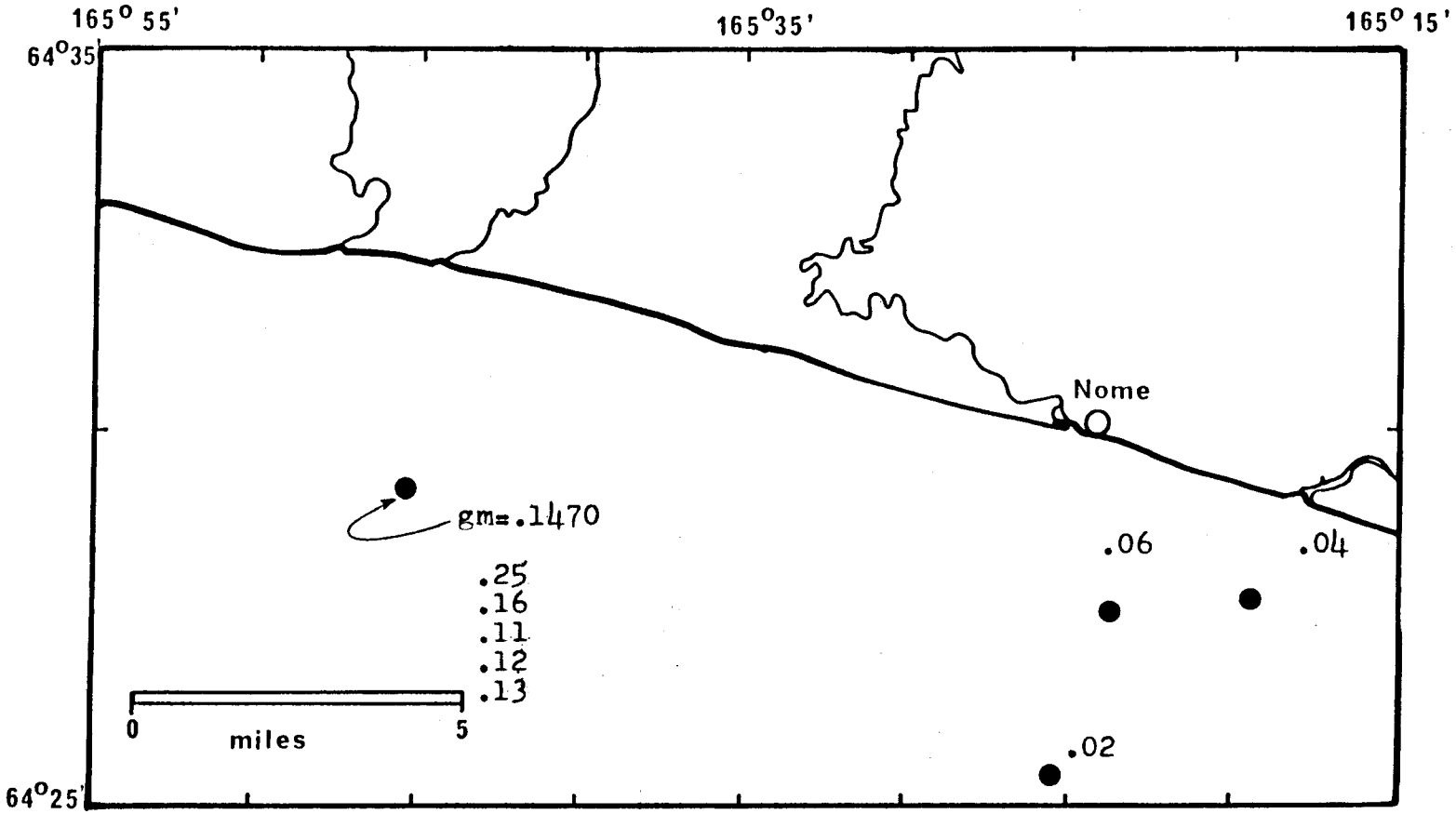

Fig. 27. Mercury concentrations in surface sediments 0-10 cm, off Nome, in ppm dry weight. Sampled by van Veen grabs and box corers. The western station represents the geometric mean of five subsamples of a single grab. Adapted from Nelson, et al (1972).

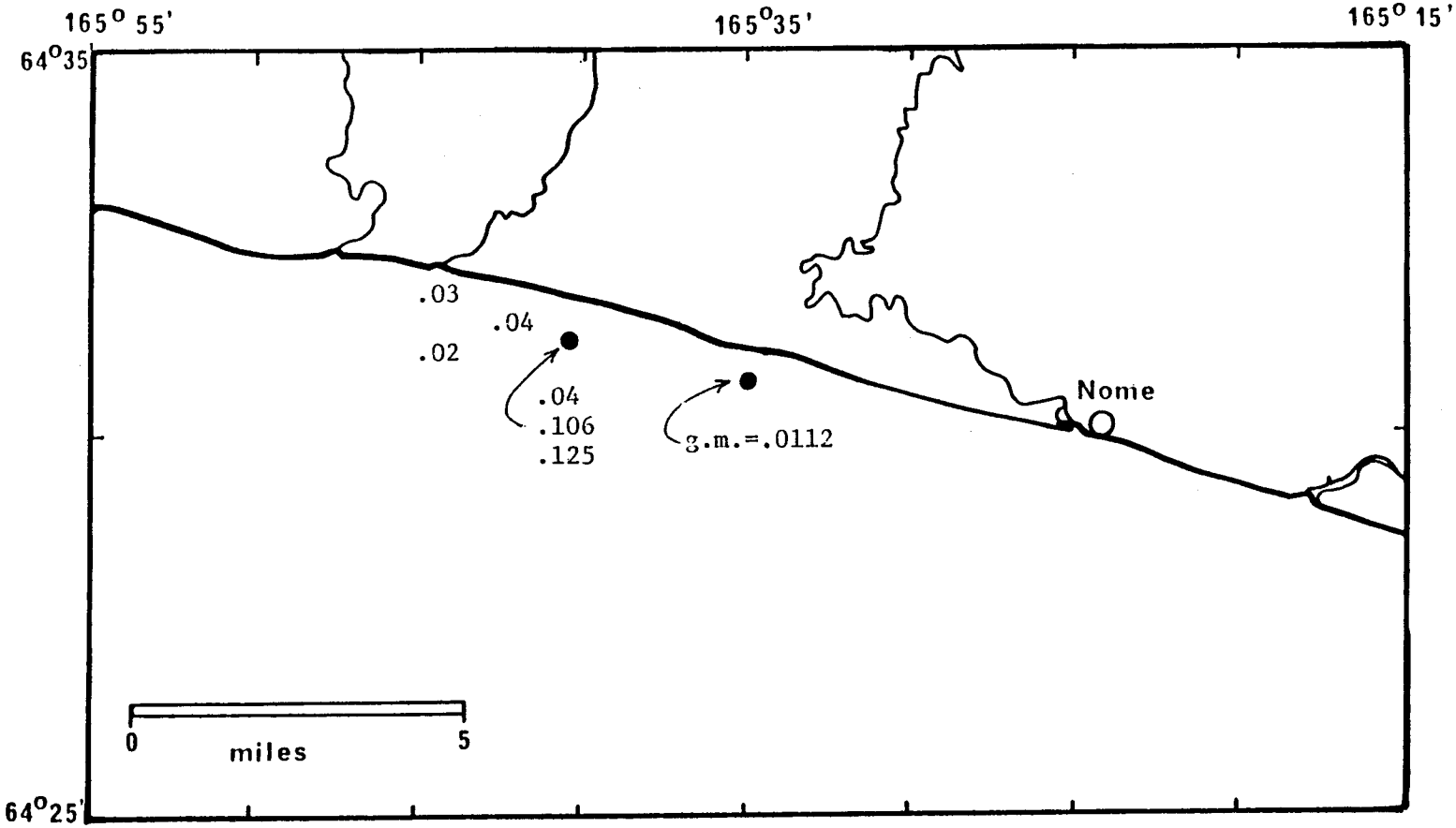

Fig. 28. Background mercury concentrations in surface sediments near the BIMA dredge, 1985-1987, in ppm dry weight. Shown are six determinations at four approximate locations, and the geometric mean of sixteen grabs and determinations at the eastern-most location. The geometric mean was calculated from sixteen values, including seven values equal to lower detection limit. Drawn from Rusanowski, et al (1988: Table 3.3-1).

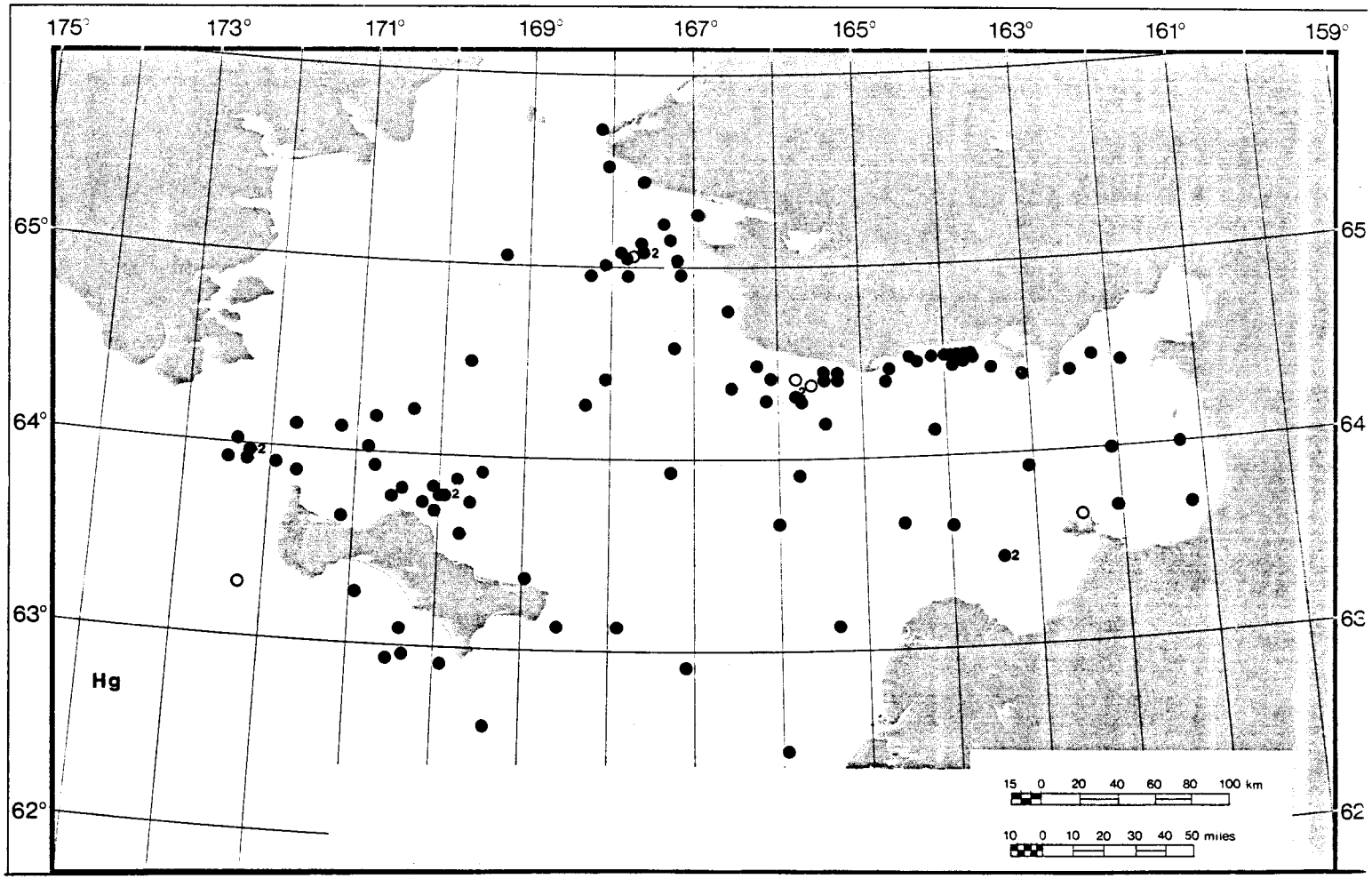

Fig. 29. Sampling locations for mercury concentrations in surface sediment, 0-10 cm, using van Veen grabs and box corers. At five locations, two determinations were made. At another five locations, five determinations were made; these locations are represented by open circles. Adapted from Nelson, et al (1972: Appendix I).

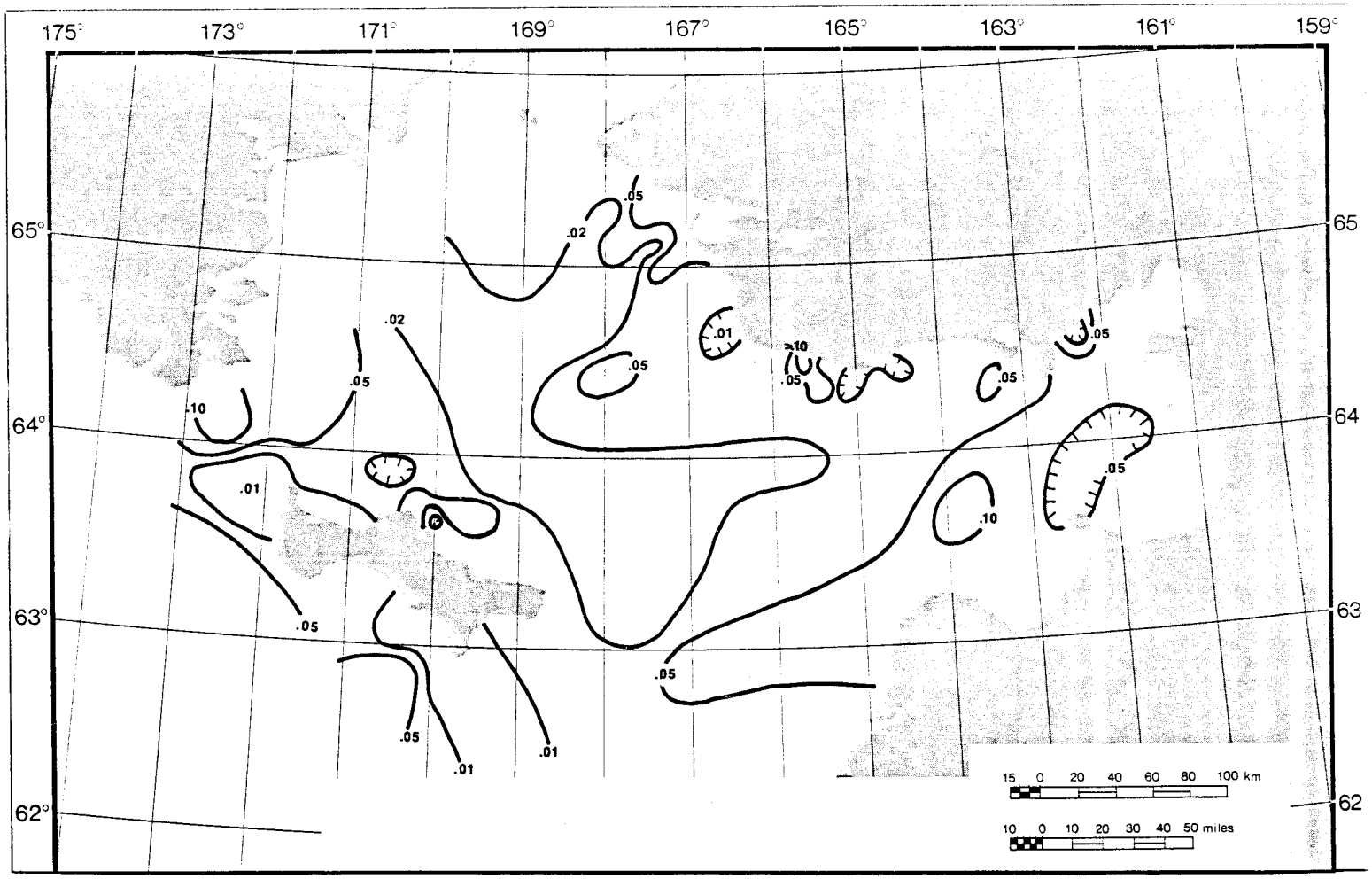

Fig. 30. Mercury concentrations in surface sediments 0-10 cm, based on 105 van Veen grabs and box core samples; ppm dry weight. Drawn from tabular data in Nelson, et al (1972: Appendix I).

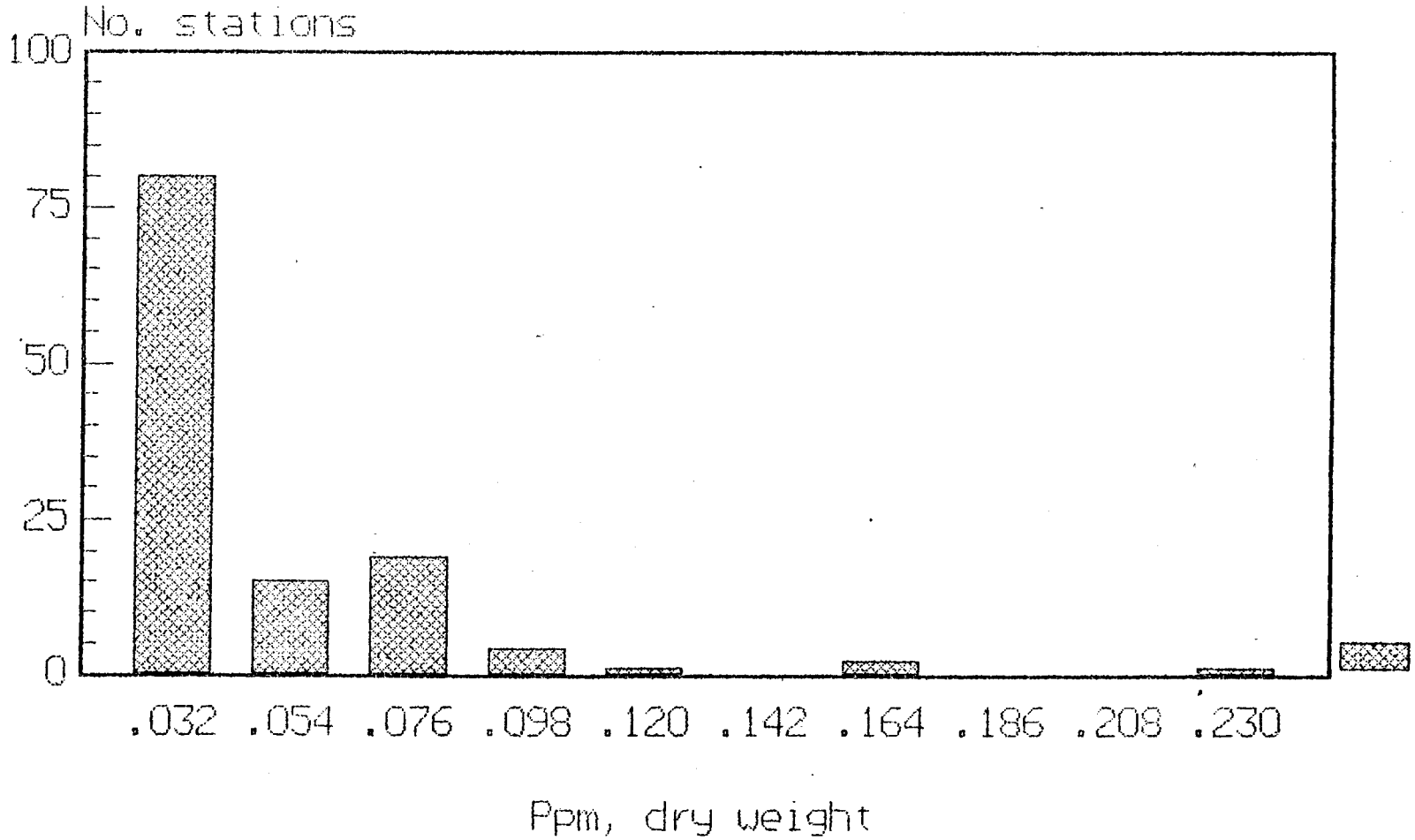

Fig. 31. Mercury in surface sediment at 122 stations in Norton Basin area, Alaska. Based on Nelson, et al (1972).

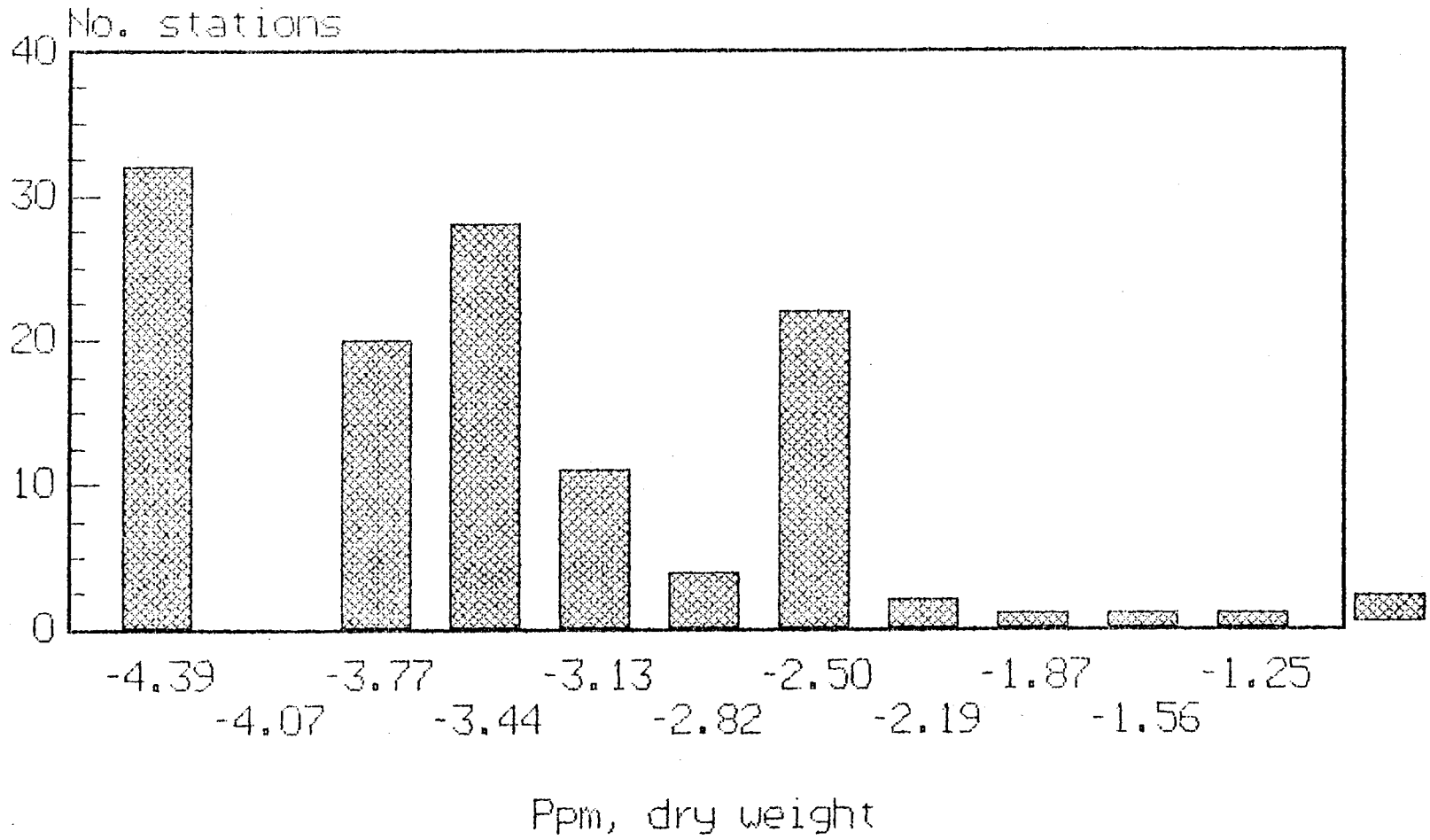

Fig. 32. Log normal of ppm mercury at 122 stations in Norton Basin area, Alaska. Based on Nelson, et al (1972).

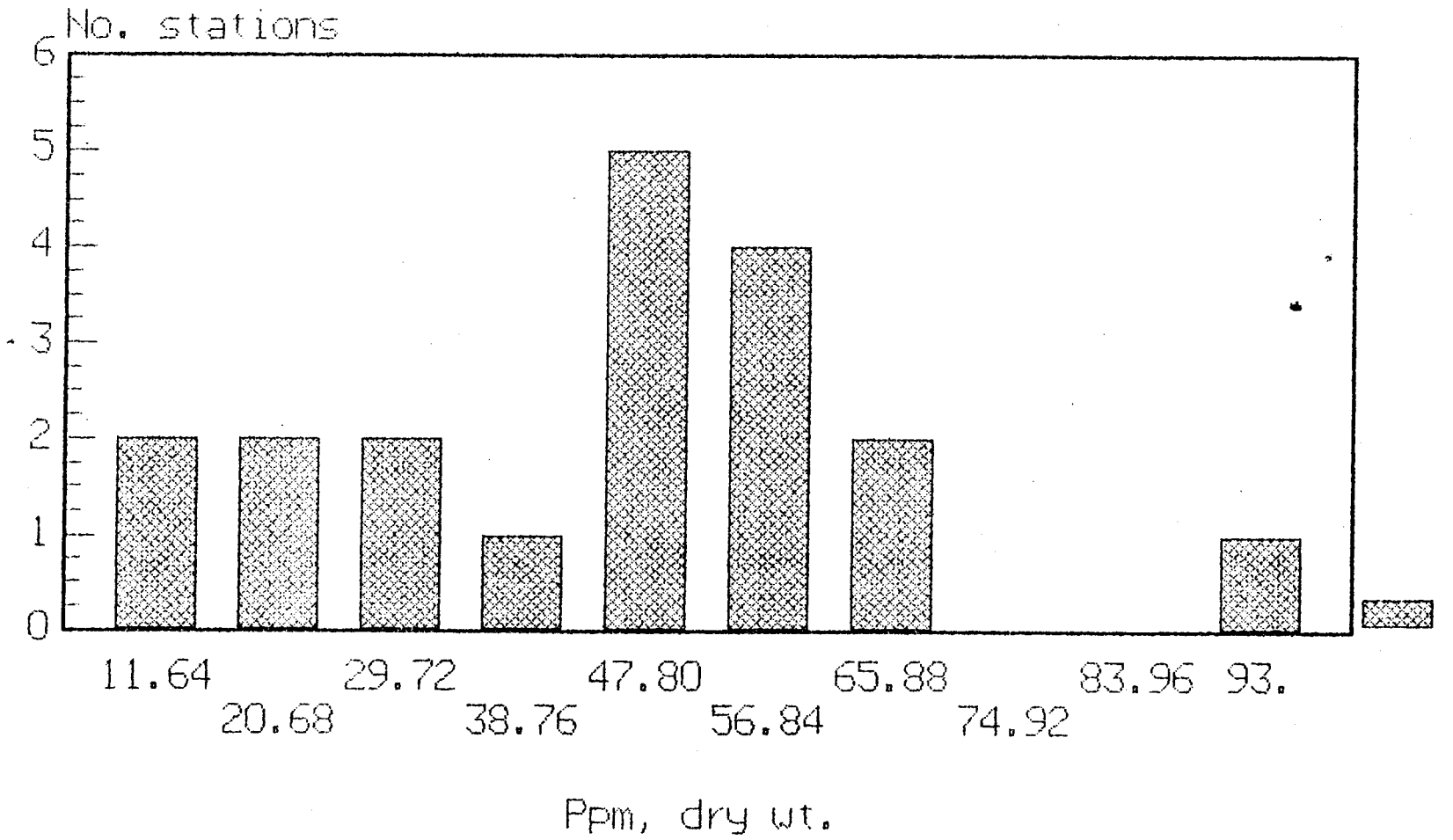

Fig. 33. Nickel in surface sediment at 19 stations near Nome. Based on Rusanowski, et al (1988).

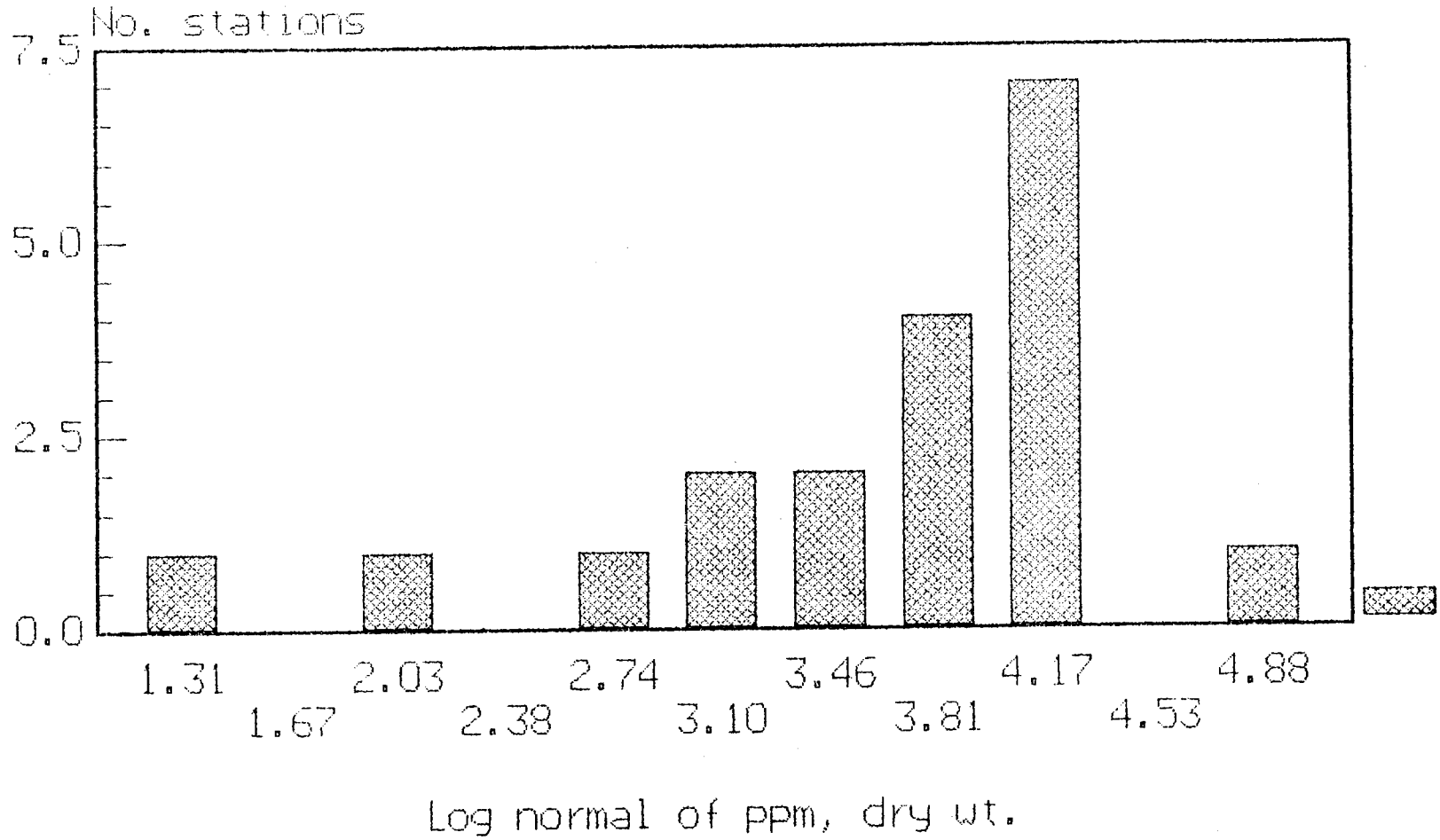

Fig. 34. Log normal of ppm of nickel in surface sediment at 19 stations near Nome. Based on Rusanowski, et al (1988).

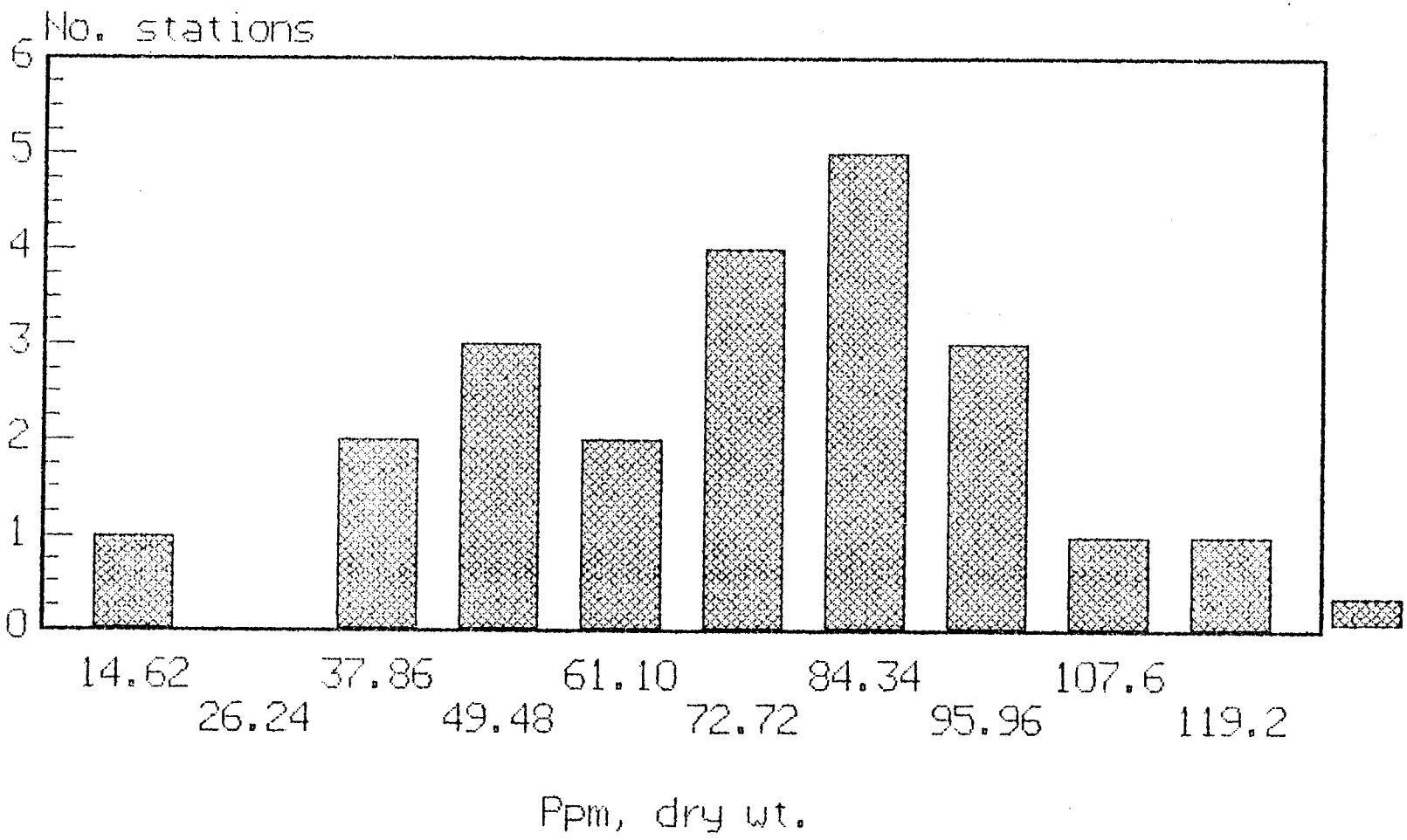

Fig. 35. Zinc in surface sediment at 22 stations near Nome. Based on Rusanowski, et al (1988).

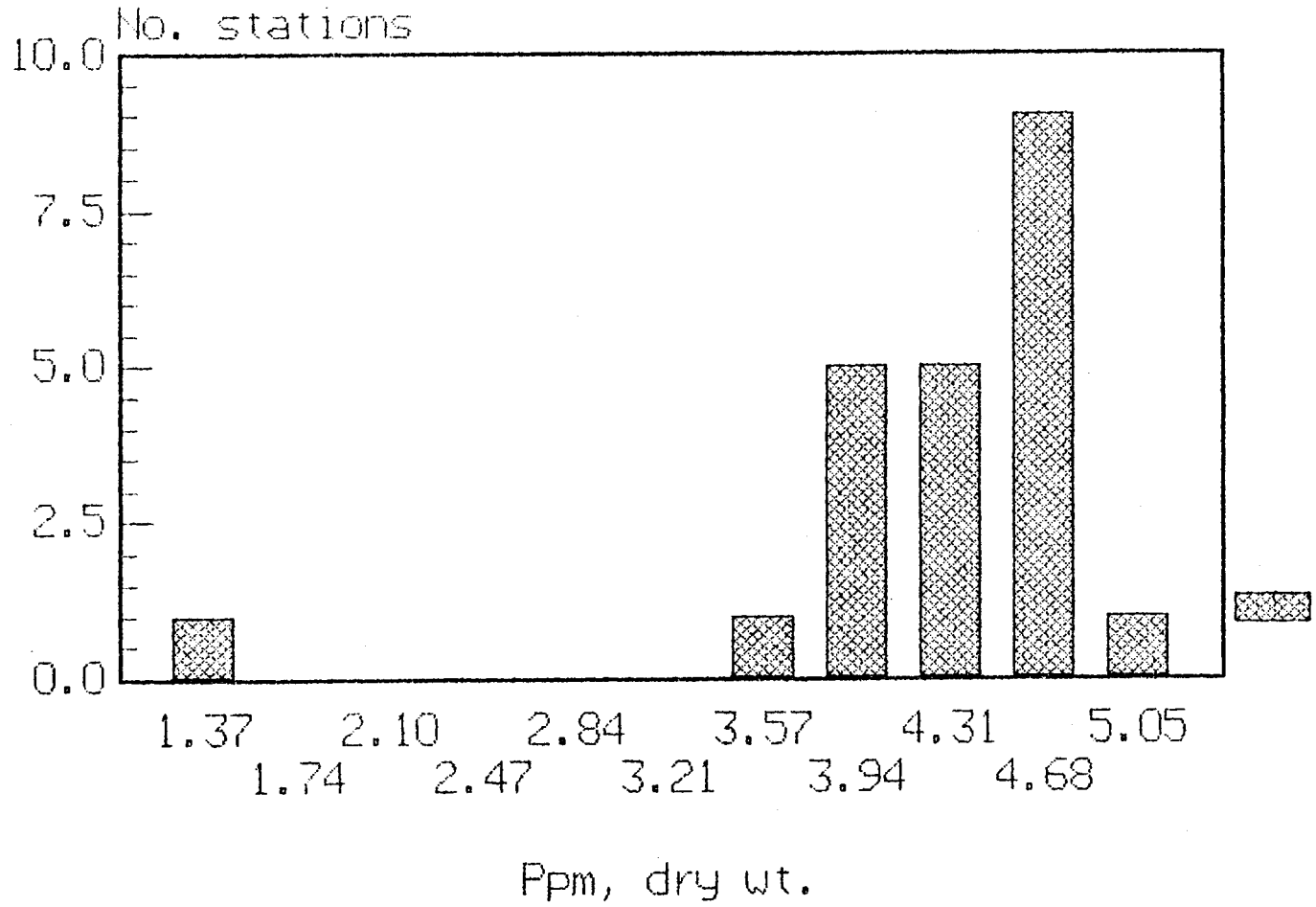

Fig. 36. Log normal of zinc in surface sediment at 22 stations near Nome. Based on Rusanowski, et al (1988).

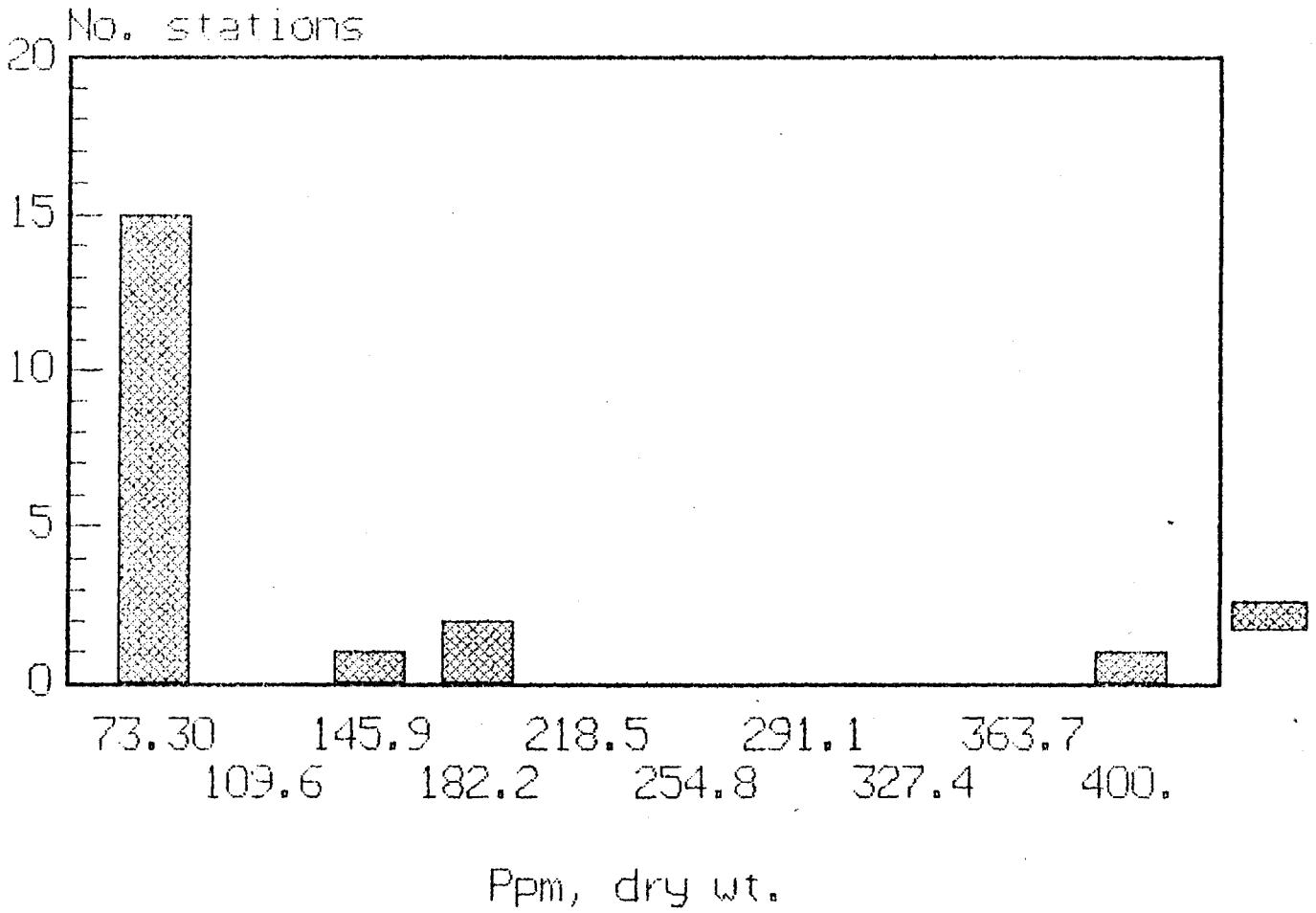

Fig. 37. Zinc in surface sediment at 19 stations near Nome. Based on Sharma (1974).

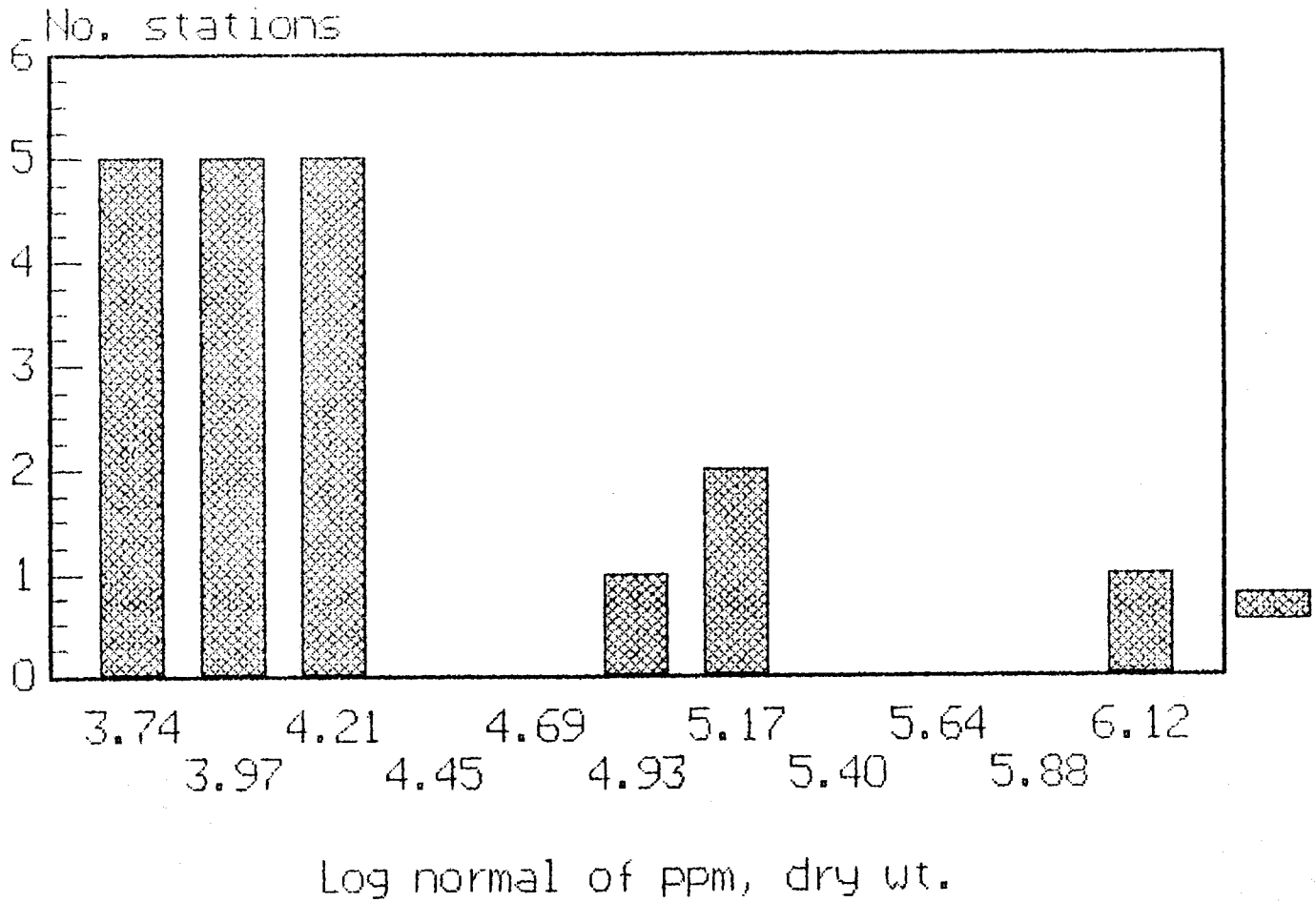

Fig. 38. Log normal of zinc in surface sediment at 19 stations near Nome. Based on Sharma (1974).

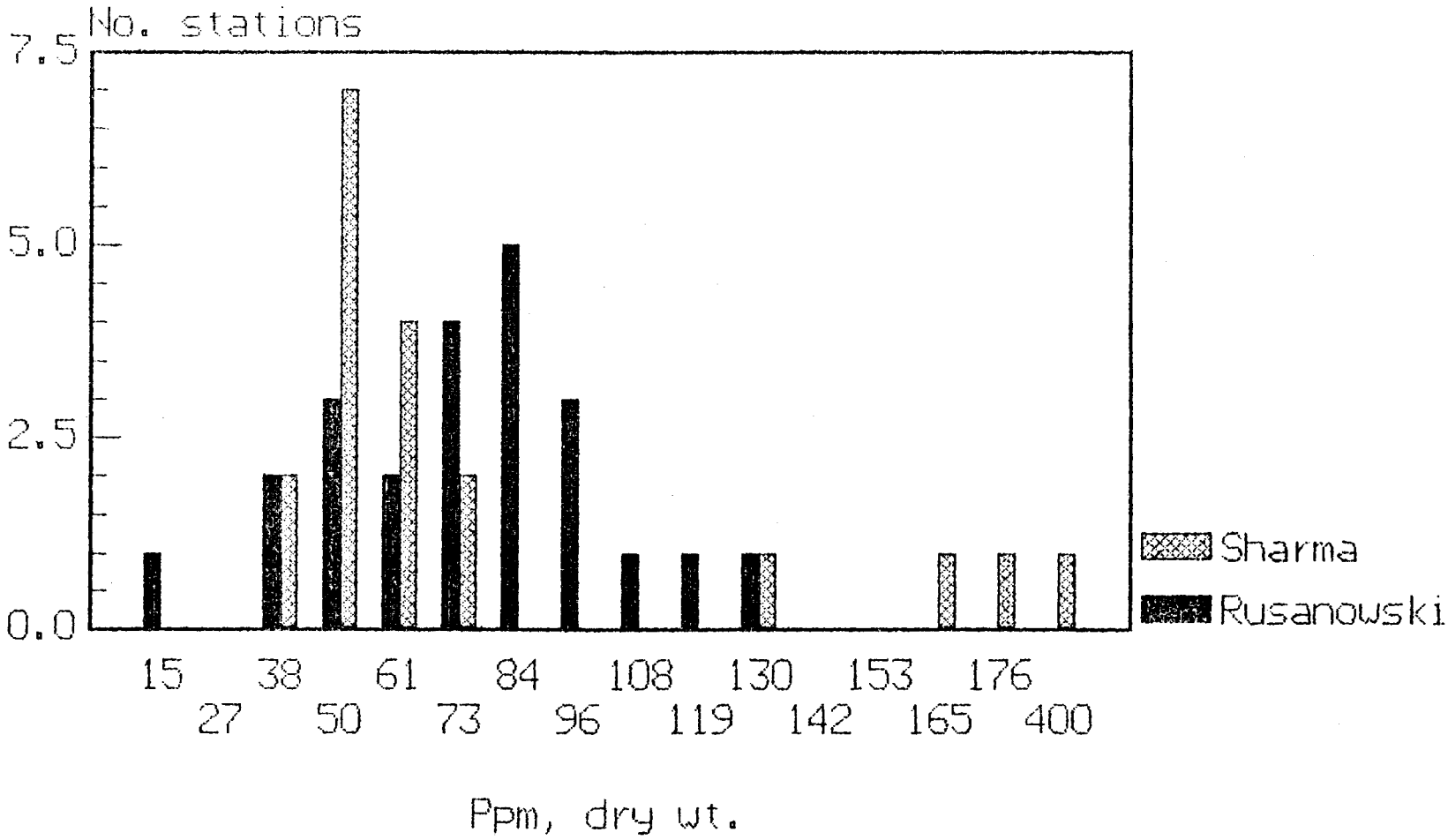

Fig. 39. Zinc in surface sediment near Nome, based on 22 samples of Rusanowski, et al (1988) and 19 samples of Sharma (1974).

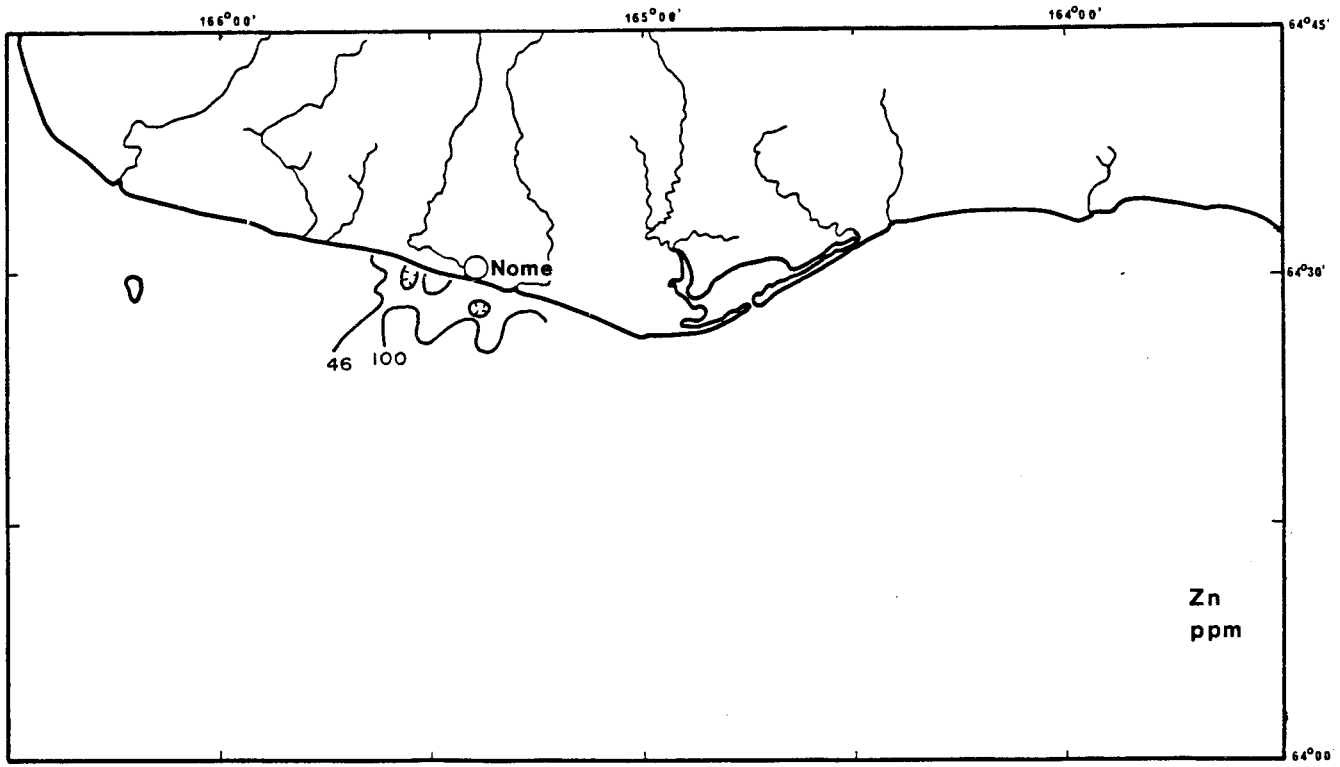

Fig. 40. Isolines of zinc concentration in surface sediments based on 19 van Veen grabs. Drawn from Sharma (1974:139).

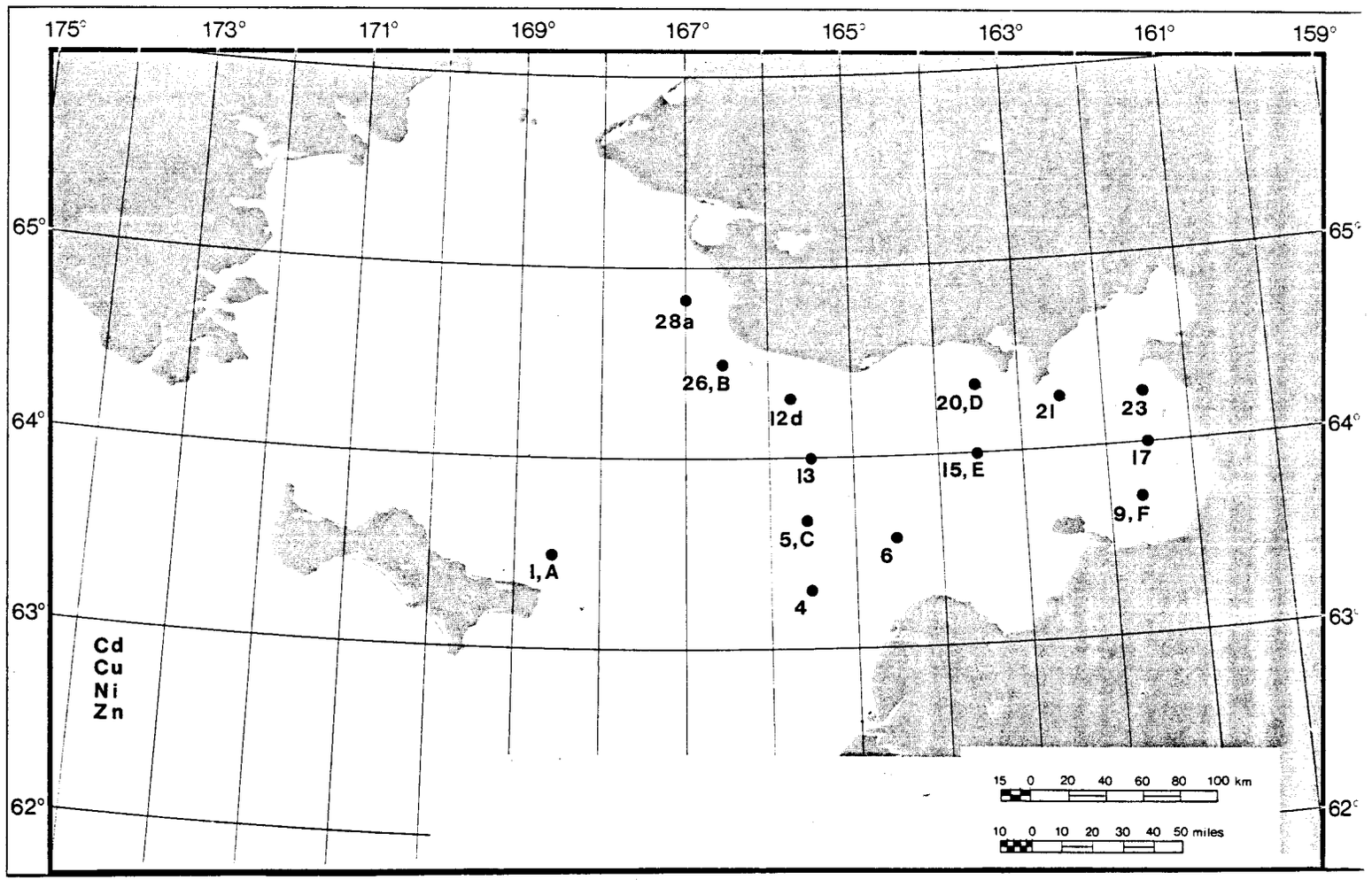

Fig. 41. Locations sampled for "acid-extractable" concentrations of cadmium, copper, nickel, and zinc by HAPS corer. The numbers are station labels of Burrell (1977). The letters are labels of stations analyzed for other metals in "whole-rock" samples by Robertson and Abel (1979).

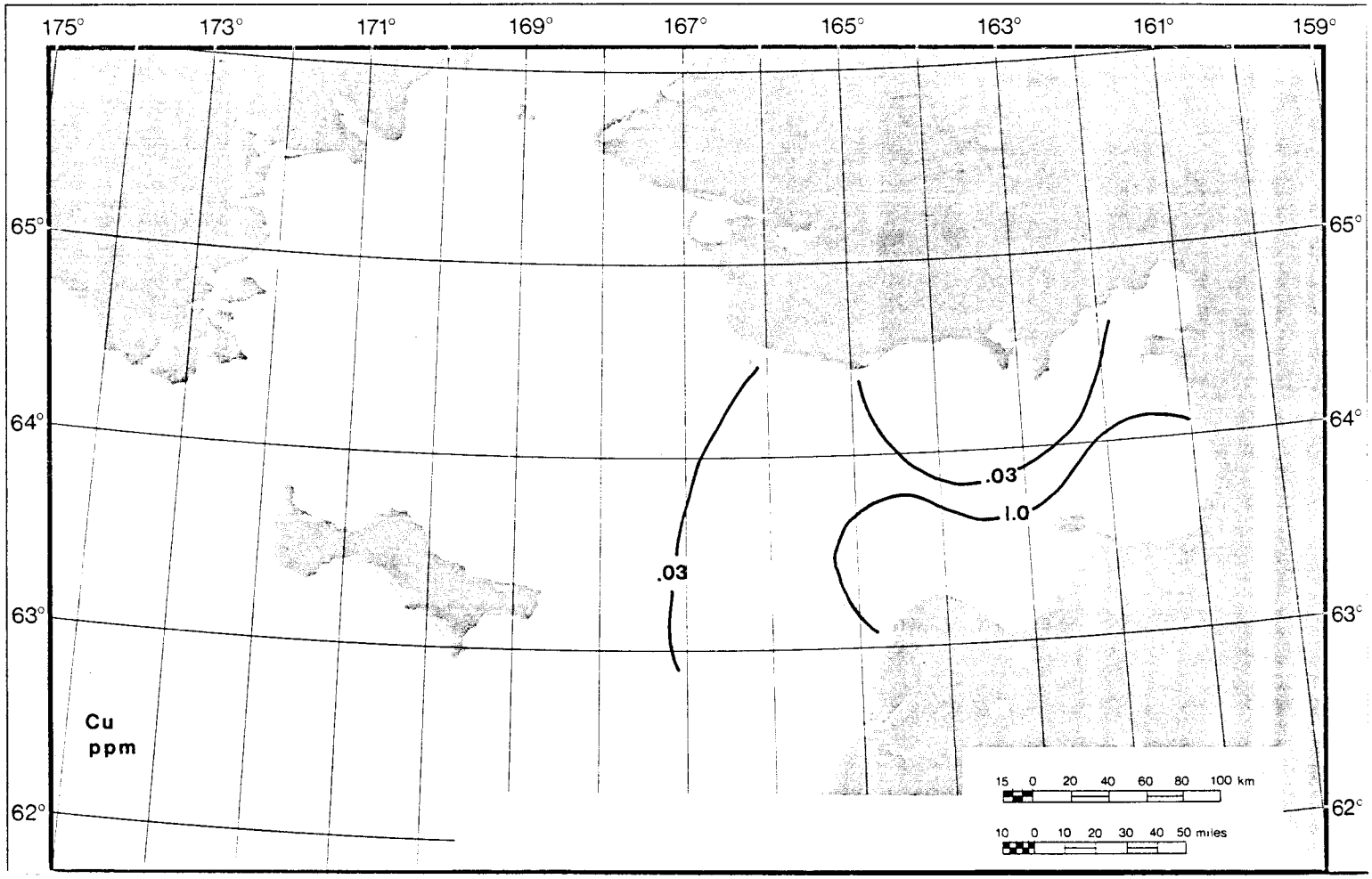

Fig. 42. Isolines of the concentration of extractable copper in surface sediment, based on 14 HAPS cores, 1976, in ppm. Adapted from Burrell (1978: Table 1).

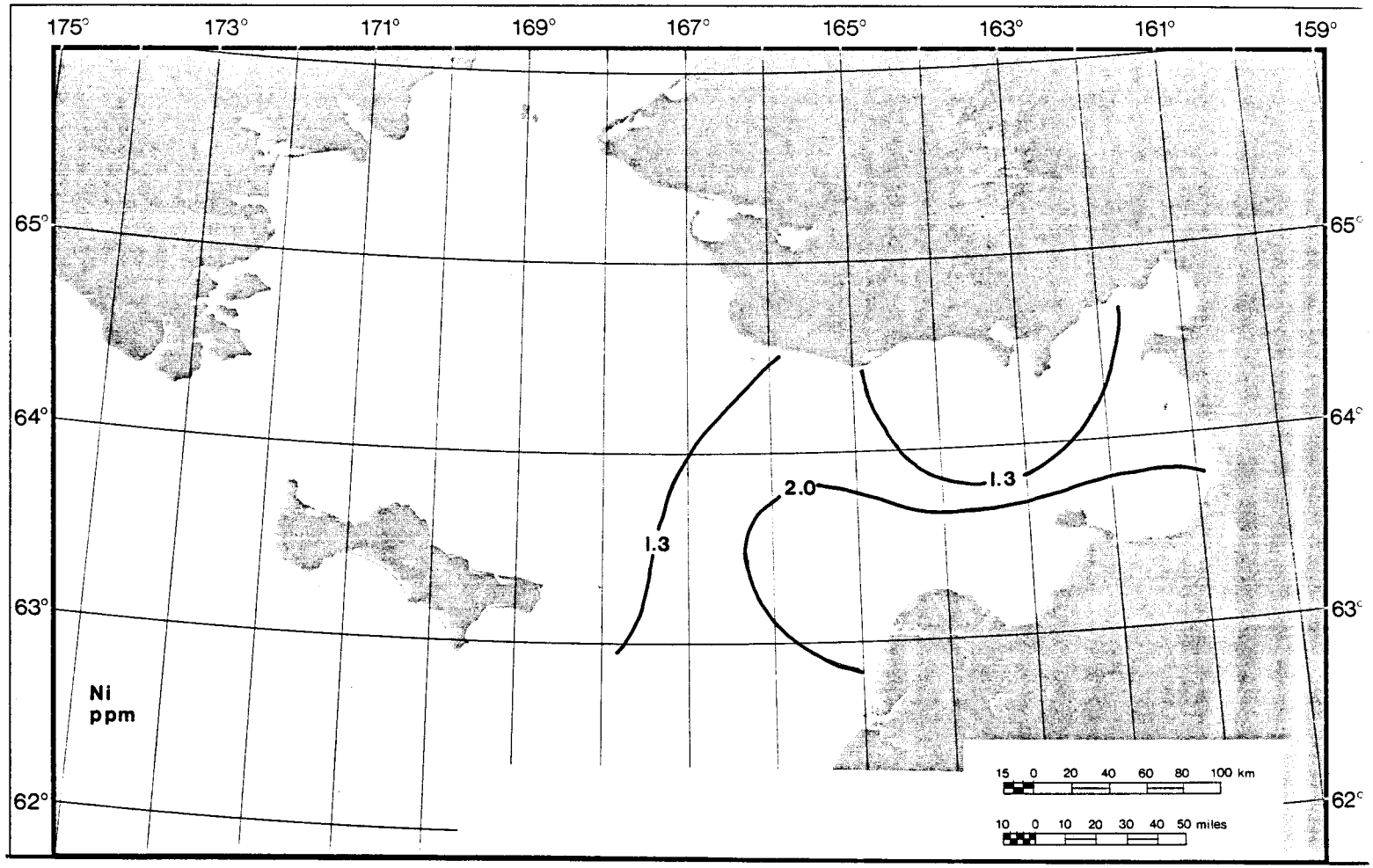

Fig. 43. Isolines of the concentration of extractable nickel in surface sediment, based on 14 HAPS cores, 1976, in ppm. Adapted from Burrell (1978: Table 1).

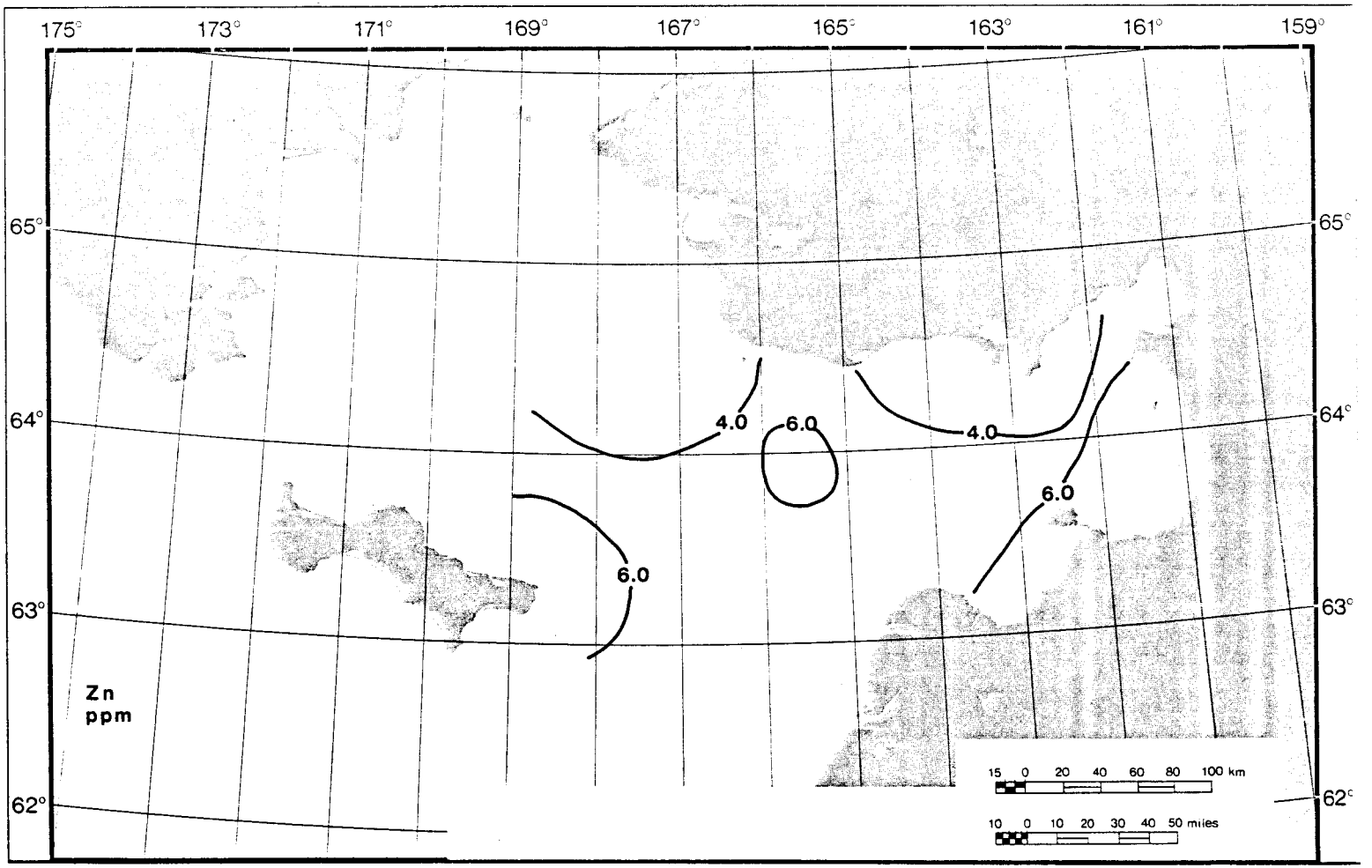

Fig. 44. Isolines of the concentration of extractable zinc in surface sediment, based on 14 HAPS cores, 1976, in ppm. Adapted from Burrell (1978: Table 1).

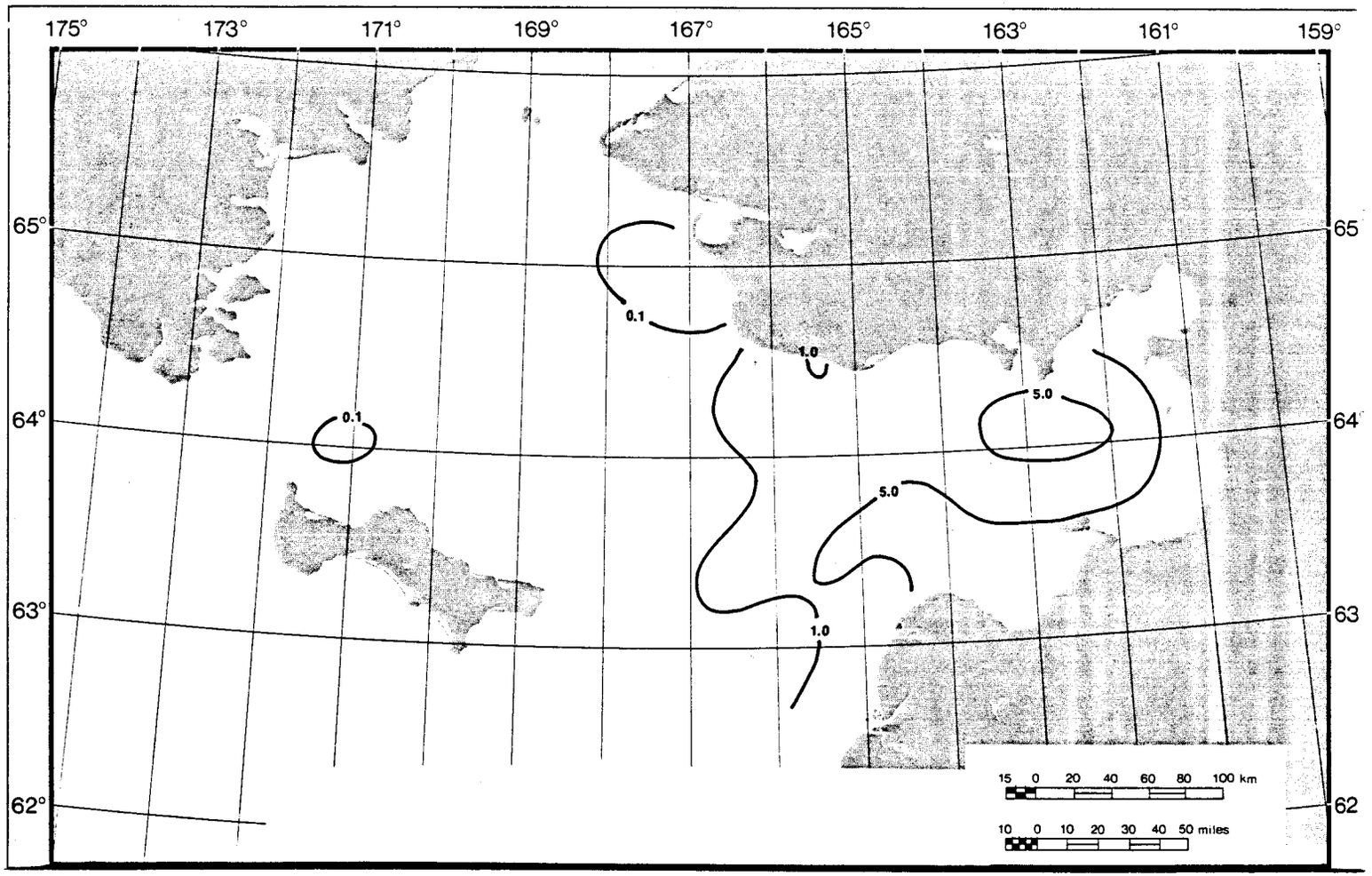

Fig. 45. Isolines of the concentration of total n-alkanes, resolved by gas chromatography, from C15 to C34, in ppm dry weight, in surface sediment. Based on 41 samples obtained by various methods in 1976, 1977, and 1979. Drawn from tabular data in Kaplan, et al (1980).

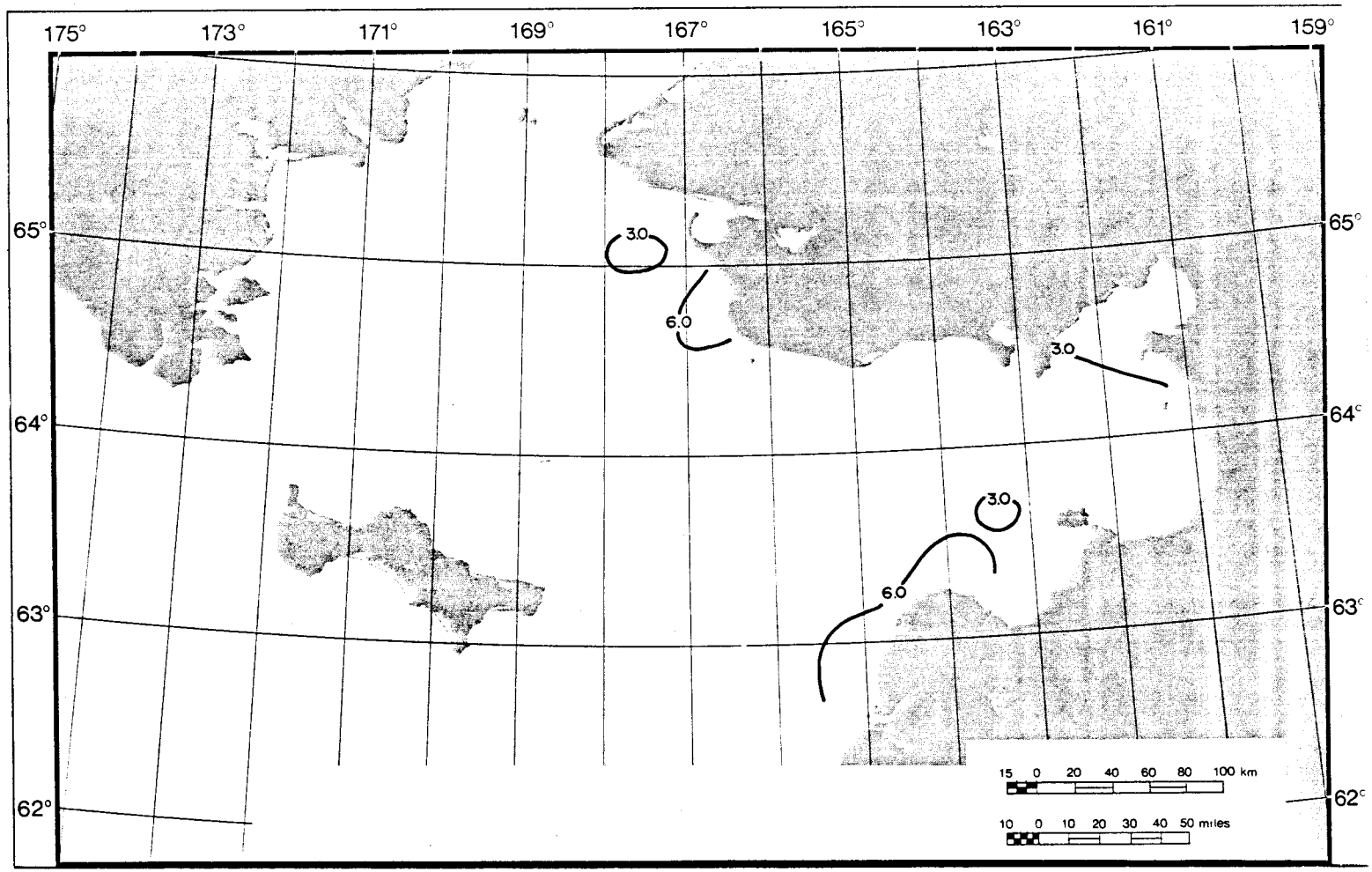

Fig. 46. Isolines of the odd-to-even ratio for n-alkanes summed from C15 to C34 in surface sediments. Based on 41 samples obtained by various methods in 1976, 1977, and 1979. Drawn from tabular data in Kaplan, et al (1980).

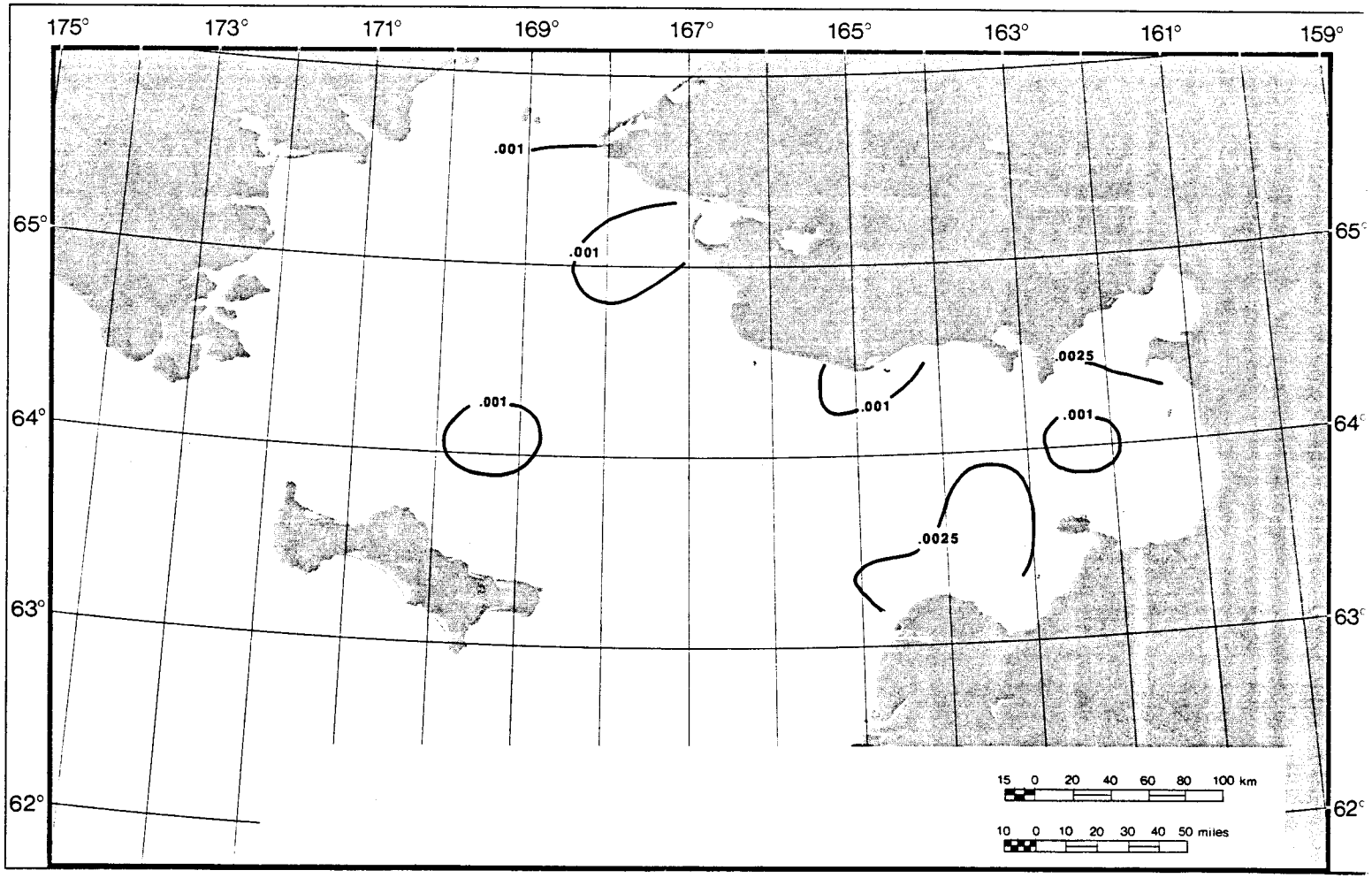

Fig. 47. Isolines of the ratio of the sum of the aliphatic and aromatic fractions (ppm dry wt.) to total organic carbon in surface sediments. Based on 33 samples obtained by various methods in 1976, 1977, and 1979. Drawn from tabular data in Kaplan, et al (1980).

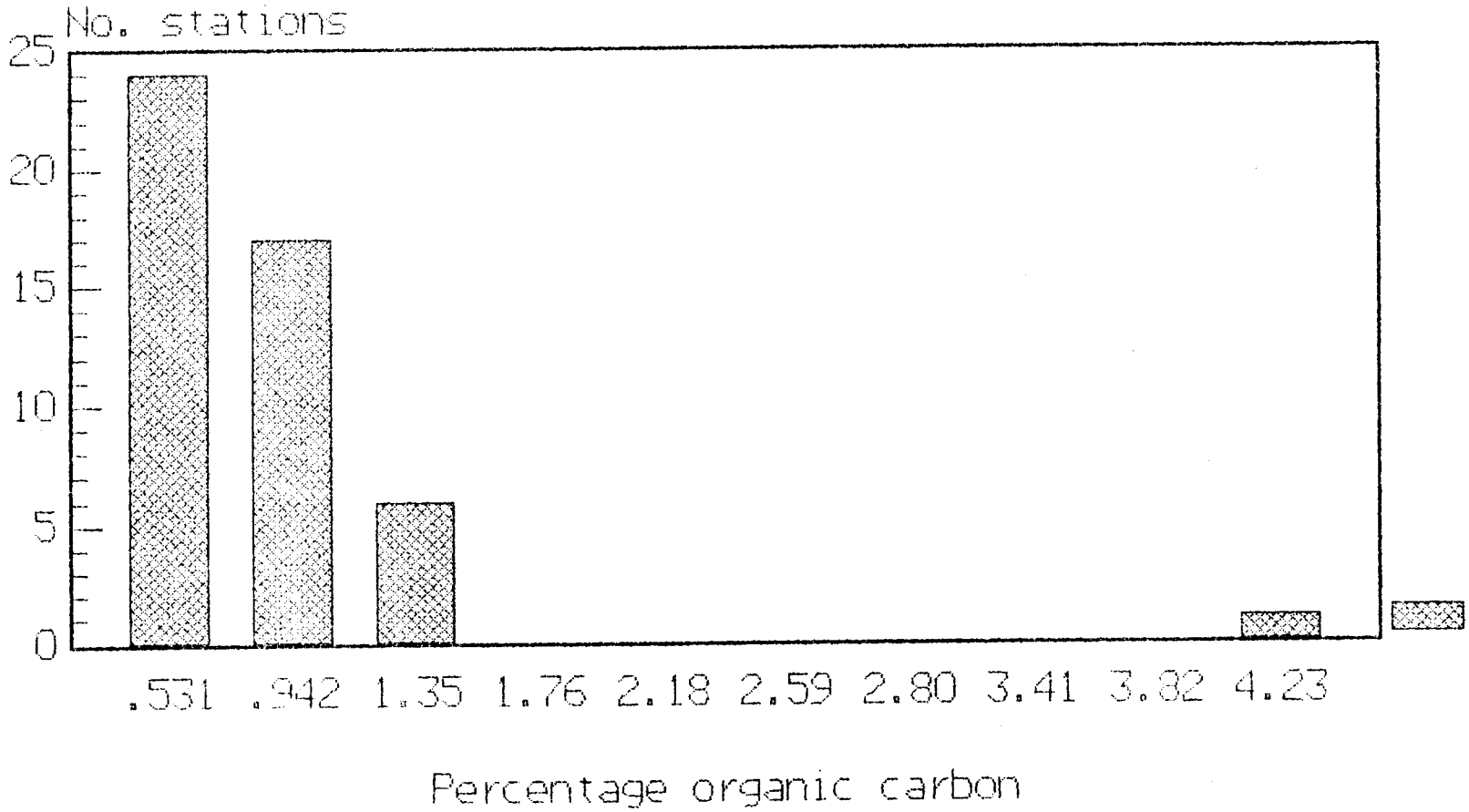

Fig. 48. Percentage of organic carbon in surface sediment at 48 stations in Norton Sound. Based on Kaplan, et al (1979).

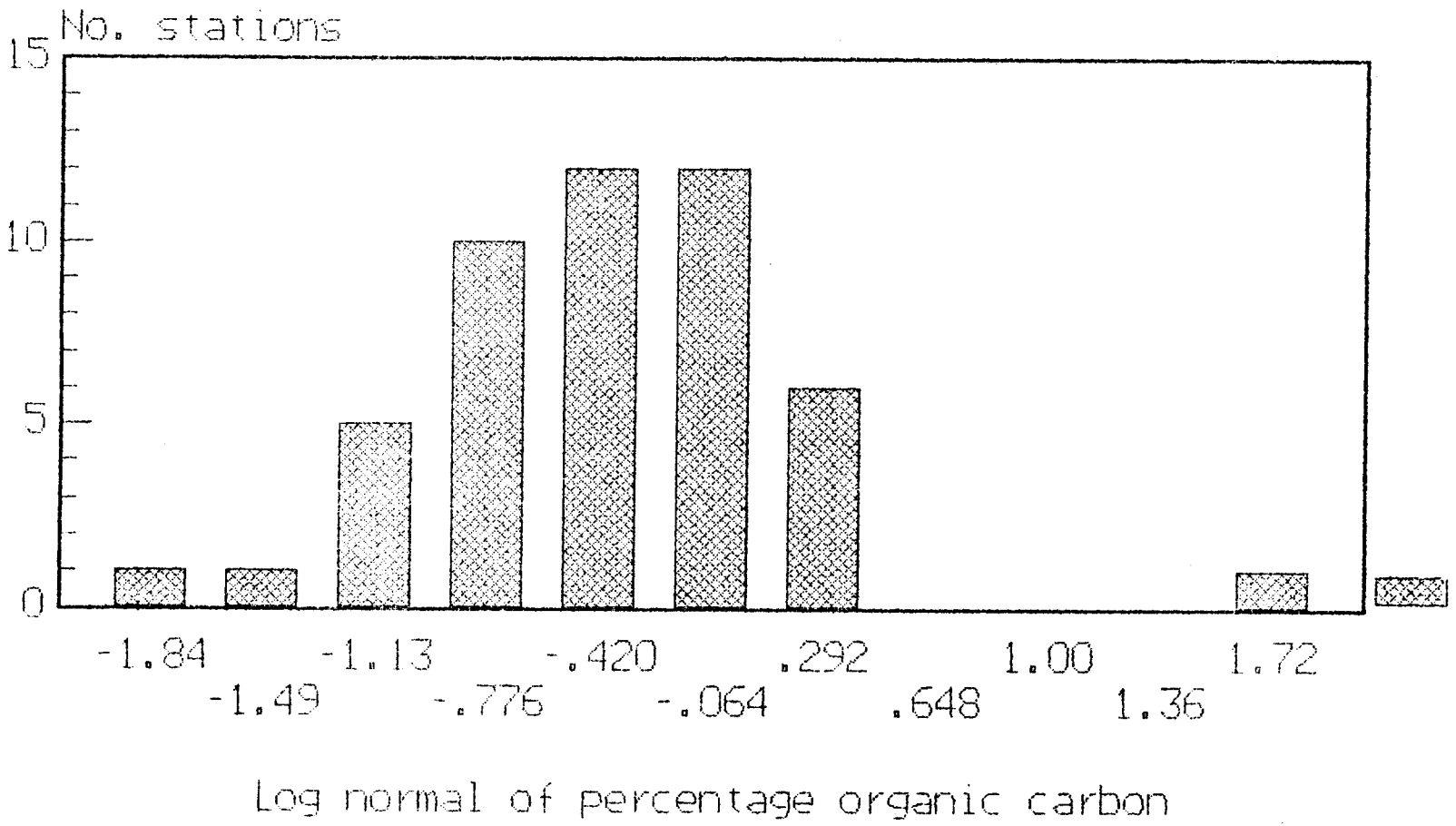

Fig. 49. Log normal of percentage of organic carbon in surface sediment at 48 stations in Norton Sound. Based on Kaplan, et al (1979).

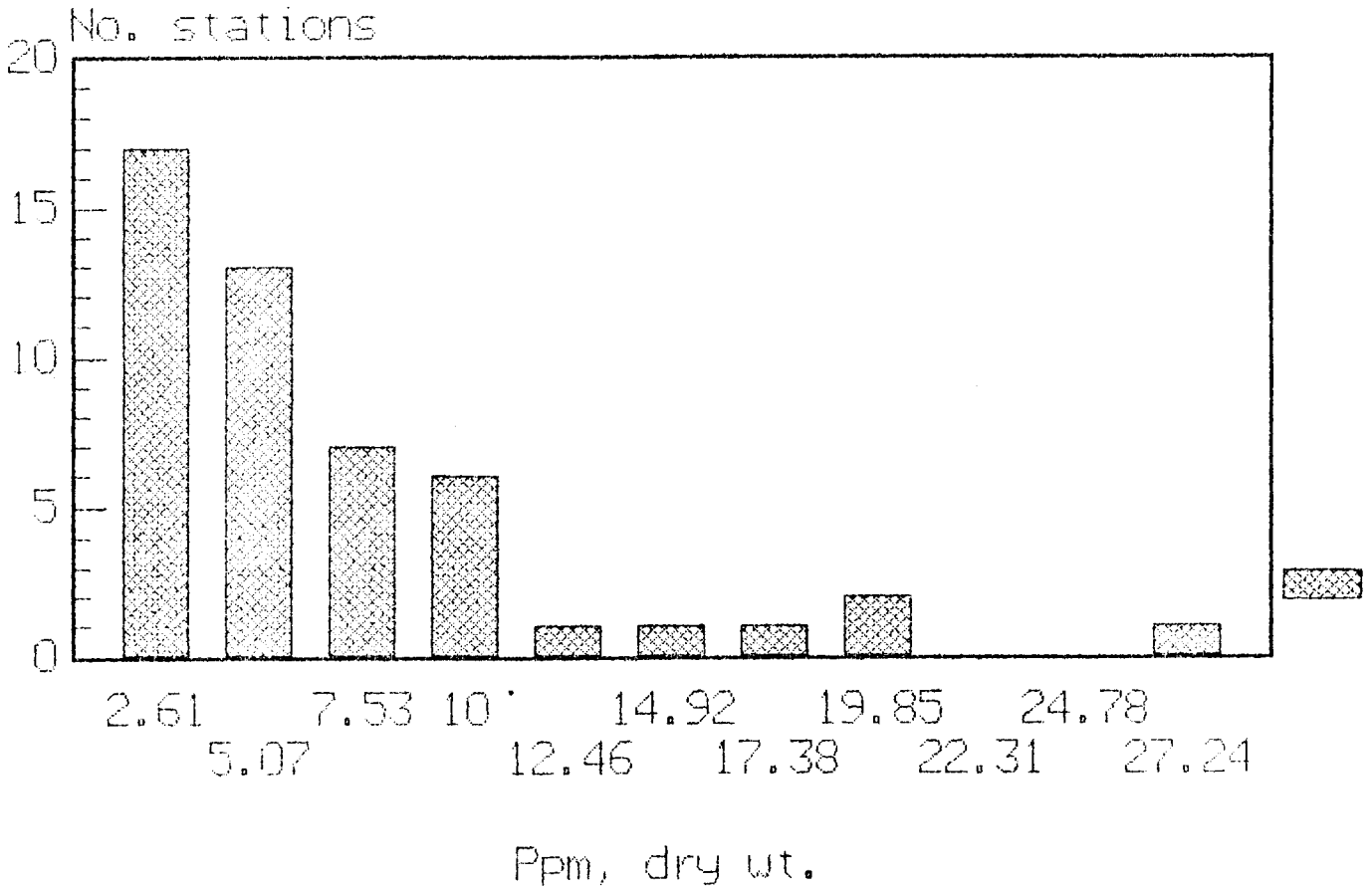

Fig. 50. Aliphatic hydrocarbons in surface sediment at 49 stations in Norton Basin. Based on Kaplan, et al (1979).

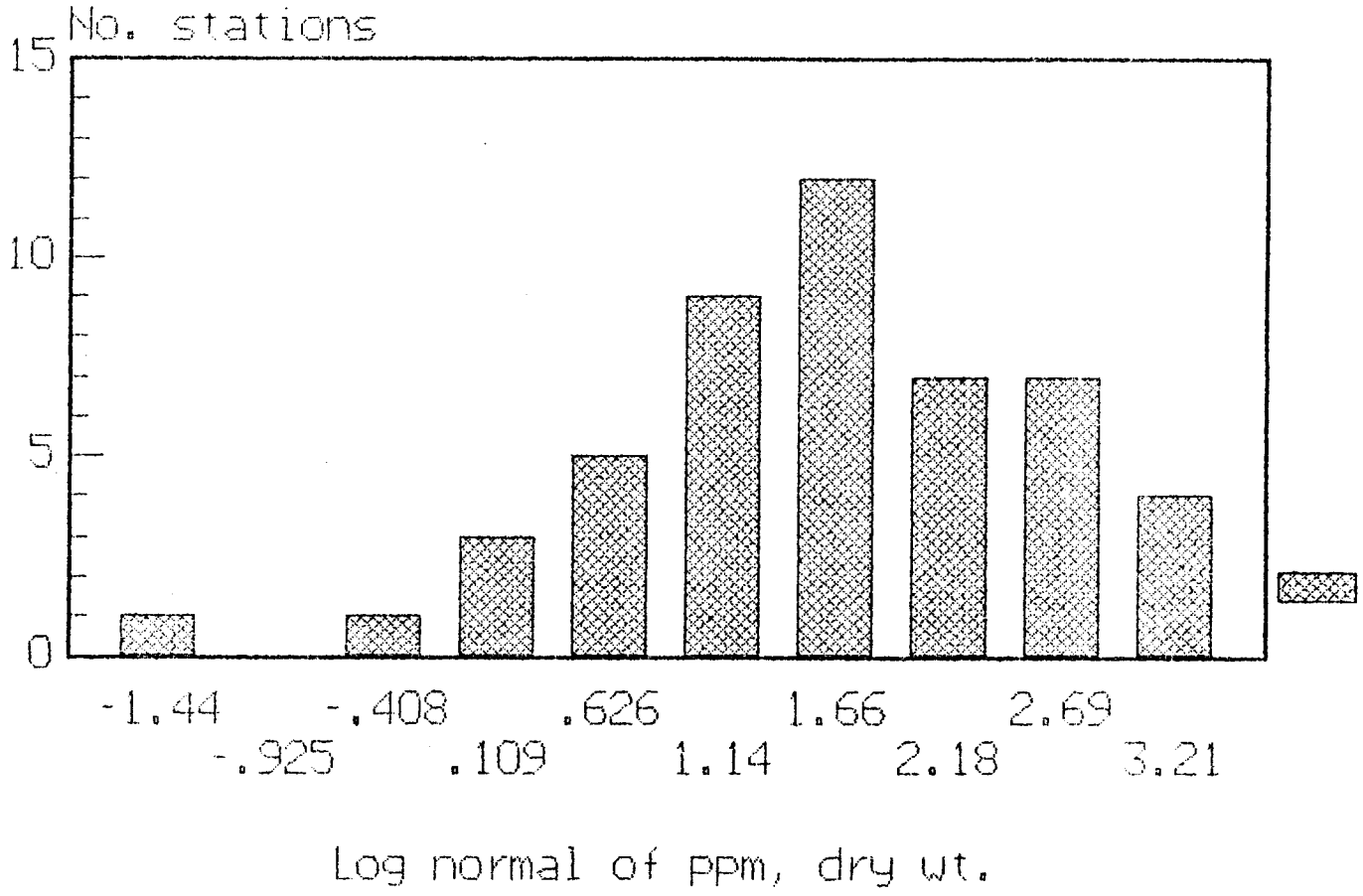

Fig. 51. Log normal of ppm of aliphatic hydrocarbons in surface sediment at 49 stations in Norton Basin. Based on Kaplan, et al (1979).

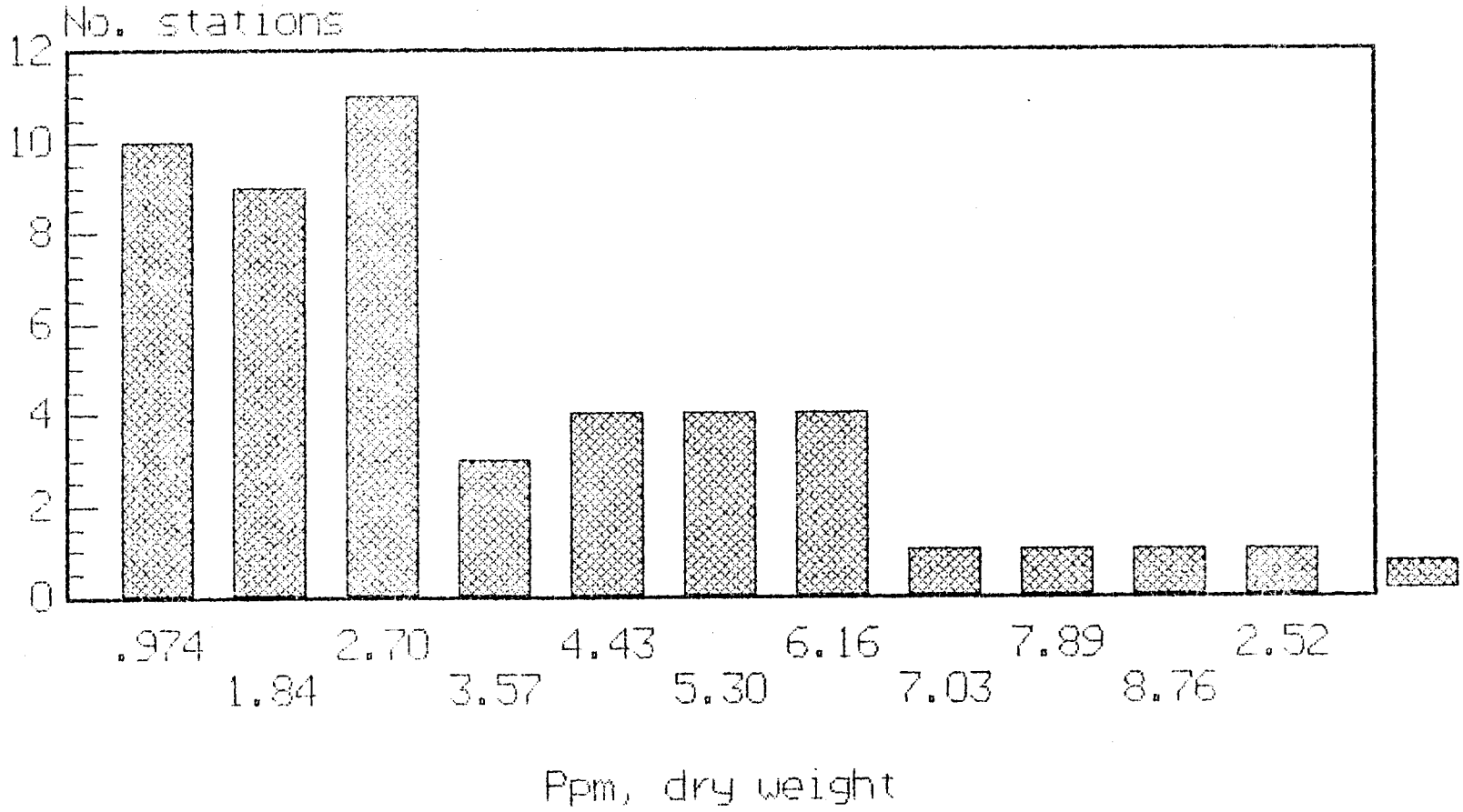

Fig. 52. Aromatic hydrocarbons in surface sediment at 48 stations in Norton Basin area, Alaska. Based on Kaplan, et al (1979).

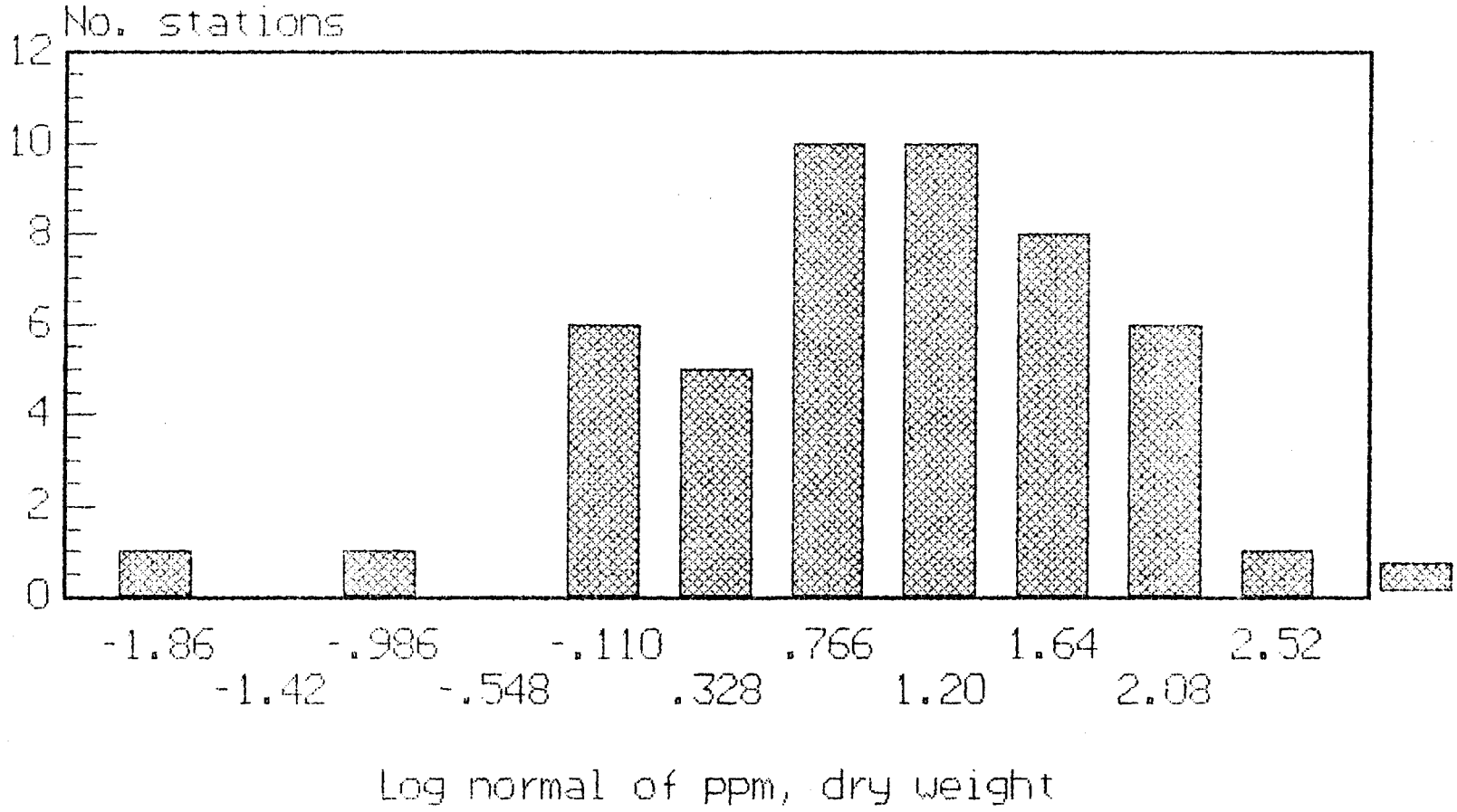

Fig. 53. Log normal of aromatics in surface sediment at 48 stations in Norton Basin area, Alaska. Based on Kaplan, et al (1979).

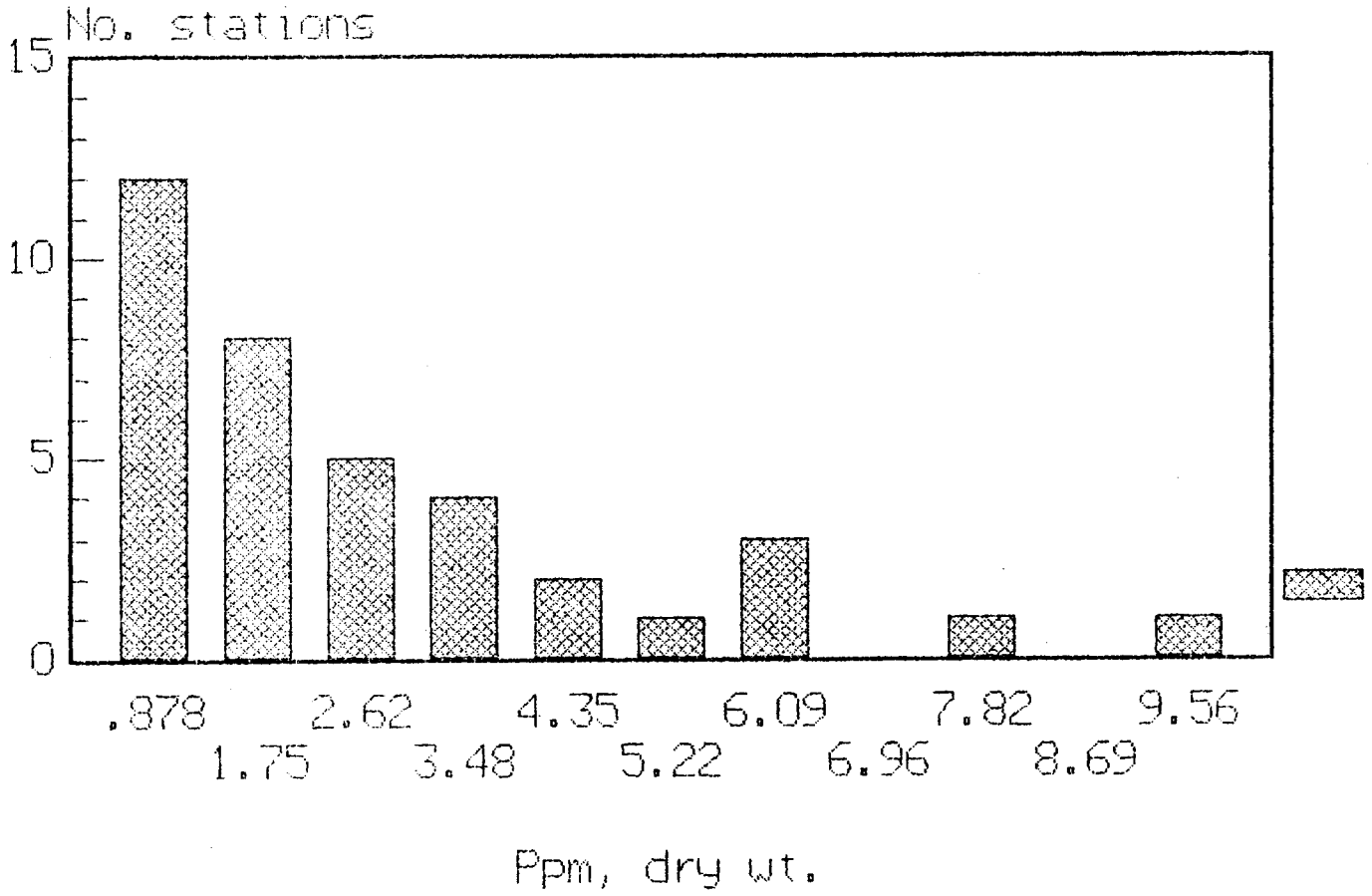

Fig. 54. N-alkane hydrocarbons in surface sediment at 37 stations in Norton Basin. Based on Kaplan, et al (1979).

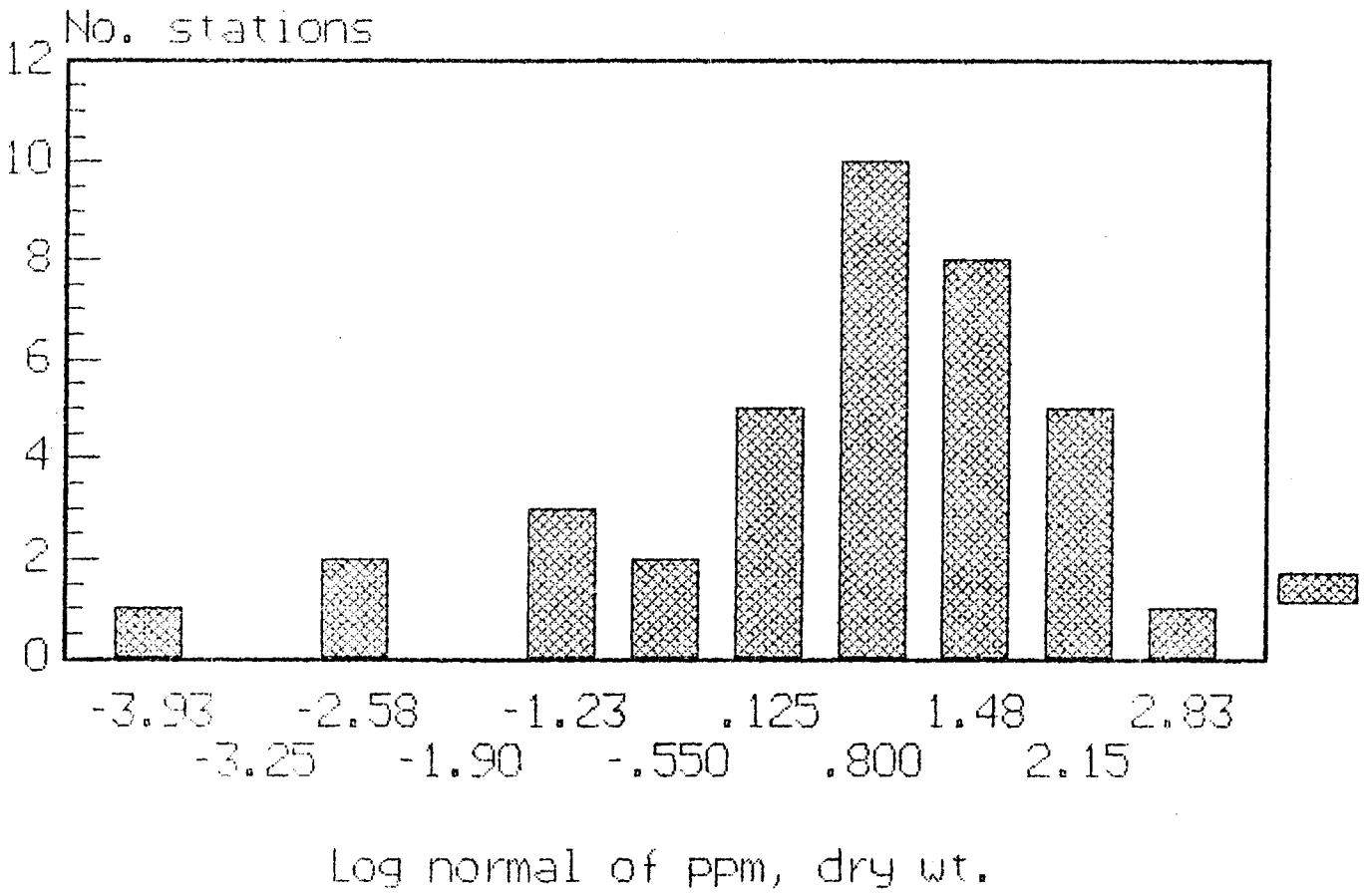

Fig. 55. Log normal of n-alkane hydrocarbons in surface sediment at 37 stations in Norton Basin. Based on Kaplan, et al (1979).

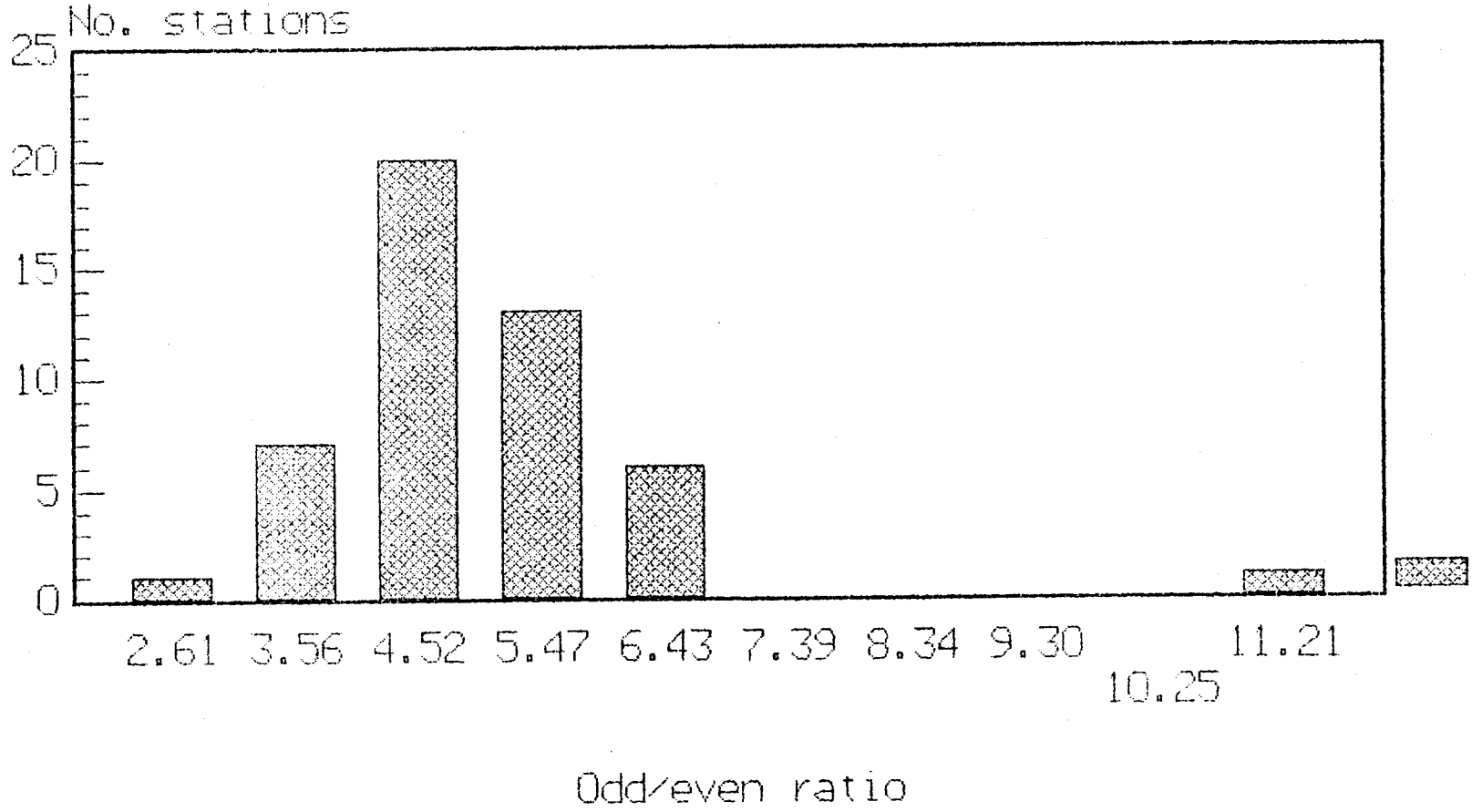

Fig. 56. Odd/even ratio of n-alkane hydrocarbons in surface sediment at 48 stations in Norton Basin. Based on Kaplan, et al (1979).

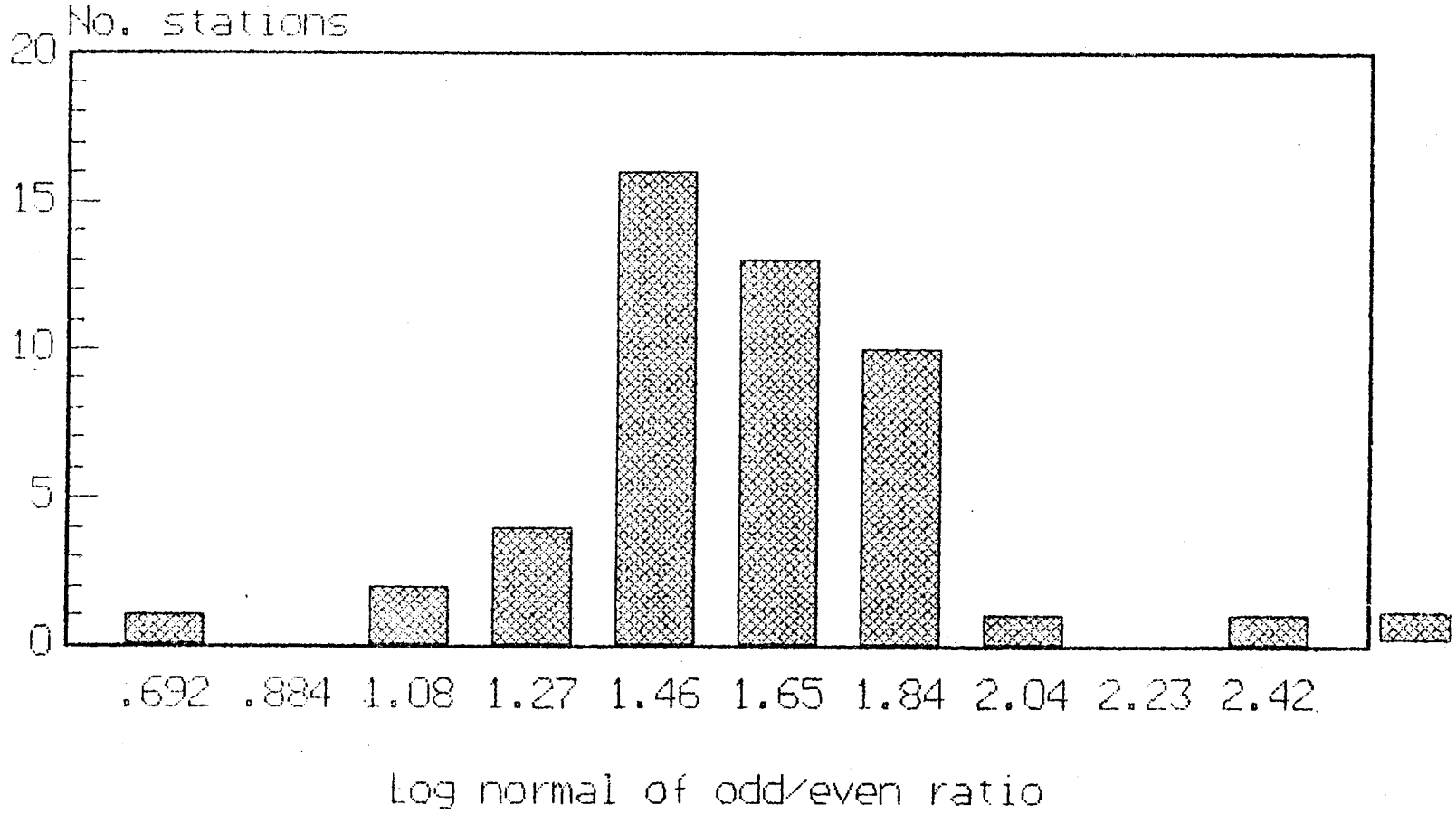

Fig. 57. Log normal of the odd/even ratio of n-alkane hydrocarbons in surface sediment at 48 stations in Norton Basin. Based in Kaplan, et al (1979).'

APPENDIX A

Annotated bibliography of data reports on trace contaminants in surface sediment and animal tissue in the northern Bering Sea

Trace contaminant concentrations data for the surface sediment and animal tissues of the northern Bering Sea are available in twenty research reports. These reports, both published and unpublished, present the results of four investigations sponsored by the Outer Continental Shelf Environmental Assessment Program as well as four other independent programs.

The contents of the data reports are briefly characterized in Table A1 and Table A2 by analytes and type of sampled material.

Table A3 shows the research programs responsible for the data reports.

All the reports are available as copies at the Alaska Office of the Ocean Assessment Division of NOAA. The OAD office also has magnetic spreadsheets and print files from those reports which presented tabular data.

Table A1. Reports of trace contaminants data from surface sediment of the Bering Sea north of 63 degrees and funded through the Outer Continental Shelf Environmental Assessment Program. Full citations are listed in the References section.

Citations	Analytes	Material
Burrell 1977, 1978, 1979	6 metals from extracts	sediment
Kaplan 1979, 1980, 1981	hydrocarbons	sediment
Larsen 1980	>50 elements	sediment
Nelson 1977	22 elements	sediment
Patry 1977	27 elements	sediment
Robertson 1979	17 elements	sediment
Venkatesan 1981	hydrocarbons	sediment

Table A2. Reports of trace contaminants data from surface sediment and animal tissue in the Bering Sea north of 63 degrees which were not part of the Outer Continental Shelf Environmental Assessment Program. Full citations are listed in the References section.

Citation	Analytes	Material	Taxa
Metsker 1984	5 metals & 2 org.chlor.	blubber	walrus
		liver	walrus
		kidney	walrus
Nelson 1972, 1975	mercury	sediment	--
NORTEC 1985	47 elements	sediment	--
Rusanowski 1986, 1987, 1988	8 elements	sediment	--
		muscle	red king crab
		hepatopancreas	red king crab
		unknown	8 invert. genera
		liver	least cisco
		liver	saffron cod
		muscle	least cisco
		muscle	saffron cod
		liver	spotted seal
		kidney	spotted seal
		blubber	spotted seal
		muscle	spotted seal
		liver	bearded seal
		kidney	bearded seal
		blubber	bearded seal
		muscle	bearded seal
Sharma 1974	4 elements	sediment	--
Sharma 1979	15 elements	sediment	--

Table A3. Reports of trace contaminants data from surface sediment and animal tissue in the Bering Sea north of 63 degrees, grouped within their research programs. Full citations are listed in the References section.

Research program	Citation
OCSEAP research unit 162	Burrell 1977 Burrell 1978 Burrell 1979
OCSEAP research unit 413	Larsen 1980 Nelson 1977 Patry 1977
OCSEAP research unit 480	Kaplan 1979 Kaplan 1980 Kaplan 1981 Venkatesan 1981
OCSEAP research unit 506	Robertson 1969
USFWS, Resource Contaminant Assessment Program	Metsker 1984
USGS	Nelson 1972 Nelson 1975
Nome Offshore Placer Project	NORTEC 1985 Rusanowski 1986 Rusanowski 1987 Rusanowski 1988
Alaska Sea Grant Program	Sharma 1974 Sharma 1979

Appendix B

Tables of data from original reports

Table B1. Concentrations (ppm, dry wt.) of metals in 14 HAPS core "acid-extracts" of sediment from greater Norton Sound, September, 1976. Adapted from Burrell (1977:32) and Burrell (1978:73).

Sta.	% clay & silt	Lat. Deg	Lat. Min.	Long. Deg.	Long. Min.	Water depth (m)	Cd	Cu	Ni	Zn	Fe	Mn
1	22.1	63	31.8	168	32.2	29	<0.1	<0.3	<1.3	6.2	746	8
4	87.0	63	19.7	165	29.9	21	<0.1	0.5	2.5	5.0	3050	48
5	64.3	63	39.5	165	32.1	22	<0.1	0.5	2.9	5.0	2843	86
6	86.4	63	38.4	164	31.0	13	<0.1	2.0	3.3	5.7	3084	121
9	89.0	63	41.5	161	31.1	15	<0.1	1.1	4.3	8.0	4250	79
12d	59.5	64	23.5	165	44.8	26	<0.1	0.6	1.4	5.1	1609	230
13	81.9	64	59.7	165	29.7	20	<0.1	0.5	1.8	6.0	2086	283
15	81.9	64	0.3	163	30.5	20	<0.1	<0.3	<1.3	5.1	1779	75
17	85.6	64	0.0	161	30.3	18.5	0.1	2.2	4.2	9.1	2961	193
20	35.2	64	20.1	163	31.0	20	<0.1	<0.3	<1.3	3.5	966	58
21	21.5	64	15.3	162	29.7	19	<0.1	0.3	<1.3	3.5	1219	52
23	43.8	64	17.5	161	30.7	15	<0.1	0.6	1.8	6.6	2066	70
26	17.6	64	30.2	166	31.5	28	<0.1	<0.3	<1.3	2.5	565	60
28a	14.8	64	44.6	167	1.0	24	<0.1	<0.3	<1.3	2.5	745	20

Table B2. Index ratios for hydrocarbons in Norton Sound sediments, 1976. Adapted from Kaplan (1979: Table 6).

Sta.	(n-alkanes/ organic carbon) x10e4	Pristane/ n-C17	Phytane/ n-C18	Pristane/ phytane	Odd/ even
47	3.74	0.38	0.20	2.00	5.38
49	5.08	0.30	0.14	1.50	6.06
70	0.03	2.66	0.25	8.00	1.65
88b	1.30	2.03	3.80	2.14	4.11
105	0.08	L	L	L	11.21
125	1.25	0.40	0.19	2.00	4.02
131	16.32	L	L	L	2.80
137		0.64	0.18	3.00	4.07
147	6.79	0.60	0.36	1.80	2.85
154	5.51	0.64	0.17	3.60	5.69
156	3.89	0.50	0.19	2.67	5.57
162	0.49	0.50	0.23	2.00	4.75
166s	0.14	0.67	0.23	4.00	5.16
168s	1.35	0.58	0.17	3.50	5.26
169s	2.89	0.58	0.23	3.60	4.47
170s	4.95	0.46	L	L	5.80
172s	3.33	L	L	L	4.70
174s	2.19	2.00	2.20	6.00	4.50

Table B3. Concentrations (dry wt.) of hydrocarbons in Norton Sound surface sediments, 1976.
Samples are from 0-2cm except B- bulk and S- surface.
L represents concentrations below detection limit, i.e. "too low to be calculated accurately." Adapted from Kaplan, et al (1979: Tables 4, 5, 6).

Sta.	Sample depth	Lat. Deg	Lat. Min	Long Deg	Long Min	Depth (m)	% Total carbon	% Organic carbon	Aliphatic fr. (ppm)	Aromatic fr .(ppm)	PPB NORMAL ALKANES: n-C15	n-C16
47	0-2cm	64	25.00	165	29.00	15	1.02	0.93	9.644	7.47	L	L
49	0-2cm	63	27.77	163	52.57	10	1.4	1.12	24.782	4.13	L	L
70	0-2cm	65	6.13	167	40.40	31	0.37	0.31	2.207	6.186	L	0.1
88b	bulk 0-10cm	65	46.01	168	5.51	9	0.84	0.53	3.953	5.682	6.9	4.5
105	0-2cm	64	49.00	166	44.00	15	1.29	0.93	1.845	0.886	L	L
121	0-2cm	63	52.99	163	1.34	20	1.37	1.18				
125	0-2cm	64	0.12	162	24.60	18	0.98	0.55	0.141	2.438	1.6	1.4
131	0-2cm	64	23.60	161	49.27	17	0.96	0.44	9.035	2.988	L	L
137	0-2cm	63	40.89	161	13.29	4			17.766	4.531	L	L
147	0-2cm	63	47.00	163	41.50	17	0.87	0.33	6.779	2.293	4.6	L
152	0-2cm	64	5.00	164	26.50	22	0.5	0.35				
154	0-2cm	63	45.08	164	37.43	18	1.25	0.99	16.264	4.182	L	L
156	0-2cm	63	28.39	165	19.28	17	1.4	1.3	7.119	5.511	L	L
157s	surface 1mm	63	18.11	165	3.26	8	1.16	0.82				
160s	surface 1mm	62	54.50	165	8.15	10	2.4	0.7				
162	0-2cm	63	2.80	165	53.99	21	1.26	0.92	45.09	2.316	1.1	1.1
166s	surface 1mm	63	14.62	167	2.21	26	1.54	1.16	39.99	0.756	L	L
168s	surface 1mm	63	26.25	166	29.64	28	1.33	1.1	57.03	2.18	L	L
169s	surface 1mm	63	34.79	166	5.53	27	1.09	0.33	117.12	4.001	3.2	2.6
170s	surface 1mm	63	41.72	165	45.81	25	0.87	0.52	62.89	2.208	L	L
172s	surface 1mm	64	0.10	165	29.25	20	1.36	0.87	80.14	3.773	L	L
174s	surface 1mm	64	21.15	165	0.40	36	1.48	0.82	53.21	2.005	L	L

Table B3 con't

n-C17	Pris-tane	n-C18	Phy-tane	n-C19	n-C20	n-C21	n-C22	n-C23	n-C24	n-C25	n-C26	n-C27
10.7	L	11.9	L	35	43.7	164.5	142.4	384.3	1.4	434.1	111.5	740.1
L	L	L	L	45.9	61.3	226.2	201.8	552	200.9	624.4	154.9	1351.9
0.3	0.8	0.4	0.1	0.6	0.5	0.6	0.6	0.7	0.6	0.7	0.5	0.9
10	20.3	2.5	9.5	19.3	13.3	257.4	14.6	23.1	17	31.1	20.4	75.6
L	L	L	L	L	L	2.6	2.9	8.3	3.2	9.7	L	19.1
3.5	1.4	3.7	0.7	9	9.8	L	26.5	66.4	28	78.9	25	151.4
21.3	L	L	L	30.6	37.7	174.7	150.5	469.9	169.6	647.4	169.1	1490.2
13.1	L	18.5	L	61.9	85.5	291.1	283.7	761.3	316.4	883.7	292	1861
14.4	L	11.3	L	32.2	37.2	113.6	100	262.8	108.5	299.6	79.3	533.7
13.4	L	15.8	L	51	58.2	215.4	182.2	501.8	177.4	594.9	149.1	1375.4
15.7	L	15.1	L	40.4	49	178.3	158.2	446.3	169.1	557.7	132.1	1304
2.4	1.2	2.1	L	5.6	5.6	21.5	16.9	46.8	17.4	53.5	14.3	107.5
0.9	0.6	0.6	L	1.3	1.5	4.3	4.6	12.8	5.8	16.9	5	36.6
L	L	L	L	9.1	11.2	42.8	40.2	128.2	50.5	167.1	48.4	347
6.2	3.6	4.3	1	9.4	10.1	31.6	29.7	83.2	34.4	127.5	38.9	199.5
L	L	L	L	L	4.3	63.2	66.5	218.3	79.7	288.3	73.9	631.2
L	L	L	L	L	L	84.3	67	261.3	68.2	339.3	65	616.9
L	L	L	L	7.7	13.5	56.2	54.5	261.3	59.2	201.2	52.9	416.7

Table B3 con't

n-C28	n-C29	n-C30	n-C31	n-C32	n-C33	n-C34	Total n-alkanes (ppm)
82.1	539.6	131.4	480.5	21.1	143.9	L	3.277
139.5	956.2	47.4	114.1	L	266.3	L	5.688
0.5	1.3	0.4	1	0.3	0.3	L	0.0102
32.6	57.4	7.8	59.1	10.7	18.5	6.2	0.688
L	13.2	L	15.6	L	L	L	0.0745
21.2	106	12.4	99	6.3	31.5	3.3	0.6876
167.9	1098	925.3	1051.9	28.6	310.1	L	7.184
243.9	1362.1	344.9	1296.7	87.9	486.6	42.2	8.694
52.3	310.4	168.4	16.6	L	71.2	L	2.241
132.6	879.1	67.6	63.8	L	40.7	L	5.451
119.9	821.6	59.1	702	38.7	224.7		5.061
10.6	63.4	5.1	52.2	3.5	15.9	1.4	0.4477
4.6	26.9	2.2	24.6	1.3	7.5	L	0.1571
43.5	255.1	33.4	230.5	9.1	64.4	L	1.481
26.5	143.5	14.9	132.6	8.3	43.1	3.6	0.954
62.1	443.5	72.6	432.2	7.7	117.6	L	2.573
60.8	521	168.1	454.1	78.5	109.6	L	2.894
46	285.3	75.5	272.5	7.7	72.6	L	1.792

Table B4. Index ratios for hydrocarbons in Norton Sound sediments, 1977. Adapted from Kaplan, et al (1979: Table 9).

Sta.	Sample depth	(alkanes/ organic carbon) x10e4	Pristane/ n-C17	Phytane/ n-C18	Pristane/ phytane	Odd/ even
34	0-2cm	0.75	1.38	0.14	2.00	4.55
35	0-2cm	0.87	1.67	0.22	7.00	5.15
39	surface 1mm	0.24	1.44	0.33	2.50	5.35
41	surface 1mm	0.53	1.00	0.25	4.00	4.78
42	surface 1mm	2.60	1.82	0.25	5.50	4.78
43	0-2cm	0.64	1.06	0.16	6.50	4.22
44	0-2cm	0.48	1.44	0.13	6.00	3.21
48	surface 1mm	0.38	1.38	0.17	5.00	6.37
14	IK 0-3cm	4.37	0.55	0.23	3.10	5.26
17	0-3cm	2.04	2.03	0.19	1.30	5.12
17	SV 0-3cm	6.40	0.50	0.17	2.00	5.67

Table B5. Concentrations of hydrocarbons in Norton Sound surface sediments, 1977. L represents concentrations below detection limit, i.e. "too low to be calculated accurately." Adapted from Kaplan, et al (1979: Tables 7 and 8).

Sta.	Sample depth	Lat. Deg.	Lat. min.	Long. Deg.	Long. min.	Water depth (m)	% Total carbon	% organic carbon	Aliphatic fraction (ppm)	Aromatic fraction (ppm)	PPB ALKANES: n-C17
34	0-2cm	64	52.30	167	39.65	32	0.35	0.12	0.809	0.678	L
35	0-2cm	65	14.90	167	45.70	52	0.67	0.59	2.248	1.132	1.4
39	surface 1mm	64	7.09	171	18.00	34	1.54	0.38	0.643	0.247	0.2
41	surface 1mm	64	2.75	171	36.10	27	0.91	0.44	2.466	0.847	L
42	surface 1mm	63	58.40	169	22.65	39	1.76	0.32	4.444	1.922	1.7
43	0-2cm	63	57.85	167	48.03	35	0.63	0.6	1.01	1.714	1.2
44	0-2cm	63	45.40	167	0.50	31	0.66	0.52	2.072	0.9	L
48	surface 1mm	62	58.20	165	16.25	10	9.08	4.23	5.829	5.012	4
14	IK 0-3cm	64	14.80	165	25.50	18	1.12	0.28	5.36	1.296	4.4
17	sv 0-3cm	64	5.10	165	28.62	19	1.09	0.86	14.066	2.228	2.7
17	0-3cm	64	5.10	165	28.62	19	0.31	0.24	5.494	2.667	L

Pristane	n-C18	Phytane	n-C19	n-C20	n-C21	n-C22	n-C23	n-C24	n-C25	n-C26	n-C27
L	L	L	0.9	1.2	3.2	3.3	7.7	3.3	8.6	3.2	18.9
2.4	1.5	L	3.2	4	13.2	13.4	39.8	17.2	52.2	16.9	117.8
0.3	0.3	L	0.7	0.8	1.8	2	5.1	2.8	7.8	3	19.6
L	L	L	1.3	1.8	6	6.1	18	8.8	24.7	8.8	49.5
3.2	1.8	L	9.7	7.1	23.7	22.3	63.8	27.8	79.7	27.1	170.2
1.3	1.2	L	3.5	3.9	12.1	11.8	1.6	14.2	41.6	14.2	88.6
L	0.6	L	1.7	2.5	9.2	14.3	34.5	22.3	34.1	13	49.5
5.6	5.1	L	16.7	17.3	66.3	43.3	136.5	47.5	185.1	39.1	459
L	4.6	L	11.1	13.1	42.3	36.8	104.2	42.7	129.9	35.9	284.8
L	4.5	L	14.6	18.3	63	55.3	149.3	59.2	180.5	53.7	409
L	L	L	22.7	15.6	54.5	49.2	138	53.6	166.1	45	367.7

n-C28	n-C29	n-C30	n-C31	n-C32	n-C33	n-C34
2.9	14.9	1.4	14.7	0.9	4.9	L
16.5	95.4	10.4	101	6.6	32.3	2.6
3.1	17	0.4	19.2	1.3	6.2	0.7
8.6	41.1	4	41.2	2.4	11.6	L
27.5	142.8	16	148.1	10.2	45.2	3.2
13.5	70.2	7.6	69.4	4.6	21.9	2
6.3	28.4	0.9	22.8	L	6.4	L
39.4	260.8	14.7	190.7	9.9	59.6	L
32.6	201.6	18.1	186.8	11.7	62.5	L
46.8	292.4	26.1	268	16.1	87.3	0.66
40.3	256.2	18.4	223.8	12.1	71.7	L

Table B6. Index ratios for hydrocarbons in Norton Sound sediment, 1979. Adapted from Kaplan, et al (1979: Table 17).

Sta.	(n-alkanes/ organic carbon) x10e4	Pristane/ n-C17	Phytane/ n-/C18	Pristane/ phytane	Odd/ even
1	4.92	0.37	0.18	0.75	3.37
5	7.74	1.06			3.91
7	7.58	0.95			3.80
8	12.93	0.48	0.25	1.71	3.27
13	5.48	0.59	0.24	1.65	4.32
15	3.39	0.5	0.17	2.47	3.81
18	4.62	0.44	0.19	1.86	4.04
20	3.76	0.44			4.03
21	6.07	0.62			4.40
22	3.29	0.42	0.18	2.44	3.35
25	2.38	0.41			4.12
29a	3.38	0.37	0.23	1.50	4.33
29b	2.49	0.31			3.56
33a		0.54			4.09
36					3.97
40	0.38				5.27
47a		0.62			4.29
49		2.27	0.28	8.88	4.18
50	0.9	0.75			3.87

Table B7. Concentrations (dry wt.) of hydrocarbons in Norton Sound surface sediments, 1979. L represents concentrations below detection limit. Adapted from Kaplan, et al (1979: Tables 15 and 16).

Sta.	Lat. Deg	Lat. Min	Long. Deg	Long. Min	Depth (m)	% Total carbon	% Organic carbon	Aliphatic fraction (ppm)	Aromatic fraction (ppm)	PPB ALKANES: n-C15	n-C16
1	64	19.20	162	0.50	17	1.2	0.72	4.68	3.31	3.2	3.3
5	63	39.90	161	17.80	13	1.63	0.74	17.83	8.76	4.7	4.7
7	63	40.30	162	59.80	17	1.28	0.57	9.66	6.08	L	2.4
8	64	0.30	163	4.00	20	0.69	0.46	1.56	1.49	0.8	0.9
13	63	20.20	165	12.40	15	0.65	0.38	4.51	5.14	L	L
15	63	59.60	164	58.50	18	0.73	0.48	3.96	1.79	L	L
18	64	19.90	165	23.20	25	0.62	0.48	3.15	1.53	L	L
20	64	6.60	165	30.40	18	0.64	0.4	5.4	1.52	L	L
21	64	12.10	165	30.50	18	0.72	0.47	9.08	5.14	L	1.8
22	64	19.80	165	42.70	21	1.34	0.86	8.87	5.54	5.9	5.5
25	64	20.20	166	0.80	22	1.14	0.66	5.19	1.95	L	L
29a	63	50.30	165	41.70	20	0.61	0.41	2.77	0.96	L	L
29b	63	46.10	166	7.50	27	0.96	0.54	3.93		2	1.3
33a	62	25.40	166	40.20	20			1.68	0.87	L	L
36	63	40.00	167	2.80	29			8.67	1.73	L	L
40	64	40.20	167	3.60	26	0.2	0.17	2.25	0.11	L	0.5
47a	62	26.00	168	48.60				1.37	1.14	0.7	1
49	64	20.10	169	0.30	40			2.45	3.04	1	0.5
50	64	39.40	169	0.30	44	0.33	0.28	1.67	1.92	1.1	

Table B7 con't

n-C17	Pris-tane	n-C18	Phy-tane	n-C19	n-C20	n-C21	n-C22	n-C23	n-C24	n-C25	n-C26	n-C27	n-C28
9.3	7.6	8.7	1.6	25.4	30.7	116	96.3	289	124.1	332.5	154.9	875.4	98.7
12.7	13.4	14.4	L	43.1	59.8	199.4	185.9	504.5	215.2	795.8	233.8	1154	153.8
11.1	10.5	13.1	L	38.8	49.4	163.6	138.7	369.2	154.9	570.2	172.3	892.1	116.7
2.5	1.2	2.8	0.7	7.8	8.9	26	20.9	50.2	23.2	73.1	22.6	105.5	15.7
4.3	2.6	6.5	1.6	21	31.7	101.9	84.6	218	85	242.4	60.5	415.7	41
4.1	2	4.9	0.8	14.3	19.8	70.4	63.3	166.4	69.6	195.9	55.8	322.4	36.9
4.1	1.8	5.2	1	15.7	20.3	68.6	62.9	175.9	80.4	280.6	64.8	492.6	59.4
5.1	2.3	5.2	L	15	19.9	65.9	57.1	148.7	60.2	171.9	49.7	287.2	33.3
6.3	3.9	7.2	L	22.3	28.9	100.5	83	230.8	89.3	435.6	115	694.7	71.4
12.7	5.3	12.3	2.2	33.1	42.1	157.4	133.4	346.5	136.6	363.2	97.6	493.4	58.1
5.7	2.7	6.1	L	16.2	20.3	66.4	57.8	150.6	61	177.3	60.2	295.8	35.6
4.1	1.5	4.4	1	13.3	16	50.4	44	120.1	49.3	180.8	55.6	301.4	38.2
3.5	1.1	3.4	L	10.7	13.2	46.9	47.4	128.9	69.3	218.6	77.6	287.9	42
1.3	0.7	1.7	L	4	5	13.2	10.9	26.6	11.7	39.5	11.5	60.6	7.5
2.1	L	L	L	12.6	14.4	52.7	44.3	132.6	54.6	251.6	71.9	416.4	48.9
L	L	L	L	0.7	1.2	3	3.3	7.2	L	10.2	3.5	14.2	2.2
1.3	0.8	0.8	L	4	4.7	21.6	12.2	35.3	16	58.5	18.2	91.6	13
2.6	5.9	5.9	0.7	7.1	8	23	22.5	57	27.8	73.9	23.1	125.4	17.4
0.8	0.6	0.6	L	2.4	3	9	8.4	22.7	9.8	27.5	9.3	44.3	6.8

n-C29	n-C30	n-C31	n-C32	n-C33	n-C34	Total n-alkanes
536.2	252.5	422.5	22.7	121.4	121.4	3540.3
814.6	186.2	673.3	42.7	198.5	198.5	5526.7
634.7	193.1	570.2	33.7	168.8	168.8	4318.9
76.5	33.8	82.7	5.7	28.1	28.1	594.7
325.5	65.1	278.8	14.9	85.3	85.3	2084.8
249.6	68.7	206	11.5	60.3	60.3	1627.7
348.2	64.4	299.9	46.8	91	91	2217
232.2	52.5	210.7	8.9	67.9	67.9	1503.2
400.1	107.1	346.1	11.8	88.6	88.6	2853.9
363	141.5	311.9	18.6	94.5	94.5	2833.2
240.9	51.5	232	11.3	76	76	1567.5
211.9	32.2	184.2	10.9	57.6	57.6	1384.1
178.7	23.2	136.5	8.7	35.7	35.7	1344
40.6	4.6	34.6	1.2	9.3	9.3	286
263.6	100.8	210.7	7.9	50.7	50.7	1743.7
10.3	L	8.4	L	L	L	64.2
68.9	11.2	60.5	3.8	17.9	17.9	444.1
97.8	9.2	86.2	4.5	22.3	22.3	614.9
33.7	3.5	32.6	1.5	9.3	9.3	253.3

Table 88. Concentrations of heavy metals and organochlorine contaminants in walrus samples taken from the Alaska native subsistence harvest of 1981 and 1982. Pesticides analyzed for in blubber but not detected are DDE, DDD, DDT, dieldrin, heptachlor epoxide, trans-monachlor, cis-monachlor, endrin, toxaphene, hexachlorobenzene, mirex, and PCB's. Ppm, presumably wet weight basis. Adapted from Metsker, et al (1984: Table 1).

Tissue by village	Date	Sex	Age (yr)	Pb	Cd	Hg	As	Se	dieldrin	oxychlordane
Liver:										
Savoonga	1981			0.15	5.6	0.85		2.0		
Savoonga	1981				5.6	0.69	0.13	4.5		
Savoonga	1981				16.0	0.60		2.3		
Savoonga	1981				16.0	0.68		2.7		
Savoonga	1981				9.5	3.80		4.9		
Savoonga	1981				13.0	0.65		4.1		
Savoonga	1981				16.0	0.68		3.8		
Little Diomede	1982	M	14	0.11	3.7	0.20	2.7		0.12	0.12
Little Diomede	1982	M	15		6.0	0.14	1.9		0.16	0.15
Little Diomede	1982	M	20		8.4	0.46	2.3			0.11
Little Diomede	1982	F	24		5.2	0.13	2.2		0.12	
Little Diomede	1982	F	16	0.22	8.7	0.06	2.8		0.12	0.17
Little Diomede	1982	M	15		5.5	0.22	1.9			
Little Diomede	1982	M	19		1.4	0.048	1.4		0.18	0.19
Little Diomede	1982	M	16	0.22	5.6	0.15	1.4		0.26	0.29
Gambell	1981	F	11	0.10	8.9	0.66		12.0		
Gambell	1981	F	14-15		5.2	0.98		2.7		
Gambell	1981	M	21		30.0	0.39		0.05		
Gambell	1981	F	15	0.17	5.8	0.73		4.1		

Tissue by village	Date	Sex	Age (yr)	Pb	Cd	Hg	As	Se	dieldrin	oxychlordane
Kidney:										
Little Diomede	1982	M	15		28.0					
Little Diomede	1982	M	14		33.0					
Little Diomede	1982	M	19	0.16	10.0					
Little Diomede	1982	M	16	0.83	40.0					
Little Diomede	1982	F	16	0.22	41.0					
Little Diomede	1982	M	15	0.22	32.0					
Little Diomede	1982	F	24	0.11	56.0					
Little Diomede	1982	M	20		46.0					
Gambell	1981	M	21		87.0					
Gambell	1981	F	14-15		43.0					
Gambell	1981	F	11		33.0					
Gambell	1981	F	15		15.0					
Blubber:										
Little Diomede	1982	F	16						0.12	0.17
Little Diomede	1982	M	20							0.11
Little Diomede	1982	M	19						0.18	0.19
Little Diomede	1982	M	14						0.12	0.12
Little Diomede	1982	M	15						0.16	0.15
Little Diomede	1982	F	24							
Little Diomede	1982	M	16						0.26	0.29
Little Diomede	1982	M	15						0.16	0.15
Gambell	1981	F	14-15						0.11	
Gambell	1981	M	21						0.15	0.13

Table B9. Mercury concentrations (ppm dry wt.) in Norton Basin surface sediment, 0-10 cm, sampled by van Veen grab and box corer. Lower detection limit is 0.01 ppm. Adapted from Nelson, et al (1972: Appendix I).

Sample	Lat. Deg.	Lat. Min.	Long. Deg.	Long. Min.	Water depth (ft.)	Hg (ppm)
67 ANC 30	64	27.560	165	19.768	45	0.04
68 AWF 310	64	28.128	164	41.928	31	0.02
68 AWF 327	64	32.192	164	25.192		0.02
68 AWF 338	64	32.656	163	59.800	46	0.03
68 AWF 343	64	32.768	163	54.288	14	0.03
68 AWF 344	64	33.384	163	50.672	20	0.03
68 AWF 345	64	33.384	163	48.000	22	0.03
68 AWF 346	64	33.384	163	45.384	18	0.03
68 AWF 350	64	32.000	163	50.672	47	0.01
68 AWF 354	64	33.000	163	43.480	24	0.04
68 AWF 355	63	33.000	163	41.096	20	0.03
68 AWF 357	64	30.768	163	41.096	50	0.02
68 AWF 410	64	30.160	164	11.800	64	0.02
68 AWF 430	64	28.416	164	26.480	71	0.02
68 AWF 440	64	23.640	164	46.496	84	<0.01
68 AWF 505	64	32.768	166	15.000	40	0.03
68 ANC 30B	65	42.256	168	7.700	25	0.03
68 ANC 61B	65	25.000	167	36.864	49	0.06
68 ANC 70B	65	32.096	168	2.300	87	0.03
68 ANC 95B	63	49.000	171	40.000	121	0.03
68 ANC 105B	63	37.000	171	10.768	49	0.01
68 ANC 112B	63	42.000	170	38.000	117	0.02
68 ANC 115B	63	44.000	170	25.192	143	0.08
68 ANC 118A	63	41.000	170	11.000	142	0.06
68 ANC 120B	63	39.800	170	1.500	143	0.01
68 ANC 126B	63	32.000	169	44.576	121	0.02
68 ANC 140B	63	22.480	168	56.000	87	0.03
68 ANC 154B	63	50.000	169	47.000	104	0.01
68 ANC 166B	64	57.000	167	49.000	136	0.01
68 ANC 179T	65	16.192	166	57.192	50	0.07
68 ANC 181B	65	13.000	167	26.768	69	0.01
68 ANC 182B	65	10.576	167	23.384	63	0.01
68 ANC 187B	65	2.100	167	21.080	76	0.08
68 ANC 190B	64	58.000	167	10.480	45	0.03
68 ANC 200B	64	39.672	166	36.480	72	<0.01
68 ANC 212T	64	37.512	167	14.416	96	0.02
68 ANC 215B	64	26.000	168	4.600	119	0.06
68 ANC 216A	64	18.480	168	20.768	130	0.02
68 ANC 231B	64	20.768	166	8.400	135	0.04
68 ANC 233B	64	26.480	166	4.500	106	0.03
68 ANC 234B	64	29.864	166	2.300	67	0.02

68	ANC 235T	64	29.480	165	45.864	66	0.25
68	ANC 235T	64	29.480	165	45.864	66	0.16
68	ANC 235T	64	29.480	165	45.864	66	0.11
68	ANC 235T	64	29.480	165	45.864	66	0.12
68	ANC 235T	64	29.480	165	45.864	66	0.13
68	ANC 240B	64	18.192	165	40.192	69	0.03
68	ANC 241T	64	24.000	165	35.000	102	0.11
68	ANC 241T	64	24.000	165	35.000	102	0.08
68	ANC 241T	64	24.000	165	35.000	102	0.03
68	ANC 241T	64	24.000	165	35.000	102	0.02
68	ANC 241T	64	24.000	165	35.000	102	0.02
68	ANC 244T	64	27.384	165	24.672	69	0.06
68	ANC 248B	64	10.192	165	24.000	65	0.02
68	ANC 251B	64	25.000	165	14.384	71	<0.01
69	ANC 100S	63	39.192	162	29.096	53	0.14
69	ANC 100S	63	39.192	162	29.096	53	0.03
69	ANC 100S	63	39.192	162	29.096	53	0.02
69	ANC 100S	63	39.192	162	29.096	53	0.01
69	ANC 100S	63	39.192	162	29.096	53	0.02
69	ANC 101B	64	9.700	164	7.600	74	0.03
69	ANC 105B	64	20.576	166	33.672	95	0.02
69	ANC 107B	63	52.000	167	18.768	110	0.01
69	ANC 114	62	31.384	165	57.480	44	0.03
69	ANC 116	63	12.480	165	19.672	42	0.06
69	ANC 118	63	45.576	166	0.670	88	0.02
69	ANC 120S	63	39.480	164	37.000	42	0.02
69	ANC 121	63	35.480	163	59.000	47	0.16
69	ANC 122S	64	22.480	165	44.768	88	0.05
69	ANC 122U	64	22.480	165	44.768	88	0.01
69	ANC 155B	63	52.000	165	44.320	110	0.01
69	ANC 200B	64	25.800	165	25.256	39	0.02
69	ANC 204H III	63	46.576	170	1.500	141	0.04
69	ANC 206S	63	41.000	170	0.000	144	0.03
69	ANC 207	63	43.672	169	54.192	138	0.14
69	ANC 207	63	43.672	169	54.192	138	<0.01
69	ANC 208B	63	42.576	169	36.576	125	0.05
69	ANC 209B	63	53.384	169	29.768	105	<0.01
69	ANC 215	63	54.000	170	48.480	93	0.01
69	ANC 216	64	0.900	170	49.480	89	0.02
69	ANC 220 B	63	51.288	171	59.384	125	0.01
69	ANC 221 B	63	52.288	172	18.000	177	<0.01
69	ANC 222 H II	63	56.768	172	31.000	180	0.1
69	ANC 223	64	0.900	172	25.100	184	0.23
69	ANC 224 A	63	58.288	172	12.768	177	0.01
69	ANC 224 B	63	58.288	172	12.768	177	0.03
69	ANC 227 B	64	8.200	171	47.288	159	0.06
69	ANC 229	64	8.100	171	13.120	118	0.04
69	ANC 230	64	13.000	170	52.120	118	0.02
69	ANC 232	64	15.480	170	18.000	125	0.04
69	ANC 235	64	29.864	169	39.672	121	0.01
69	ANC 237	65	4.500	169	14.672	164	0.03
69	ANC 245 H II	65	11.192	167	53.192	102	0.03
69	ANC 247H VII	65	13.864	167	39.480	118	0.03
69	ANC 251S	65	6.300	167	37.192	69	0.03
69	ANC 251T	65	6.300	167	37.192	69	0.02
69	ANC 252H IV	65	5.100	167	43.384	120	0.28

69	ANC	252H IV	65	5.100	167	43.384	120	0.08
69	ANC	252H IV	65	5.100	167	43.384	120	0.05
69	ANC	252H IV	65	5.100	167	43.384	120	0.03
69	ANC	252H IV	65	5.100	167	43.384	120	0.02
69	ANC	252H IV	65	5.100	167	43.384	120	0.03
69	ANC	253S	65	5.100	167	47.000	102	0.01
69	ANC	254B	65	1.600	168	5.000	112	0.01
69	ANC	255UH	64	57.000	168	15.000	134	0.03
70	ANC	7B	63	17.480	172	18.000	202	0.16
70	ANC	7B	63	17.480	172	18.000	202	0.04
70	ANC	7B	63	17.480	172	18.000	202	0.01
70	ANC	7B	63	17.480	172	18.000	202	0.01
70	ANC	7B	63	17.480	172	18.000	202	0.03
70	ANC	11B	63	18.480	170	55.864	88	0.06
70	ANC	13B	63	8.200	170	28.000	124	<0.01
70	ANC	14B	62	54.768	170	36.768	139	0.06
70	ANC	15S	62	57.672	170	27.384	147	0.06
70	ANC	16S	62	54.000	169	58.000	137	0.01
70	ANC	20S	62	37.288	169	24.000	115	<0.01
70	ANC	24S	63	10.000	168	38.000	88	0.04
70	ANC	27B	63	9.600	167	56.864	77	<0.01
70	ANC	29S	62	52.000	167	4.000	91	0.07
70	ANC	32B	64	26.672	163	51.288	58	0.04
70	ANC	35S	64	28.576	163	25.480	53	0.09
70	ANC	40B	64	23.288	163	2.500	39	0.03
70	ANC	45S	64	23.768	162	32.768	61	0.07
70	ANC	47B	64	31.672	162	14.000	42	<0.01
70	ANC	48B	64	30.288	161	56.576	43	0.07
70	ANC	53S	64	0.000	162	1.500	60	0.03
70	ANC	54S	64	1.500	161	16.576	51	0.06
70	ANC	56B	63	41.384	161	11.576	42	0.07
70	ANC	58S	63	45.480	162	2.500	52	0.07
70	ANC	59T	63	53.100	163	5.576	61	0.08
70	ANC	61S	63	26.100	163	27.192	36	0.09
70	ANC	61T	63	26.100	163	27.192	36	0.05
71	ADE	3	60	32.384	172	53.192	95	0.01
71	ADE	6	60	30.100	172	50.672	76	0.01
71	ADE	10	60	25.288	172	26.768	135	0.01
71	ADE	13	60	28.576	172	22.000	192	0.01
71	ADE	15	60	30.576	172	29.480	175	0.02
71	ADE	16T	60	32.288	172	32.672	168	0.03
71	ADE	17	60	33.100	172	34.864	163	0.07
71	ADE	19	60	35.864	172	42.672	146	0.05
71	ADE	20	60	32.480	172	47.576	132	0.04
71	ADE	22	60	29.384	172	41.384	92	0.02
71	ADE	26	60	24.672	172	34.192	93	0.03
71	ADE	30	60	20.192	172	25.480	42	0.05
71	ADE	32	60	23.480	172	48.000	42	0.01
71	ADE	35	60	36.192	172	53.864	117	0.01
71	ADE	36	60	37.768	172	58.100	120	<0.01
71	ADE	38	60	38.864	173	3.670	50	0.01

Table B10. Mercury concentrations (ppm, dry wt.) in surficial sediments sampled by box corer and van Veen grab in Norton Basin as adapted from Nelson, et al (1975: Table III).

	n	Arith. mean	median	Range of 70% of values	Total range min. to max.
Surface 1mm for:					
all areas	20	0.06	0.04	0.02 to 0.14	0.01 to 0.23
Surface 0-10cm for:					
less than 40km from shore	83	0.04	0.03	0.01 to 0.08	<0.01 to 0.23
more than 40km from shore	17	0.03	0.02	0.01 to 0.06	<0.01 to 0.07
less than 20km from Wales shoreline	3	0.04	0.03	0.03 -	0.03 to 0.06
less than 20 km from Nome shoreline	10	0.04	0.03	0.01 to 0.06	<0.01 to 0.15
less than 20km from Bluff shoreline	8	0.03	0.03	0.02 to 0.04	0.01 to 0.09
less than 20 km from St. Lawrence Is	29	0.04	0.03	0.01 to 0.07	<0.01 to 0.23

Table B11. Mean concentrations (dry wt.) of elements in "whole rock" surficial sediment at 0-2 cm, from six Norton Sound HAPS core samples, September 1976. Values are arithmetic mean and, presumably, one standard error. Sample size comprising each mean is not specified in the original report. Adapted from Robertson and Abel (1979: Tables C.3, C.4, C.5).

Station		N-1		N-5		N-9		N-15		N-20		N-26	
Deg/min N.		63 31.8		63 39.5		63 41.5		64 0.3		64 20.1		64 30.2	
Deg/min W.		168 32.2		165 32.1		161 31.1		163 30.5		163 31		166 31.5	
Depth (m)		29		22		15		20		20		28	
Element	Units	mean	S.E.	mean	S.E.	mean	S.E.	mean	S.E.	mean	S.E.	mean	S.E.
Al	%	5.35	0.18	6.18	0.21	7.32	0.24	5.88	0.2	5.57	0.19	4.43	1.5
Ti	%	0.45	0.09	0.46	0.09	0.36	0.09	0.45	0.09	0.46	0.09	0.36	0.08
Mn	ppm	344	21	586	30	544	29	458	25	396	23	417	54
V	ppm	82	10	113	12	149	14	102	11	73	10	56	9
Na	%	2.03	0.01	2.02	0.01	2.31	0.01	2.01	0.01	1.65	0.01	1.72	0.01
K	ppm	1.88	0.24	1.65	0.22	2.14	0.24	1.14	0.18	1.60	0.19	1.29	0.17
As	ppm	7.8	1.1	11.8	1.2	19.8	1.1	10.7	1.0	6.9	0.8	8.3	0.8
La	ppm	24.6	1.1	30.2	0.9	36.8	0.8	29.0	0.7	31.2	0.8	19.7	0.6
Sm	ppm	3.5	0.1	4.4	0.1	5.5	0.1	4.2	0.1	4.7	0.1	3.3	0.1
Sc	ppm	9.40	0.08	11.52	0.08	16.98	0.08	10.49	0.08	8.00	0.06	8.80	0.09
Cr	ppm	96	2	83	1	114	2	71	1	67	1	47	1
Fe	ppm	2.34	0.07	3.16	0.08	4.92	0.09	2.76	0.05	2.10	0.04	2.49	0.05
Co	ppm	8.49	0.05	12.53	0.17	19.05	0.10	11.27	0.23	9.31	0.06	7.29	0.08
Sb	ppm	0.68	0.06	0.97	0.05	1.79	0.08	1.03	0.07	0.76	0.04	0.84	0.06
Ba	ppm	790	30	730	20	970	30	620	30	670	20	520	30
Cs	ppm	1.85	0.09	0.66	0.05	5.61	0.17	2.42	0.10	2.44	0.08	2.18	0.09
Eu	ppm	0.92	0.03	1.08	0.02	1.36	0.02	1.03	0.03	1.02	0.02	0.87	0.02
Tb	ppm	0.58	0.05	0.78	0.06	0.84	0.06	0.69	0.06	0.64	0.05	0.62	0.05
Ta	ppm	0.68	0.05	0.75	0.08	0.93	0.09	0.65	0.07	0.72	0.07	1.32	0.13
Th	ppm	5.48	0.07	7.36	0.06	11.60	0.10	0.62	0.07	6.92	0.06	4.75	0.06

Table B12. Concentrations (ppm, dry wt.) of recoverable background trace metals in surficial sediments near Nome. The method of sampling is not specified in the original reports. Adapted from Russanowski, et al (1986: Table 3.22), Russanowski, et al (1987: Table 3.3-1), Russanowski, et al (1988: Table 3.3-1).

*Sediment sample was gray colored and very sticky; handled like a silt high in clay-sized material; different in appearance from all other sediment samples.
**Different in appearance from other sediment samples as evidenced by by the percent total solids value.

Location	Date	As	Cd	Cr	Cu	Pb	Zn	Hg	Ni	% total solids
1985										
Norton Sound		24.9	0.80	13.3	10.6	4.44	53.8	0.139		
Offshore Penny River	10/10/85	29.3	0.50	10.2	6.12	4.29	51.2	0.020		
Surfzone Penny River	10/10/85	37.1	1.50	15.5	14.5	7.25	68.6	0.030		
1985 dredge location	10/10/85	27.9	<0.5	10.4	6.95	4.4	46.9	0.040		
1986										
500m upstream of dredge	8/21/86	15.8	8.00	4.2	2.5	5	36.4	0.040	15.0	77.3
500m upstream of dredge	9/2/86*	62.99	3.26	31.35	53.41	13.57	119.2	0.125	58.8	49.8
500m upstream of dredge	9/25/86	9.35	2.46	12.92	16.88	1.99	39.31	0.106	19.7	74.0
1987										
500m upstream of dredge	6/26/87	120.0	1.90	11	22.0	10.0	65.0	0.077	30.0	78.9
500m upstream of dredge	7/8/87**	77.0	39.00	24	32.0	22.0	75.0	0.140	53.0	10.0
500m upstream of dredge	7/16/87**	4.3	1.35	26	29.0	34.0	76.0	0.050	39.0	40.1
500m upstream of dredge	7/23/87	29.2	1.87	32	40.0	10.0	85.0	0.002	49.0	67.1
500m upstream of dredge	7/29/87	28.6	2.37	32	38.0	13.0	85.0	0.003	48.0	63.3
500m upstream of dredge	8/5/87	24.1	0.30	28	34.0	11.0	80.0	0.003	40.0	69.4
500m upstream of dredge	8/12/87	130.0	1.30	18	25.0	<9	69.0	<0.005	43.0	73.9
500m upstream of dredge	8/26/87	9.3	2.40	23	29.0	14.0	80.0	0.009	46.0	76.8
500m upstream of dredge	9/3/87	11.0	1.50	33	36.0	92.0	78.0	0.004	52.0	72.1
500m upstream of dredge	9/9/87	31.5	0.97	<8.8	<8.8	17.0	29.0	<0.02	<2.6	75.3
500m upstream of dredge	9/16/87	33.0	2.50	6.9	10.0	4.3	42.0	0.024	22.0	92.4
500m upstream of dredge	9/22/87	140.0	1.80	25	47.0	12.0	100.0	<0.035	60.0	57.7
500m upstream of dredge	9/29/87	89.0	3.30	7	17.0	4.8	53.0	<0.023	24.0	86.4
500m upstream of dredge	10/7/87	92.0	<0.93	24	26.0	12.0	68.0	<0.009	93.0	74.0
500m upstream of dredge	10/27/87	2.7	0.69	<5.6	<3.4	0.6	3.0	<0.002	<5.6	98.6
500m upstream of dredge	11/8/87	120.0	1.90	27	30.0	<9.4	94.0	<0.005	42.0	72.9

Table B13 . Concentrations (ppm, dry wt.) of trace metals in sediments between Cripple River and Nome River within 5 miles of shore. Lead was not detectable in any sample. Modified van Veen grab, July 1973. Adapted from Sharma (1974: 111-142).

Sample no.	Wt. % of 1.5 to 2.0 phi	Wt. % of 2.5 to 3.0 phi	Wt. % non-carbonate carbon	Minutes 64 deg.	165 deg.	Water depth (m)	Cd	Cu	Zn
NS-1	3.6	5.3	0.66	26.2	25.9	27	11	10	130
NS-3	2.5	4.4	0.542	28.1	24.8	18	11	10	38
NS-4	4.5	4.68	0.666	29.1	24.2	13	7.7	12	58
NS-5	0.5	39.8	0.364	29.35	34.2	8	7.7	10	37
NS-8	7.34	17.8	0.893	28.6	29.3	20	6.5	18	55
NS-9	2	9.5	0.9	27.4	30	23	5.1	13	48
NS-10	11.8	29.7	0.827	26.7	30.4	21	5.1	10	62
NS-11	0.6	3.2	1.568	27.2	35.2	23	7.7	60	170
NS-12	0.6	1.5	0.904	28.1	34.5	20	1.05	11	52
NS-13	0.7	0.15	1.355	29.3	30.4	14	4	8	160
NS-16	9.8	27.7	0.611	30.9	37.7	11	4	10	67
NS-18	7.1	1.4	0.423	29.9	38.2	14	4	10	42
NS-19	1.88	6.07	0.837	28.7	38.8	20	4	11	55
NS-20	2.6	1.28	0.694	28	40	22	4	12	45
NS-21	5	24.76	0.786	28.2	43.8	24	1	19	42
NS-23	2.08	0.5		30.7	43.3	16			
NS-24	0.12	0.13		31.5	42.5	13			
NS-26	45.9	3.41	0.356	31.1	47.7	16.5	5	11	45
NS-27	1.4	0.6		29.5	48	18			
NS-28	1.37	3.9	0.704	28.8	48.5	18	4	11	40
NS-29	6.45	5.5	0.868	26.3	23.2	20	7.5	19	50
NS-30	5.87	8.35	0.855	26	20.5	21	4	27	>400

TRACE CONTAMINANTS IN SURFACE SEDIMENT OF THE NORTHERN BERING SEA: A STATISTICAL REVIEW

by

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ABSTRACT

Reported data on the concentrations of trace chemical contaminants in surface sediments and animal tissues are reviewed for the greater St. George Basin area of the southeastern Bering Sea. The tabular data from original reports are compiled in an appendix, summarized statistically, and compared among investigations.

Thirty reports from sixteen investigations were found for the area. These include hydrocarbon concentrations for sediment from one investigation and for animals from two other studies. Organochlorine residue data are examined from four investigations of fur seals and one report on seabird eggs. Concentrations of elements, including trace metals, are reviewed from three investigations of surface sediment. Seven other research efforts, including five investigations of seals, provide data on metals concentrations in animals.

The reports vary in their usefulness for monitoring contaminant levels. Many samples are constrained by low testing power and by frequency distributions which violate assumptions of parametric methods. However, other investigations report large samples, examine them for normality of distribution, and accompany them with measures of auxiliary variables. These latter data offer more robust estimates of trace contaminant levels for monitoring and further analyses.

Keywords: Bering Sea, hydrocarbons, marine contaminants, Pribilof Islands, seals, sediments, trace metals.

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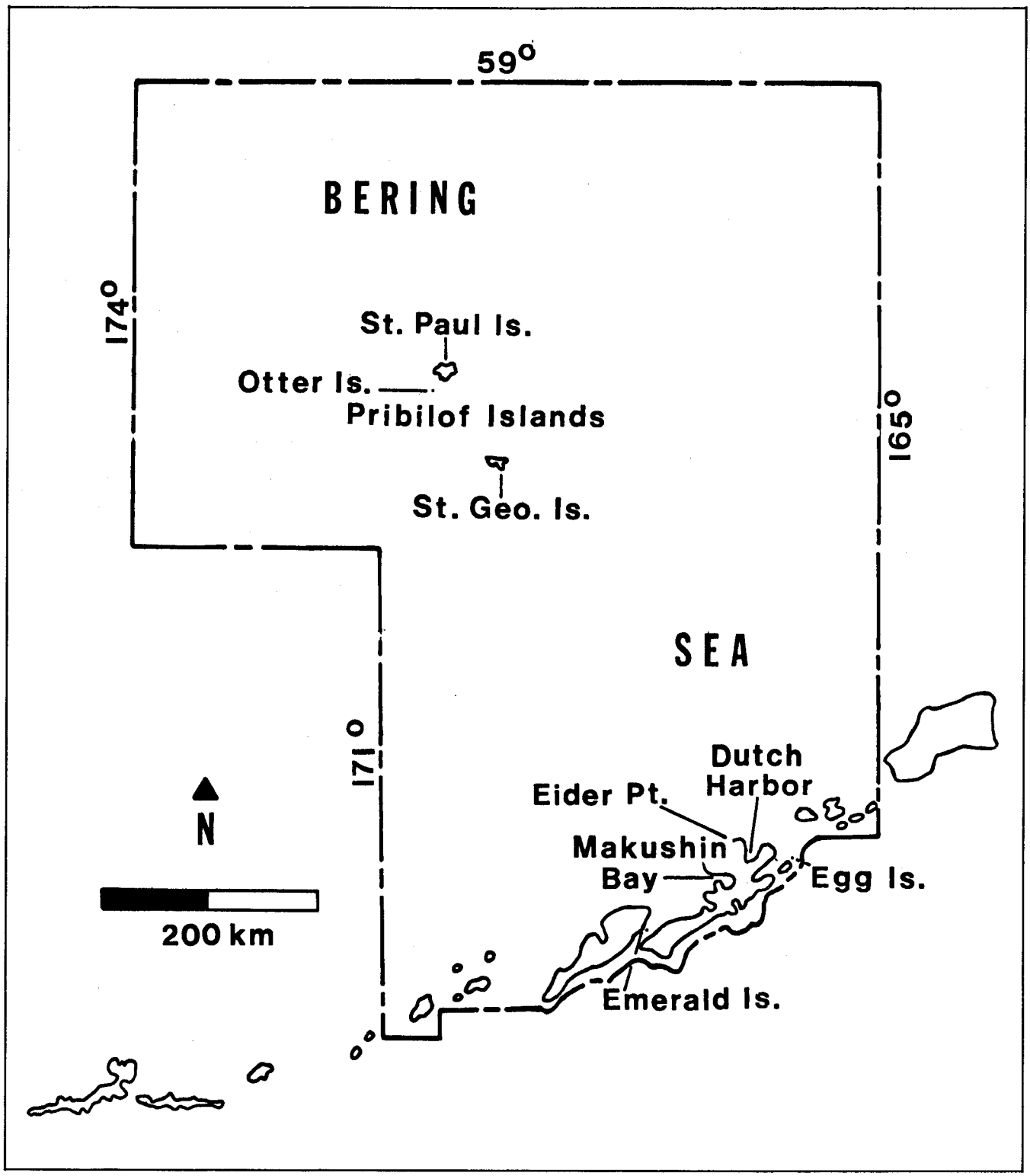

Frontispiece. Map of the location of the St. George Basin planning area in the southeastern Bering Sea, Alaska.

INTRODUCTION

The monitoring of marine pollutants in the southeastern Bering Sea will become increasingly important as the area is leased for oil and gas development. To evaluate pollution changes in the area, scientists and regulators are likely to rely on past reports of contaminants. However, some of these past research efforts may be more useful than others for detecting trace chemical trends and anomalies.

This review indicates the availability of data on trace contaminant concentrations in surface sediment and organisms of the greater St. George Basin according to area, sampled material, and chemical analyte. The report also characterizes contaminant levels statistically, compares the results of various investigations, and indicates features of samples which affect their usefulness for statistical inferences.

METHODS

Tabular data were extracted from available reports of trace element and organic contaminant concentrations in surface sediment and animal tissue in the St. George Basin lease planning area.

These extracted data are presented in a series of tables in the appendix of this report. Although the data in the appendix are rearranged for clarity, they are otherwise unchanged and uncorrected from the original reports. The calculations and figures in this review are based solely on data in the appendix tables.

All the data reviewed here were taken at face value from original reports. No assumptions were made regarding the appropriateness of collecting, storage, or laboratory methods. Furthermore, the accuracy of the data was not evaluated and data were not selected on the basis of quality.

The appendix tables were written as Lotus electronic spreadsheets to include variables of interest from the original reports. The appendix tables reflect the information, labels, and conventions of expression as found in the original reports.

For statistical calculations and histograms, data matrices were imported to Complete Statistical System (CSS), produced by SoftStat, Inc., Tulsa, Oklahoma. Each sample was tested for departure from normal skewness and kurtosis. Samples significantly different from normal were transformed to log-normal values for parametric treatment. The 95% confidence intervals of the mean were calculated as plus or minus two standard errors of the mean, and they were determined only with samples indicating a normal distribution. Significance tests were at probability level alpha=.05.

Power of t-tests for the significance of the difference between two means was determined from Table E-1 in O. L. Davies (ed.) 1978. The design and analysis of industrial experiments. Longman Group Ltd., New York. 636pp.

Histograms of expected, normal frequency distributions are based on calculations of areas under the normal curve carried out with a C-language program written by Ray Vaa.

Lines of equal concentrations were interpolated by eye for the contour maps of trace chemical concentrations in the St. George Basin lease planning area.

As illustrated in the frontispiece, the planning area includes the Pribilof Islands and Unalaska and Umnak Islands. It is bounded on the south by the southern shore of the Aleutian Island chain, on the east by 165 degrees west longitude, and on the north by 59 degrees north latitude. The western boundary is 174 degrees west longitude near the Pribilof Islands and 171 degrees west longitude southward of those islands.

RESULTS

Sediment hydrocarbons

Concentrations and ratio indices of hydrocarbons in surface sediment were reported for the greater St. George Basin by Kaplan, et al (1977) and Venkatesan, et al (1981). They analyzed sediment from fourteen locations within the St. George Basin lease planning area. Unsummarized tabular data from these specimens presented in the original reports are repeated in the appendix. Figure 1 shows the locations of the sampling stations.

Geographical variation in four measures of hydrocarbons within the lease planning area is depicted by lines of equal quantities in Figures 2 to 5. These isolines are interpolated for 12 to 14 sampling locations.

The regional trends suggested by the contour maps, however, are valid only if it is assumed that variation is actually small within localities. Because localities are represented by single grab specimens, local variation and regional variation cannot be distinquished.

In the statistical summaries of the data for this review, station 35 is omitted. As Venkatesan, et al (1981) pointed out, hydrocarbons were anomalously high in the grab specimen. Indeed, the concentrations of the aliphatic fraction, the aromatic fraction, and total hydrocarbons each exceeded their respective regional means by more than three standard deviations at this station.

Table 1 lists the means and confidence intervals for hydrocarbon indicators and a normalizing variable. None of the variables was found to be significantly different from an expected normal distribution, on the basis of two-tailed t-tests of skewness and kurtosis ($P>.05$).

Percentage organic carbon accounts for a significant part of the variation in the concentrations of total n-alkanes and total hydrocarbons. These two dependent variables show significant simple linear regressions on percentage of organic carbon ($P<.0026$, $P<.0002$, respectively). The coefficients of determination, based on the adjusted R-squares, indicate that 72% of the variation in n-alkanes, and 90% of the variation in total hydrocarbons can be "explained" by variation in organic carbon. No other hydrocarbon measure shows a significant affect by organic carbon.

The samples of this investigation provide a moderate power to detect differences in means representing the region. The four estimates of hydrocarbon concentrations shown in Table 1 have samples of size 13 and coefficients of variation in the narrow range of .48 to .58, where coefficient of variation is the sample standard deviation divided by the mean. Samples with these means and dispersions will reject a null hypothesis of no difference between means about 65% of the time when the means differ by

Table 1. Summary of the concentrations (ppm, dry weight) of hydrocarbons in upper 10 cm of sediment in the greater St. George Basin. Based on data in Kaplan, et al (1977) and Venkatesan, et al (1981). N-alkanes are carbon chain lengths 15 to 34.

The 95% confidence interval of the mean is two standard errors about the mean. The 95% confidence interval of the sample is two standard deviations about the mean and measures "precision."

Variable	n	Arith. mean	95% confidence interval of mean	95% confidence interval of sample
N-alkanes, ppm	13	1.198	.7758-1.621	0-2.663
Aliphatics, ppm	13	6.523	4.464-8.582	0-13.66
Aromatics, ppm	13	5.992	4.082-7.903	0-12.61
Total hydrocarbons, ppm	13	12.52	9.079-15.95	.6120-24.42
Org. carbon, %	12	.5300	.4272-.6328	.1891-.8709

an amount equal to the standard deviation.

Sediment metals

The small surveys

Three OCSEAP regional reconnaisance surveys of trace metal concentrations in surface sediment provide small sample sizes for the St. George Basin planning area.

Concentrations of nine metals in surface sediment of the southeastern Bering Sea were determined by Burrell (1977, 1978) using a weak acid-extraction method. Figure 6 shows the locations of the fourteen specimen cores obtained within the St. George Basin planning area. In this area, Burrell shared eight locations with the investigation of Kaplan, et al (1977) and Venkatesan, et al (1981), and four locations with Robertson and Abel (1979). However, Burrell's "acid-extracts" determinations are not directly comparable to concentrations from the "whole-rock" fraction measured by other investigators.

Robertson and Abel (1979) report "whole-rock" mean concentrations of elements in the surface sediment at eight locations in the St. George Basin planning area (Figure 7). Table 2 lists summary statistics of the mean concentrations for 10 elements. None of the samples of means is significantly different from a normal distribution. Excluded from the summary statistics is one mean each for the aluminum, vanadium, and arsenic samples which exceeded three standard deviations. Robertson and Abel (1979) did not provide original, unsummarized concentrations of elements in their sediment specimens nor indicate sample size.

The Gardner survey

Statistical summaries

Gardner, et al (1978a, 1978b) reported the largest collection of sediment samples of elemental concentrations in the southeastern Bering Sea. The authors measured 31 elements, grain size, total carbon, and mineral composition at 65 stations, but did not measure organic carbon. Their reports provide summary statistics and analysis of variance for log-transformed data. They also illustrate "contour" distributions of metals, grain size, mineral, and carbon normalizing variables.

Gardner, et al (1978a, 1978b) estimated the variation in analyte concentrations within stations, as well as regional variation among stations. After measuring local variation, they concluded that differences between stations showed real regional trends and were not simply a result of sampling error within collecting locations.

Figure 8 shows a chart of the collecting locations. The

Table 2. Summary of the concentrations (dry weight) of elements in the whole-rock fraction of surface sediment in the greater St. George Basin. Based on data in Robertson and Abel (1979: Tables C.1 and C.2).

Variable	No. of means	Mean of means	95% confidence interval of mean	95% confidence interval of sample
Aluminum, %	8	4.851	3.726-5.976	1.875-7.828
Calcium, %	8	2.366	2.182-2.847	1.391-3.638
Manganese, ppm	8	441.1	371.9-510.3	258-624.3
Vanadium, ppm	8	87.50	79.53-95.47	66.41-108.6
Arsenic, ppm	7	3.000	2.138-3.862	.8888-3.056
Barium, ppm	5	644.0	298.4-989.6	0-1,335
Cobalt, ppm	7	8.871	8.189-9.554	7.195-10.54
Chromium, ppm	7	71.57	53.11-90.04	26.34-116.4
Iron, ppm	7	2.657	2.320-2.794	1.831-3.483
Antimony, ppm	7	.5900	.5310-.6490	.4454-.7346

latitude and longitude points for Figure 8 are based on unpublished data received from Gardner (pers. comm., 1988).

Gardner, et al (1978a, 1978b) transformed their original values to log values and then summarized the data (Gardner, et al, 1978b: Tables 6 and 7). Using their summary statistics for eight selected elements, I calculated the confidence intervals shown in Table 3.

Effect of collection methods

Gardner, et al (1978a, 1978b) collected samples by different methods according to the coarseness of the sediment. Coarse sediment was collected with a van Veen grab and yielded the undisturbed top 3 cm for analysis. Finer sediments were collected with core devices and the analyzed material was representative of the homogenized top 30 cm. The variation among specimens in percentage silt and clay (dry weight) is graphed in Figure 9. The horizontal axis is labelled with the upper limits of the frequency intervals.

I tested the possibility that the use of various collection instruments led to differences in estimates of element concentrations which are not solely the result of grain size variation. The calculations below show that, with one exception, estimates were not biased by sampling device differences.

Initial Kolmogorov-Smirnov tests show that the frequency distributions of some of the element concentrations are

significantly different between collection techniques. Such differences between techniques, however, are expected if grain size affects the concentrations. Indeed, levels of mercury, zinc, chromium, copper, nickel, vanadium, silt-clay, and total carbon differ significantly between the gravity core sample and the van Veen grab sample ($P<.05$). Barium and arsenic, however, do not differ between the two methods.

The van Veen and piston core techniques differ significantly for mercury, zinc, copper, and vanadium, but do not result in significant differences for barium, chromium, and nickel.

Differences are not significant between the gravity core and the piston core samples for any variable.

To further determine the affect of collection method without the affect of area, I compared gravity cores and van Veen grabs obtained within the same area. Table 4 shows the results of t-tests of normalizers over that area near St. George Island. Without area affects, collection methods are seen to yield significant differences in the means and variances of percentage silt and clay and percentage total carbon, as expected.

Table 3. Summary statistics for concentrations (dry weight) of elements in surficial sediments of greater St. George Basin. Pooled sample calculations are based on the sample sizes, logarithm variances and geometric means reported for 103 grab specimens at 65 stations by Gardner, et al (1978b: Tables 6 and 7). The confidence intervals shown with geometric means are the antilogs of the confidence limits of the log values and are calculated for this review. The underlying lognormal frequency distributions may not be normal.

Arithmetic means and intervals are calculated from samples, pooled for 1976 and 1977, having skewness and kurtosis not significantly different from normal. The original data were presented in appendices of Gardner, et al (1978a, 1978b) and are in the appendix of this review.

Method & analyte	n	Geom. mean	95% confidence interval of mean	95% confidence interval of sample
All methods pooled				
Barium, ppm	103	570	547-594	371-875
Chromium, ppm	103	50	45.92-54.45	20-123
Copper, ppm	103	30	26.49-33.96	8.6-105
Mercury, ppm	103	.041	.0387-.0435	.022-.076
Nickel, ppm	103	20	18.49-21.63	8.8-46
Vanadium, ppm	103	130	121.6-139.0	64-262
Zinc, ppm	103	80	75.68-84.53	47-135

Table 3. con't

		Arith. mean		
Gravity core				
Silt-clay, %	41	58.31	49.52-67.09	2.749-113.9
Tot. carbon, %	41	.5493	.4626-.6360	.0013-1.097
Zinc, ppm	81	85.22	80.58-89.86	43.71-126.7
Copper, ppm	98	36.73	32.81-42.66	0-75.38
Vanadium, ppm	98	138.2	129.1-147.2	49.39-226.9
van Veen grab				
Silt-clay, %	15	7.805	6.219-9.392	1.870-13.74
*Tot. carbon, %	15	.2640	.2160-.3120	.0842-.4438
Mercury, ppm	15	.0333	.0301-.0365	.0213-.0453
Arsenic, ppm	9	5.616	4.92-6.311	3.648-7.584
Barium, ppm	27	651.9	591.1-712.6	342.2-961.5
Vanadium, ppm	27	99.63	85.86-113.4	29.4-169.9
Piston core				
Mercury, ppm	6	.0517	.0351-.0683	.0145-.0889
Zinc, ppm	6	103.2	90.05-115.7	75.18-131.2
Barium, ppm	8	700.0	553.6-846.4	312.7-1,087
Chromium, ppm	8	58.75	45.97-71.53	24.93-92.57
Copper, ppm	8	58.75	43.9-73.60	19.46-98.04
Nickel, ppm	8	23.75	18.84-28.66	10.76-36.74
Vanadium, ppm	8	156.3	134.2-178.3	96.30-216.2

		Geom. mean		
van Veen grab				
Chromium, ppm	27	78.52	67.77-90.97	37.07-166.3
Nickel, ppm	27	29.8	24.32-36.51	10.57-83.99

*Estimated kurtosis=2.69 > critical value=2.35 at .05 level.

Table 4. Tests of differences between gravity cores and van Veen grabs for two normalizing variables in surface sediment collected by Gardner, et al (1978a, 1978b) between 168 and 170 degrees longitude in 1976 and 1977. The variables percentage silt and clay and percentage total carbon are normally distributed. Dry weight.

	% Silt & clay		% Total carbon	
	gravity core	van Veen	gravity core	van Veen
mean	51.63	7.805	.8375	.2640
n	12	15	12	15
SD	31.6	2.97	.5153	.0899
2-tail t value	5.2		4.1	
test probability	<.001		<.001	
H0:F value	33.8		33.5	
test probability	<.001		<.001	

Although total carbon differs significantly between collection methods by t-test (Table 4), this difference becomes insignificant when adjusted for silt and clay. Gardner, et al (1978b:28) noted that concentrations of total carbon generally show a negative correlation with grain size in fine-grain marine environments. Analysis of covariance (ANCOVA) in this review indicates a significant covariance between these two normalizing variables ($F=14.2$; $df=1, 24$; $P=.001$) near St. George Island. The adjusted means of percentage total carbon are .589 and .463 for gravity cores and van Veen grabs, respectively, and the affect of collecting method on percentage total carbon becomes insignificant after this adjustment ($F=.592$; $df=1, 24$; $P=.455$).

Of the elements examined, only arsenic remains significantly different between collection methods after adjustment by the covariate of percentage silt and clay ($F=20.23$; $df=1, 8$; $P=.0024$). None of the other seven elements listed in Table 3 demonstrate a significant difference in means after adjustment using percentage silt and clay as the covariate. Hence, except for arsenic, collection methods cannot be said to introduce differences unaccounted for by grain size.

Effect of year

Six variables examined in this review are significantly affected by differences between sampling years (Table 5). Kolmogorov-Smirnov tests using data in the appendix

indicate significant differences between 1976 and 1977 for percentage total carbon and for the concentrations of arsenic, chromium, copper, nickel, and zinc. Consequently, these samples cannot be combined between years.

In contrast, year differences are not significant for percentage silt and clay, or for concentrations of barium, mercury, and vanadium. Thus, the year samples for these four variables may be combined for stronger estimates.

Table 5. Kolmogorov-Smirnov tests of differences between 1976 and 1977 for selected elements and normalizers sampled by Gardner, et al (1978a, 1978b). Dry weight.

Variable	1976 n	1976 mean	1977 n	1977 mean	Max. absol. difference	Signif.
Silt & clay, %	56	39.9	12	45.5	.40	NS
Tot. carbon, %	52	.52	13	1.21	.85	S
Arsenic, ppm	42	5.9	8	16.5	.33	S
Barium, ppm	132	614	18	744	.17	NS
Chromium, ppm	132	60.0	18	41.4	.38	S
Copper, ppm	132	34.2	18	81.4	.75	S
Mercury, ppm	102	.044	18	.046	.28	NS
Nickel, ppm	132	24.6	18	35.3	.52	S
Vanadium, ppm	132	132	18	182	.33	NS
Zinc, ppm	103	82.8	16	101	.46	S

Normality of the distributions

Half of the variables examined in this review have frequency distributions for 1976 which exhibit significant skewness or kurtosis (Table 6). The majority of the specimens of Gardner, et al (1978a, 1978b) was collected in 1976. The sample for 1977 was small, offers poor testing power, and is omitted from tests for normality. Testing for skewness and kurtosis in the 1976 data shows that arsenic, barium, chromium, mercury, and nickel are not from normally distributed statistical populations. Furthermore, log normal transformation of the original values for these five elements does not make their distributions normal. Consequently, these five elements in 1976 do not meet the assumption of normality necessary for parametric statistical methods. Because parametric methods of statistical analyses are sensitive to departures from zero skewness, and somewhat

affected by departures from zero kurtosis, they should not be applied to the five samples.

The frequency distributions of the five elements found to be different from normal in 1976 are graphed in Figures 10 to 14. Each histogram compares the observed number of specimens to the number expected if concentrations were normally distributed in the sediment.

Table 6. Skewness and kurtosis of selected elements and normalizers sampled in surface sediment of greater St. George Basin in 1976 by Gardner, et al (1978a, 1978b). Dry weight.

Variable	n	Skewness	Signif.	Kurtosis	Signif.
Silt and clay, %	56	.27	NS	-1.49	NS
Tot. carbon, %	52	.509	NS	-1.23	NS
Arsenic, ppm	42	3.24	S	12.8	S
Barium, ppm	132	1.74	S	7.01	S
Chromium, ppm	132	1.60	S	3.88	S
Copper, ppm	132	.765	NS	-.27	NS
Mercury, ppm	102	2.06	S	5.22	S
Nickel, ppm	132	4.01	S	22.7	S
Vanadium, ppm	132	.404	NS	-.069	NS
Zinc, ppm	103	.272	NS	-.905	NS

Effects on variances

Collection method affects variances for four variables measured in 1976 (Table 7). F-tests, on samples between 168 and 170 degrees longitude indicating no significant departure from zero skewness and kurtosis, show significantly larger variances for the cores than for van Veen grabs with regard to silt and clay, log normal total carbon, arsenic, and log normal mercury. Refer to Table 4 for F-test results on the two normalizers pooled between years. Such differences among grain-size catagories probably reflect a correlation between grain size, mean concentrations and variance of the concentrations.

Such differences violate the assumption of equal variances which underlies parametric methods, and thus preclude multivariate analyses for percentage silt-clay, percentage carbon, arsenic, and mercury.

However, the variances of the log-normal values of

barium, chromium, and vanadium are not significantly affected by collection method and thus may be used in multivariate analyses.

Table 7. Tests for differences in variances between cores and van Veen grabs for the area between 168 and 170 degrees longitude, 1976, based on data in Gardner, et al (1978a, 1978b). F-tests are conducted only on pairs of samples showing no significant departures from normal distribution. Dry weight.

Variable	Core SD	Grab SD	F	Test prob.	Signif.
Silt and clay, %	17.1	2.97	33.8	<.001	S
ln tot. carbon, %	.42	.19	4.93	.013	S
Arsenic, ppm	5.2	.98	29.5	<.001	S
ln Mercury, ppm	.40	.19	4.3	.009	S
ln Barium, ppm	.25	.19	1.64	.229	NS
ln Chromium, ppm	.34	.37	1.16	.709	NS
ln Vanadium, ppm	.33	.31	1.06	.889	NS

Effect of the normalizing variables

Copper, mercury, zinc, and vanadium concentrations increase significantly with percentage silt and clay and with percentage total carbon. Chromium and nickel concentrations, however, decrease significantly with increases in either normalizer. Arsenic and barium are not significantly correlated to either normalizer. Table 8 shows the results of Spearman's rank order non-parametric tests of correlation from which these trends are inferred. The correlations indicate that the two normalizers can reduce the variance of five of the elements, thereby increasing the power of tests and the precision of estimated means.

In Table 8, coefficients of determination (R-square) indicate the part of the variation in the concentrations of elements which is "explained" by normalizing variables.

Tissue hydrocarbons

Hydrocarbon concentrations in animals in the greater St. George Basin are not well documented. Two research projects, sponsored by the Outer Continental Shelf Environmental Assessment Program, examined levels of hydrocarbons in small samples of animals.

Table 8. Spearman rank order correlations for element concentrations (ppm, dry weight) with normalizing variables measured in 1976. Calculations for this review are based on data from surface sediment specimens collected in greater St. George Basin (Gardner, et al 1978a, 1978b), and repeated in the appendix of this review.

Variables	Spearman R	R-square	Z	Test prob.	Signif.	n
% Silt and clay with:						
Arsenic	-.073	-	.309	.75	NS	19
Barium	-.20	-	1.48	.13	NS	56
Chromium	-.42	.18	3.09	.0025	S	56
Copper	.75	.81	5.57	.00001	S	56
Mercury	.52	.27	3.27	.003	S	56
Nickel	-.28	.078	2.08	.035	S	56
Vanadium	.57	.33	4.25	.0001	S	56
Zinc	.74	.55	5.50	.00001	S	56
% Total carbon:						
Arsenic	.050	-	.201	.821	NS	17
Barium	-.149	-	1.065	.287	NS	52
Chromium	-.358	.128	2.560	.0102	S	52
Copper	.715	.511	5.11	.0002	S	52
Mercury	.564	.318	3.99	.00022	S	51
Nickel	-.226	-	1.61	.103	NS	52
Vanadium	.496	.246	3.54	.0007	S	52
Zinc	.713	.508	5.09	.00002	S	52

For one of these projects, Boersma (1984) reported n-alkanes in the regurgitate of pelagic birds at rookeries including two Aleutian Islands. The geometric mean of the quantity of n-alkane peaks in 32 specimens collected in 1981 is 207 ng/ml (Boersma, 1984: Table 24). "Dirty" specimens are considered those regurgitates which contained n-alkane peaks matching a Prudhoe Bay crude oil standard. Frequency of occurrence of dirty specimens is shown in Table 9.

Shaw (1977, 1978) surveyed fish and invertebrates in the Bering Sea for tissue concentrations of hydrocarbons. He concludes that, "None of the plankton analyses show evidence of petrogenic hydrocarbons," and that, "...None of the [fish] materials analysed shows evidence of petrogenic hydrocarbons," (Shaw, 1977: 43, 44). He further states that, "All the hydrocarbons...identified in the biota of the Bering Sea are biogenic and probably algal in origin," (Shaw, 1978:65). Table 10 shows the hydrocarbon concentrations reported by Shaw (1977, 1978) for the St. George Basin planning area.

Tissue metals

Invertebrates

Robertson and Abel (1979) reported estimates of metals in small samples of invertebrate animals collected in 1976. Their data are repeated in the appendix for eight metals and four animal taxa. Table 11 summarizes the authors' data pertaining to king crab mercury levels.

Table 11. Mean level (ppm, wet weight) of mercury in king crab tissue in St. George Basin, based on three means presented in Robertson and Abel (1979). Sample sizes of the original means were not reported.

Arith. mean	95% conf. int.	Geom. mean	95% conf. int.
.30	.19-.41	.29	.20-.43

Burrell (1978: Tables 52 and 53) reported heavy metal concentrations in soft body tissues of blue mussels and seaweed in the intertidal zone of three islands in the southern part of the St. George Basin area. Table 12 presents the original data, in addition to summaries calculated for this review.

Table 9. The number of Aleutian Island seabird regurgitate samples having n-alkane peaks which match the peaks of a Prudhoe Bay crude oil standard and thus scored as "dirty," (Boersma, 1984:Table 7). Specimens were collected from 24 fork-tailed storm-petrels and 8 Leach's storm-petrels at Egg Island and Emerald Island near Unalaska Island in the St. George Basin planning area in 1981.

	No.	% total samples
Samples with 9 matched peaks between C-20 and C-28	7	22
Samples with 21 matched peaks between C-11 and C-32	1	3

Table 10. Hydrocarbon concentrations (ppm, wet weight) in animal tissues in the St. George Basin planning area reported by Shaw (1977, 1978). Fraction 1 represents hydrocarbons eluted by hexane and consists of saturates and some olefinic hydrocarbons. Fraction 2 has larger unsaturates, aromatics, and some non-hydrocarbon organic compounds.

The data are taken from Shaw (1977: Table 2, p. 21) and Shaw (1978: Table 8-3, p. 66), except geometric means which are calculated for this review.

1975, 1976:		Fr. 1	Geom. mean	Fr. 2	Geom. mean
Chionocetes opilio, entire		0.2	.499	2.1	80.1
		3.1		3300.	
		1.0		330.	
		0.1		18.	
Hippoglossus stenolepis,	gills	6.6		130.	
	liver	6.9		1.9	
Pleuronectes quadrituberculatus		<.01		3.4	
Theragra chalcogramma,	gills	1.0		9.1	
	liver	1800.	59.1	300.	329.2
		19.		170.	
		17.		300.	
		-		470.	
		21.		590.	
	skin	7.3		30.	
	skin/flesh	.12	.0952	2.3	10.4
		.12		47.	
		.06		-	

1977:	Total satur.	GM	Total unsatur.	GM	Pristane	GM
Medusae	2.3		7.5		2.3	
Parathemisto pacifica	70		20		70	
Chaetognathae	60.2	24.56	10.3	1.05	60.2	24.56
	53.1		2.3		53.1	
	33.6		8.9		33.6	
	7.5		0.6		7.5	
	11.1		< .01		11.1	
Euphausiacea	52	14.83	31	44.47	52.5	11.22
	66		150		57.5	
	58		100		49	
	3.6		34		1.2	
	1.0		11		1.0	

Table 12. Concentrations (ppm, dry weight) of heavy metal contents in intertidal benthic tissues in St. George Basin planning area, collected in summer of 1976, reported as means of duplicate determinations by Burrell (1978: Tables 52 and 53). The geometric means with confidence intervals are added for this review.

Location	Lat/long	Cadmium	Copper	Nickel	Zinc
Mytilus, blue mussel:					
Eider Pt.	53d 58m, 166d 35m	4.0	9.8	1.3	122
Otter Is.	57d 3m, 170d 24m	4.6	6.0	1.8	156
Makushin Bay	53d 44m, 166d 46m	6.0	6.0	1.4	81
Geometric mean		4.8	7.1	1.5	116
95% confidence interval		3.8-6.1	5.1-9.8	1.2-1.8	79-169
Fucus, seaweed:					
Eider Pt.		5.5	1.5	4.9	17
Otter Is.		3.1	5.0	5.1	8
Makushin Bay		3.8	0.8	7.1	10
Geometric mean		4.0	1.8	5.6	11
95% confidence interval		2.8-5.6	1.0-3.4	4.4-7.1	7-17

Seals

Burrell (1979) reported the concentrations of heavy metals in tissues of three seal species collected in the St. George Basin planning area in 1977. The original data from that report are repeated in the appendix of this review.

Kruskal-Wallis non-parametric tests show there is no significant affect of species on levels of the metals, with one exception. Cadmium in liver is affected by differences associated with species (P=.0445). Nearly significantly different among species is cadmium in muscle (P=.0671). Frequency distributions of concentrations pooled among all three species do not depart significantly from normal, therefore the data are combined as single samples. Table 13 shows the means and confidence intervals for the four metals reported in spotted, ribbon, and bearded seals.

Four other investigations have reported metal concentrations in northern fur seals on the Pribilof Islands. None of these research projects was sponsored by the Outer Continental Shelf Environmental Assessment Program. Results of the four investigations are compared in Table 14 for those elements sampled by more than one investigation.

Although E. J. Skoch and his associates have produced a series of reports on metals concentrations in northern fur seals, only the most recent data, summarized in Skoch and Metzger (1988), are reviewed here. Earlier reports contain data which are "off by a certain factor" (Skoch, pers. comm., 1987). These earlier reports, available at the Alaska office of NOAA, are comprised of Skoch, Hoste, and Bral (no date), Hoste, Skoch, and Grills (1984), and Richard and Skoch (1986).

Statistics in Table 15 summarize the raw data in unpublished laboratory records accompanying the report by Skoch and Metzger (1988). For calculation purposes, I first substituted the data labelled "re-do's" in the laboratory records for several initial determinations. The concentrations of each analyte in each of the three tissues were then tested for skewness and kurtosis. Only those samples or their log-normal transformed values which were not found significantly different from normal are summarized as means and confidence intervals in Table 15.

Table 16 compares the arithmetic mean levels of those elements which have normal distributions and which were measured by more than one investigation.

The high mean concentration of mercury in liver is among the salient features of the four studies. Smith's (1986) sample provides an estimate that the mean level of mercury in livers of the young male fur seals on St. George Island in 1986 has a 95% chance of lying between 50 and 84 ppm, dry weight (Table 15). Goldblatt and Anthony (1983) report a similar level. Their dry weight estimates, re-calculated by dividing wet weight by their factor of .21 g dry/g wet,

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Table 13. Mean concentrations (ppm, dry wt.) of heavy metals in seal tissues in St. George Basin planning area, calculated from data in Burrell (1979: Tables 3 and 5). Data are pooled for spotted, ribbon, and bearded seals.

	n	Arith. mean	95% conf. interval
Kidney:			
Cadmium	9	29.84	21.97-37.72
Nickel	6	.2000	.0845-.3155
Copper	9	22.41	14.02-30.80
Zinc	9	110.2	88.48-131.96
Liver:			
*Cadmium	10	12.54	5.057-20.02
Nickel	7	1.543	.8817-2.33
Copper	10	22.09	15.57-28.52
Zinc	10	121.6	90.85-152.35
Muscle:			
Cadmium	10	.4090	.1803-.6377
Nickel	8	3.175	1.317-5.034
Copper	9	5.533	4.293-6.773
Zinc	10	67.20	40.91-93.49

*Includes significant species difference

Table 14. con't

WET WEIGHT BASIS:	Goldblatt n=37			Anas n=29		
	mean	SD	range	mean	SD	range
KIDNEY:						
Mercury						
Cadmium	56.05					
Zinc	58.36					
Lead	0.057					
Copper	-					
Nickel	0.117					
LIVER:						
Mercury	10.74	6.53	4.09-42.94	10.8	-	3.0-19.0
Cadmium	16.13					
Zinc	67.76					
Lead	0.328					
Copper	-					
Nickel	0.119					
MUSCLE:						
Mercury				-	-	0.1-0.4
Cadmium	0.271					
Zinc	42.16					

Table 15. Means and confidence intervals for elements in tissues of male northern fur seals, aged 2 to 4 years, at five rookeries in the Pribilof Islands. Original data are single determinations per tissue per animal, except 6 kidneys, 1 liver, and 1 muscle for which 2 determinations were recorded. Geometric means and confidence intervals are back-transformed from the log normal values. Based on data from Skoch and Metzger (1988) repeated in the appendix of this review.

Tissue & sample size		Element	Arith. mean	Geom. mean	95% conf. int.
Kidney	23	Titanium		64.3	37.6-110.1
	60	Iron		461	378-562
	72	Zinc	77.4		70.8-84.0
	72	Zinc		72.1	65.7-79.1
	66	Chromium		1.34	1.13-1.59
	72	Lead		26.8	22.1-32.5
Liver	19	Titanium		70.6	36.2-137.6
	56	Iron	1567		1306-1828
	59	Cadmium		58.3	46.2-73.4
	56	Selenium	167		146-189
	58	Nickel		4.58	3.52-5.96
	58	Copper		85.8	73.3-100
	58	Zinc	69.7		63.2-76.1
	52	Chromium		1.33	1.07-1.64
Muscle	16	Titanium		95.5	55.8-163
	54	Selenium	224		192-256
	56	Nickel		6.77	5.37-8.52
	56	Zinc		62.1	55.6-69.5
	56	Aluminum	1.22		1.16-1.29
	56	Aluminum		1.20	1.14-1.26

Table 16. Selected arithmetic means and confidence intervals for elements in tissues of northern fur seals, Pribilof Islands. Based on the data of the four investigations represented in Table 14. Samples which depart from normal in tests of skewness and kurtosis are omitted. Values are rounded for ease of comparison. Ppm, dry weight.

Tissue	Element	Author	Arith. mean	95% confid. interval
Kidney	Cadmium	Goldblatt	267	234-300
		Smith	249	120-378
	Copper	Smith	22.5	18.4-26.6
	Lead	Goldblatt	0.27	.203-.349
	Mercury	Smith	5.46	3.65-7.26
	Nickel	Goldblatt	0.556	.366-.746
	Zinc	Goldblatt	278	258-298
		Skoch	77.4	71-84
		Smith	237	182-292
Liver	Cadmium	Goldblatt	55.6	46.3-64.9
		Smith	67.3	18.6-116
	Copper	Smith	32.5	19.1-45.9
	Lead	Goldblatt	1.13	.323-1.94
	Mercury	Smith	61.1	38.0-84.2
	Nickel	Goldblatt	.411	.304-.518
	Zinc	Goldblatt	234	221-247
		Skoch	69.7	64-75
		Smith	210	157-262
Muscle	Cadmium	Goldblatt	0.9	.69-1.1
		Smith	0.6	0-1.3
	Lead	Goldblatt	0.26	.10-.42
	Mercury	Smith	1.4	.53-2.2
	Zinc	Goldblatt	139	126-152
		Smith	90	78-102

yield a mean of 51 ppm, with a 95% confidence interval of 41 to 61 ppm. The wet weight mean of Goldblatt and Anthony (1983) is almost identical to that of Anas (1973, 1974). However, Anas reported no sample dispersion and thus the two means cannot be tested for significant difference.

Assuming that the statistics of Goldblatt and Anthony (1983) are from a normally distributed statistical population, samples of mercury in liver with the size and standard deviation of theirs can detect a significant difference in means of 5 ppm wet weight (less than the standard deviation of 6.53 ppm) about 90% of the time.

Cadmium levels (dry weight) in kidney are similar and high among the three investigations reporting the element. Cadmium in kidney has among the highest concentrations of the trace elements reported in fur seals and is similar to the levels of zinc in kidney and liver (Table 14). Goldblatt and Anthony (1983) compared cadmium levels among pinniped species and also tested for the affect of animal age on cadmium levels in fur seals.

Unlike cadmium, lead concentrations (dry weight) vary widely among the studies (Table 14). The unpublished laboratory records of Skoch and Metzger (1988) indicate mean levels from 40 to 55 ppm among three tissues, which are values far greater than those of other investigators. Goldblatt and Anthony (1983) found lead levels of approximately 1 ppm and lower. Smith (1983) did not detect lead at all above the lower detection limit .034 ppm dry weight. He suggests that the higher concentrations reported by the older investigations are either representative of different animal populations or "inaccurate due to sample and analytical contamination."

Zinc in kidney and liver was measured at lower concentrations by Skoch and Metzger (1988) than measured by Goldblatt and Anthony (1983) and by Smith (1986), as shown in Table 16.

These four investigations offer little opportunity for obtaining more robust estimates of analyte concentrations by combining sample data. Significant differences in the mean levels for several analytes, as well as the absence of the original laboratory determinations in two reports preclude calculations of means and confidence intervals from pooled samples.

Nevertheless, these four studies indicate that fur seals carry greater burdens of cadmium and zinc than the three Phocidae species sampled by Burrell (1979). A comparison of the mean concentrations of the metals listed in Tables 13 and 16 shows this difference. Zinc mean concentrations appear twice as great in the fur seals of Goldblatt and Anthony (1983) as in the earless seals of Burrell (1979) for three tissues. Differences in cadmium levels are even more pronounced between the two sets of species. However, the confidence intervals of copper concentrations in kidney and liver overlap, suggesting that mean levels are not significantly greater in fur seals than in the phocids.

Tissue organochlorines

Five research programs offer data on organochlorine concentrations in animal tissues from the greater St. George Basin. The amount of data on organochlorine residue concentrations for each of the reports is summarized in Table 17. Four investigations sampled northern fur seals at the Pribilof Islands. In addition, one investigation analyzed the eggs of three species of seabirds at the Pribilof Islands and Bogoslof Island (Ohlendorf et al, 1982; Ohlendorf, pers. comm., 1988). Hence, a total of 1,560 laboratory determinations of organochlorine concentrations in various tissues is available.

Northern fur seals

Most samples of organochlorine residues in northern fur seals provide poor power to detect differences in mean levels because samples are small. For example, Anas and Wilson (1970) reported sample sizes of eight for DDE in brain and in liver. Differences in means as large as the sample standard deviation would be significant only 50% of the time. Calambokidis and Peard (1985) report sample sizes of four, which would detect differences in means equal to two standard deviations only 50% of the time.

Power is improved in the samples of Kurtz (no date) which have sizes of 18. These samples have statistical power to detect differences in means equal to one standard deviation approximately 80% of the time.

An example may illustrate the power of tests. Kurtz (no date) examined Aroclor PCB mixture 1254 in 18 fat specimens, and found a mean of 3.705 ppm, wet weight, and a standard deviation of 1.802 ppm. The 95% confidence interval of this mean is 2.86 to 4.55 ppm. The power of the t-test is determined from a power table, using the sample size and arbitrarily specifying a difference in means equal to the standard deviation. In this example, a second independent sample with size 18 and standard deviation 1.8 would require a mean as large as 5.5 ppm for a t-test to indicate a significant difference with a 80% chance of correctly rejecting the null hypothesis that the means are equal. Thus, more than 20% of the time a real increase of less than 50% in mean level of this PCB would be undetected.

Wise (pers. comm., 1988) reported two animals' concentrations of 20 PCB congeners and 15 pesticides. No other report available for this review examined PCB congeners and only Kurtz and Kim (1976) and Kurtz (no date) examined DDT and its metabolites as closely as Wise. The sampling of Wise (1988) is further distinquished by repeated determinations within individual tissues. However, the absence of the original, unsummarized values and the

Table 17. The quantity of non-proprietary data on organochlorine concentrations in animal tissue in the greater St. George Basin. Analytes are the chemical species analyzed. Specimens are the northern fur seals and seabird eggs sampled. Tissues are the types sampled within specimens. The number of concentrations in the table includes those attempts which measured no quantities of the analyte.

	NUMBER OF LAB DETERMINATIONS:			
Citation	Analytes	Specimens	Tissues	Concentrations
Anas 1970	4	8	2	64
Calambokidis 1987	5	1	4	20
Calambokidis 1985	2	4	2	16
Kurtz 1976	8	7	2	112
Kurtz no date	7	18	4	504
Ohlendorf 1982,88	12	47	1	564
Wise 1988	35	2	4	280

censoring of data below lower detection limit precludes testing of assumptions about frequency distributions. These constraints and the small sample size of two may limit comparisons among such important factors as year, age, place, and species. Nevertheless, comparisons with other investigations reviewed here indicate that some means, such as for DDE congeners and dieldrin in liver and blubber, are so much lower that statistical tests of differences with other reports are unnecessary.

For northern fur seals, the only tissue-chemical combination with testable sample sizes in more than one investigation shows significant variation in concentrations among investigations. DDE concentrations in liver of subadult males, uncorrected for percentage recovery, are significantly different according to a Kruskal-Wallis rank test using samples of Anas and Wilson (1970), Calambokidis and Peard (1985), and Kurtz (no date) (test statistic $H=11.4$; $df=2$; $P=.0037$). Figure 15 illustrates the variation in mean levels of DDE in livers among the four studies.

Because the data on DDE in liver of Calambokidis and Peard (1985) and Kurtz (no date) are similar, they may be combined to increase sample size. Their log-transformed values have means and variances which are not significantly different between studies, according to t-test and F-test. The resulting pooled sample of 22 has a geometric mean equal to .201 ppm wet weight, with a 95% confidence interval of .162 to .249 ppm. Figure 16 shows the frequency distribution of the untransformed concentration values for the pooled sample.

Seabird eggs

Ohlendorf, et al (1982) surveyed organochlorine residue concentrations in the eggs of Alaskan seabirds from 1973 to 1976. All of the data from that report regarding the four species and three islands studied in the greater St. George Basin are repeated in the appendix. The appendix also includes a table containing unpublished, unsummarized data received from Ohlendorf (pers. comm.,1988).

The values are not corrected for percentage recovery, which ranges from 83% to 104%. The lower limit of detection was .02 ppm for toxaphene and PCB's, and .005 ppm for the other pesticides (Ohlendorf, et al, 1982:4).

Table 18 shows the arithmetic means of DDE and PCB's in eggs collected in the St. George Basin area, based on the unpublished data of Ohlendorf (pers. comm., 1988). These two chemicals are represented by the largest sample sizes and the highest concentrations in the data set. Their sample distributions do not differ significantly from normal according to tests for skewness and kurtosis. Figure 17 illustrates the variation in the mean levels of DDE and PCB's among bird species shown in Table 18.

The eggs of glaucous-winged gulls on Bogoslof Island exhibit the highest organochlorine residue quantities measured for St. George Basin area eggs. This sample includes an egg with 11.0 ppm DDE, wet weight, and another with 6.3 ppm PCB's, wet weight. See the appendix.

Table 18. Mean concentrations (ppm, wet wt.) of selected organochlorines in eggs of seabirds on Pribilof Islands and Bogoslof Island. Based on data from Ohlendorf (pers. comm.,1988).

		DDE:		PCB's:	
Species	n	Mean	95% conf. int.	Mean	95% conf. int.
Northern fulmar	6	.312	.216-.408	.400	.223-.577
Glaucous-winged gull	3	6.37	.938-11.8	3.90	1.28-6.52
Black-legged kittiwake	10	.033	.023-.043	.481	.375-.587
Common murre	7	.119	.111-.127	.126	.098-.155

National Status and Trends

The National Status and Trends Program of NOAA has developed several hundred data on trace contaminants in bottom fish and surface sediments at Dutch Harbor in 1986 and 1988 (Varanasi, et al, in prep.). A preliminary view of the 1986 data indicated that the data include concentrations of 38 organochlorines, 16 metals, several

classes of polynuclear aromatic hydrocarbons, in addition to auxiliary variables from the sampled material and quality assurance documentation. The sampled material and the analytes of 1988 are similar to those of 1986.

The NS&T Program makes its data available to other users two years after the collection. Hence, the first set of data in this series will become available after October, 1988.

DISCUSSION

Availability of data

Data on trace contaminants in sediment of the St. George Basin area are available from several OCSEAP reconnaisance surveys. For three surveys, a small number of collecting stations fall in the area of the St. George Basin. Of these surveys, one measures hydrocarbons and percentage organic carbon, an important normalizing variable. The other two studies sample metals concentrations, unaccompanied by other specimen measurements. In contrast, the survey of Gardner, et al (1978a, 1978b) provides a large collection of metals determinations as well as measurements of grain size and carbon normalizers.

Tissue data for the St. George Basin were found in a wider variety of sources, including both reconnaisance and monitoring research. Concentrations of hydrocarbon fractions are provided for small samples of a large array of taxa in surveys by Shaw (1977, 1978). In addition, small samples of metals concentrations in several species of invertebrates at a few locations were determined by Burrell (1978) and Robertson and Abel (1979). Ohlendorf (1982) surveyed organochlorine residues in bird eggs. In contrast to these studies, designed to characterize contaminant levels within taxa, Boersma (1984) used hydrocarbon peaks as a tool for monitoring changes in oil pollution over time.

Seals have received more attention than any other taxon in the St. George Basin area. Seal organochlorines and metals have been sampled in five species and eight tissues by nine sets of investigators over a period of twenty years. Nevertheless, the small samples do not necessarily offer a basis for detecting increases and decreases in trace contaminant levels.

Adequacy of data

Some trace contaminant analytes in the St. George Basin area are well-characterized by robust sampling. Chief among these analytes are the elements in sediment studied by Gardner, et al (1978a, 1978b), and in the fur seal tissue of Goldblatt and Anthony (1983). Both investigations offer larger samples, attempt to account for variability in contaminant concentrations using auxiliary variables, and

are explicit about assumptions of normality. Consequently, both sets of results may be used in detecting moderate differences in metals concentrations with other investigations.

Most available data sets for the St. George Basin area do not measure geographical trends in trace contaminant concentrations. Only the research of Gardner, et al (1978a, 1978b) measures the variation in analyte concentrations within localities. Because the other studies of sediment and tissue do not partition total variance into its local and regional sources, they can offer for each analyte only a single mean which represents the entire sampled area.

Several characteristics of the data sets detract from their usefulness in monitoring temporal changes as well. First, small sample sizes for individual tissues and areas restrict testing power for detecting differences. Secondly, some results are presented as summaries, without the original determinations, precluding most further manipulation and requiring weakly supported assumptions about frequency distributions. In addition, non-normally distributed samples do not allow confidence limits of the mean or multi-variate analyses, although differences can be tested with non-parametric methods. For these reasons, most past sampling efforts in the St. George Basin area are of limited help in measuring trends and moderate changes in levels of trace contaminants.

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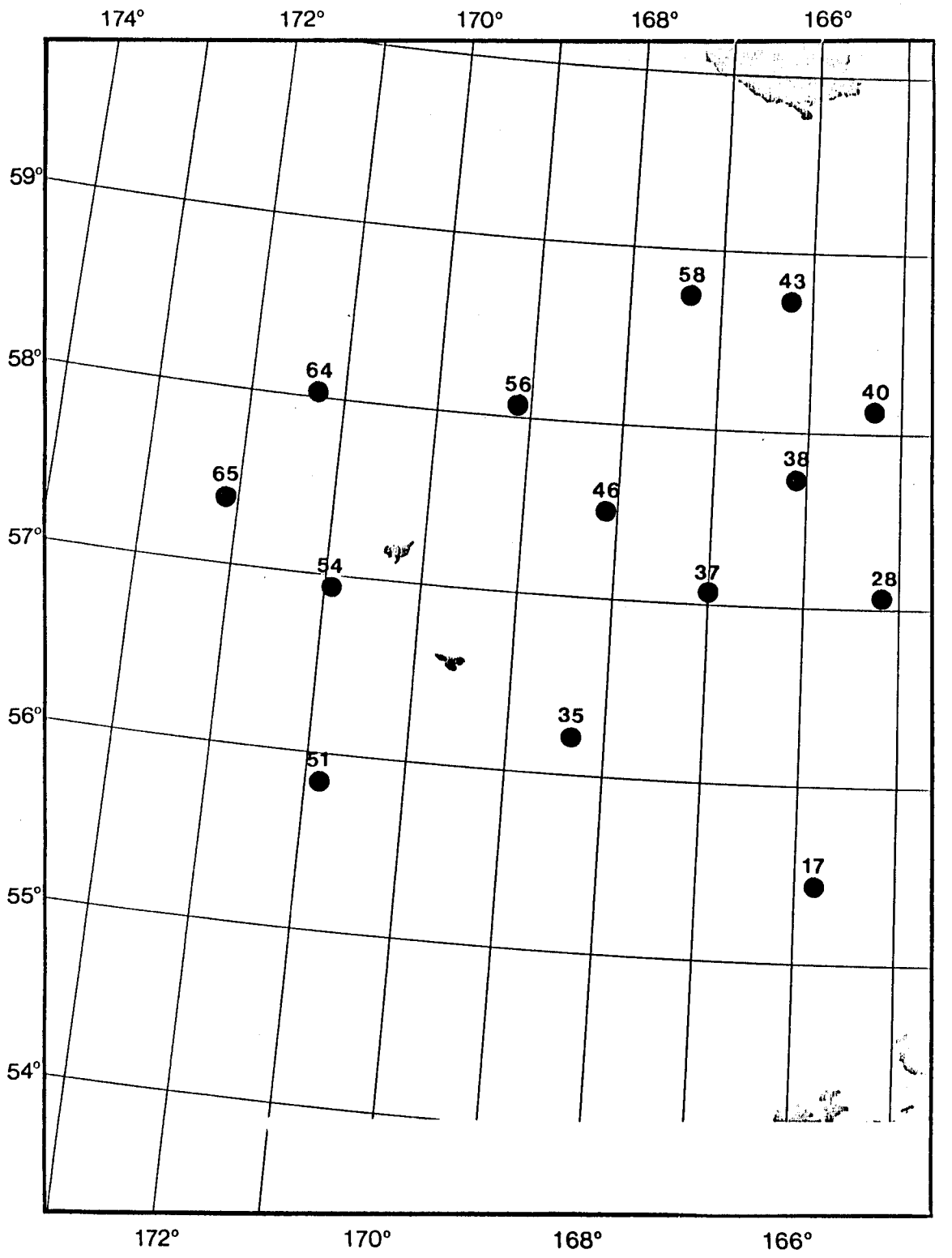

Fig. 1. Fourteen sediment grab stations reported for 1975 trace hydrocarbon sampling in the St. George Basin planning area by Kaplan, et al (1977) and Venkatesan, et al (1981). Numbers represent station labels.

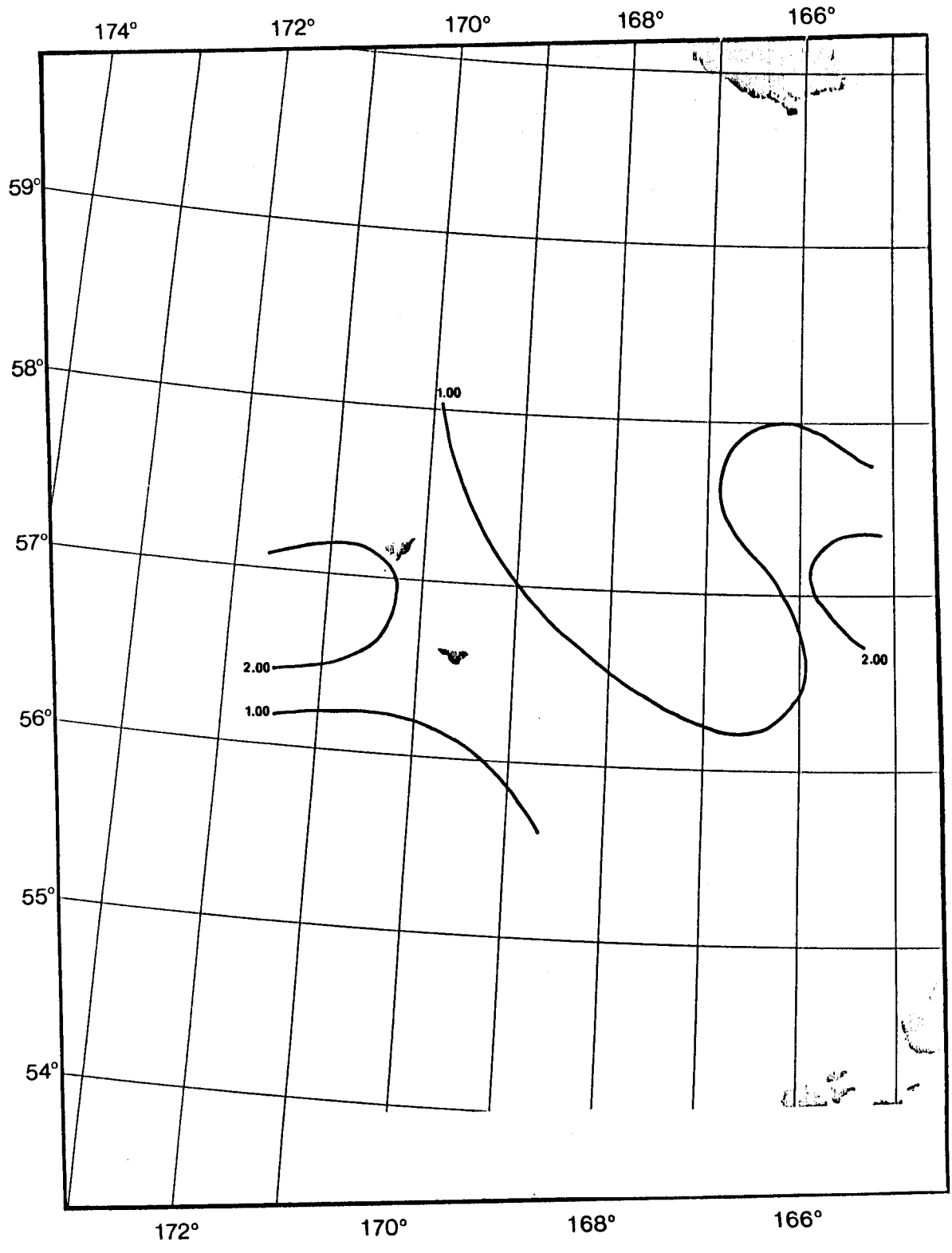

Fig. 2. Isolines of the concentration (ppm, dry weight) of total n-alkanes from C-15 to C-34 in surface sediment of greater St. George Basin. Based on 13 grab specimens in 1975 reported by Kaplan, et al (1977) and Venkatesan, et al (1981).

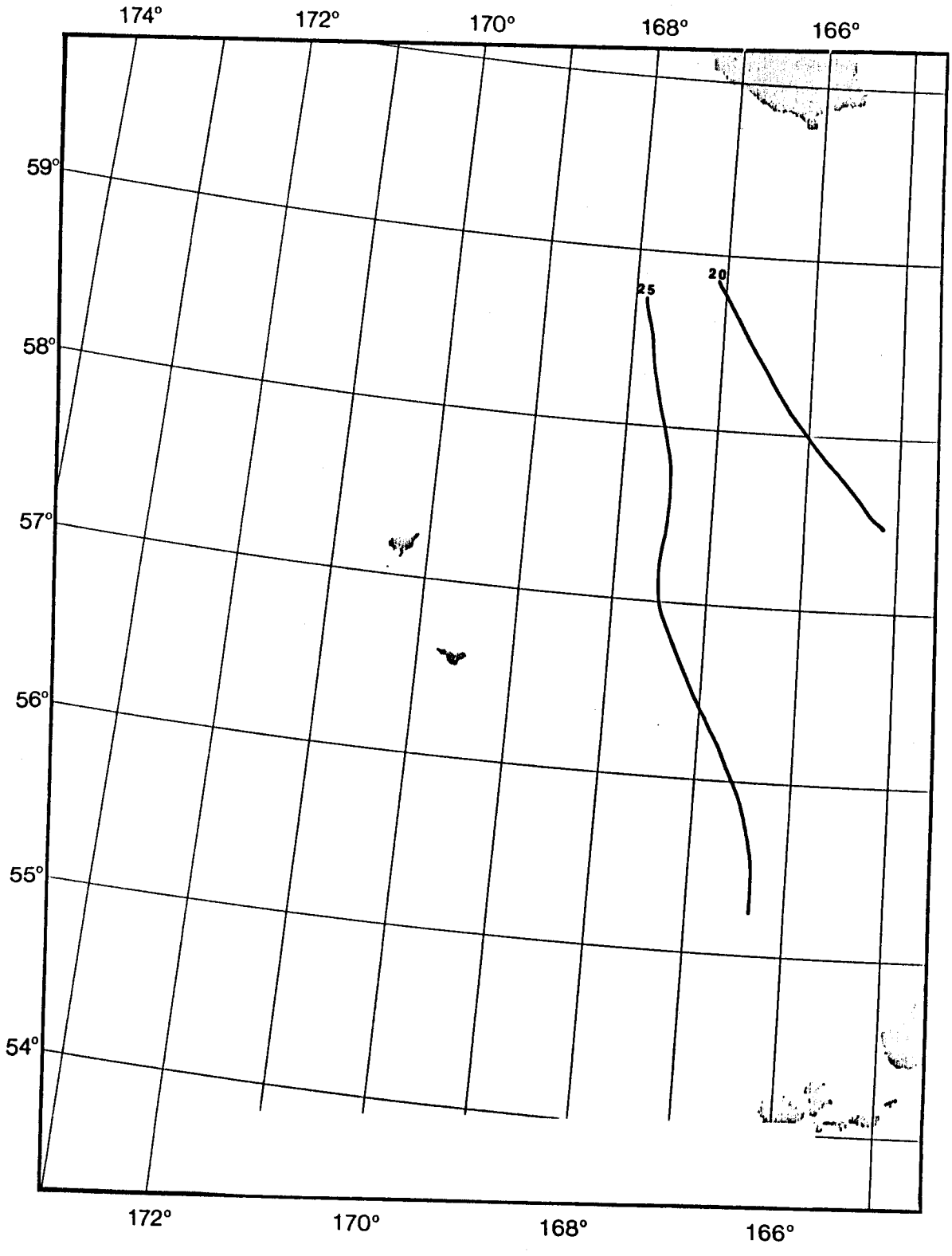

Fig. 3. Isolines of the ratio of total hydrocarbons to organic carbon x 10,000 in surface sediment of greater St. George Basin. Based on 14 grab specimens in 1975 reported by Kaplan, et al (1977) and Venkatesan, et al (1981).

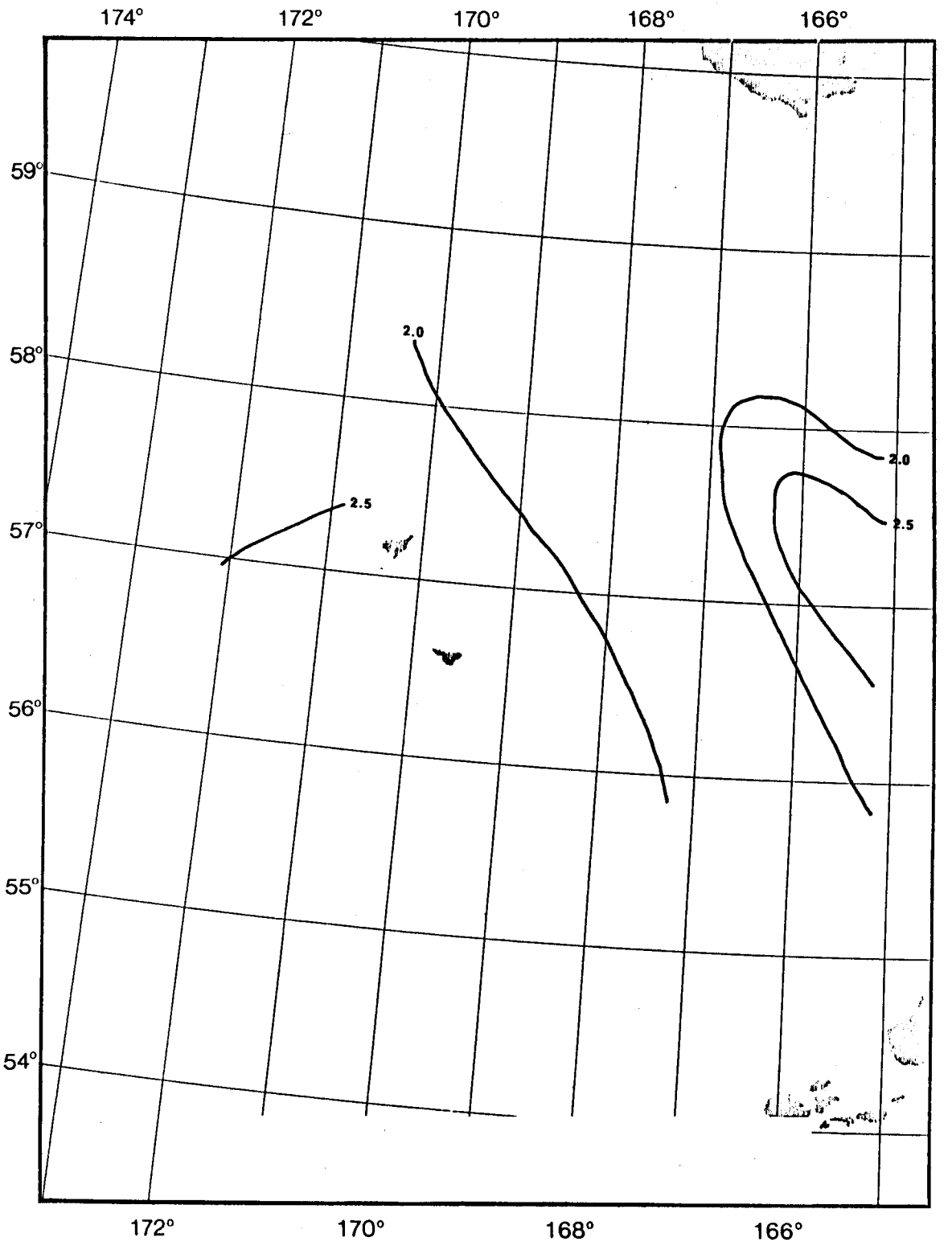

Fig. 4. Isolines of the ratio of total n-alkanes to organic carbon x 10,000 in surface sediment of greater St. George Basin. Based on 12 grab specimens in 1975 reported by Kaplan, et al (1977) and Venkatesan, et al (1981).

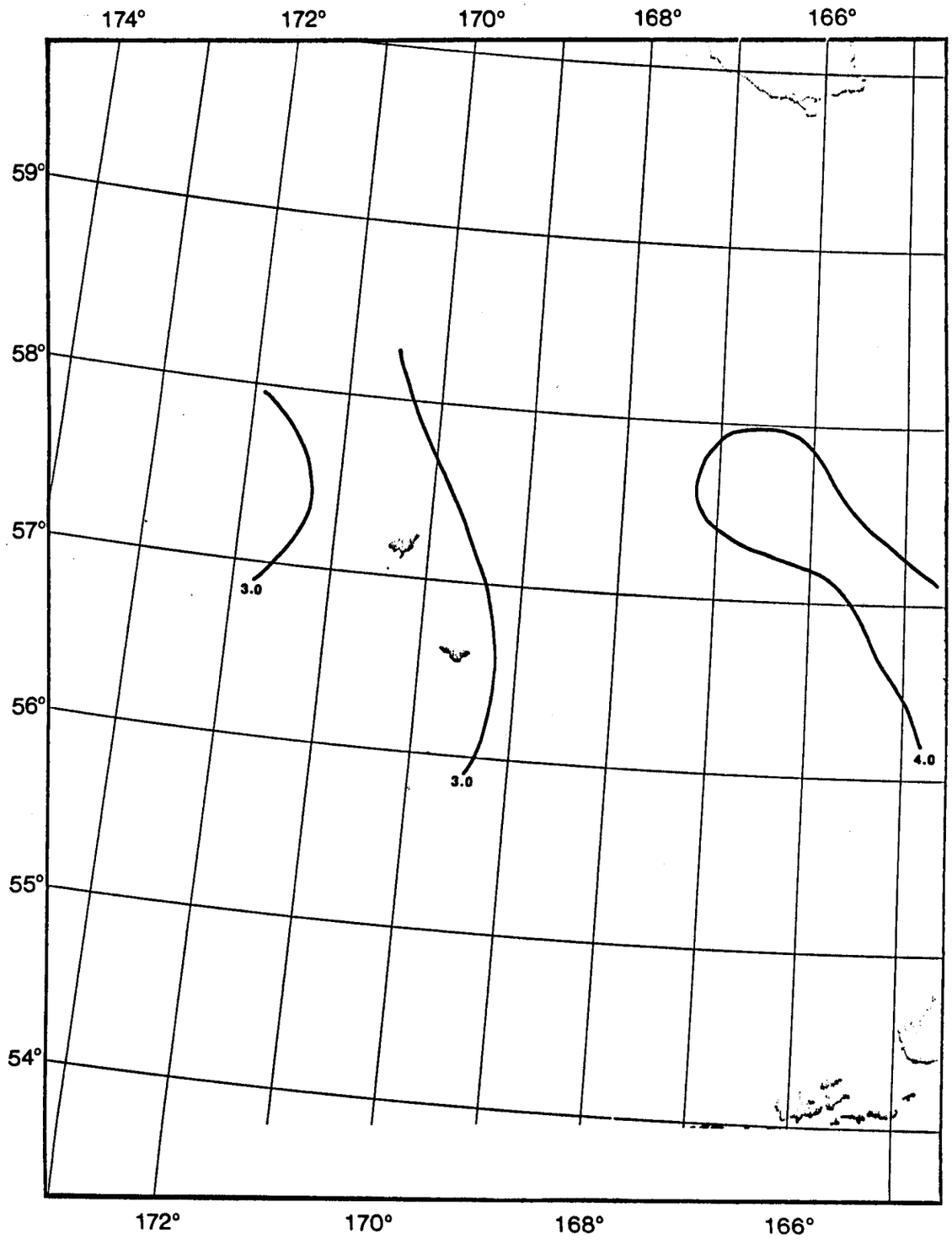

Fig. 5. Isolines of the odd-to-even ratio for alkanes C-15 to C-34 in surface sediment of greater St. George Basin. Based on 13 grab specimens in 1975 reported by Kaplan, et al (1977) and Venkatesan, et al (1981).

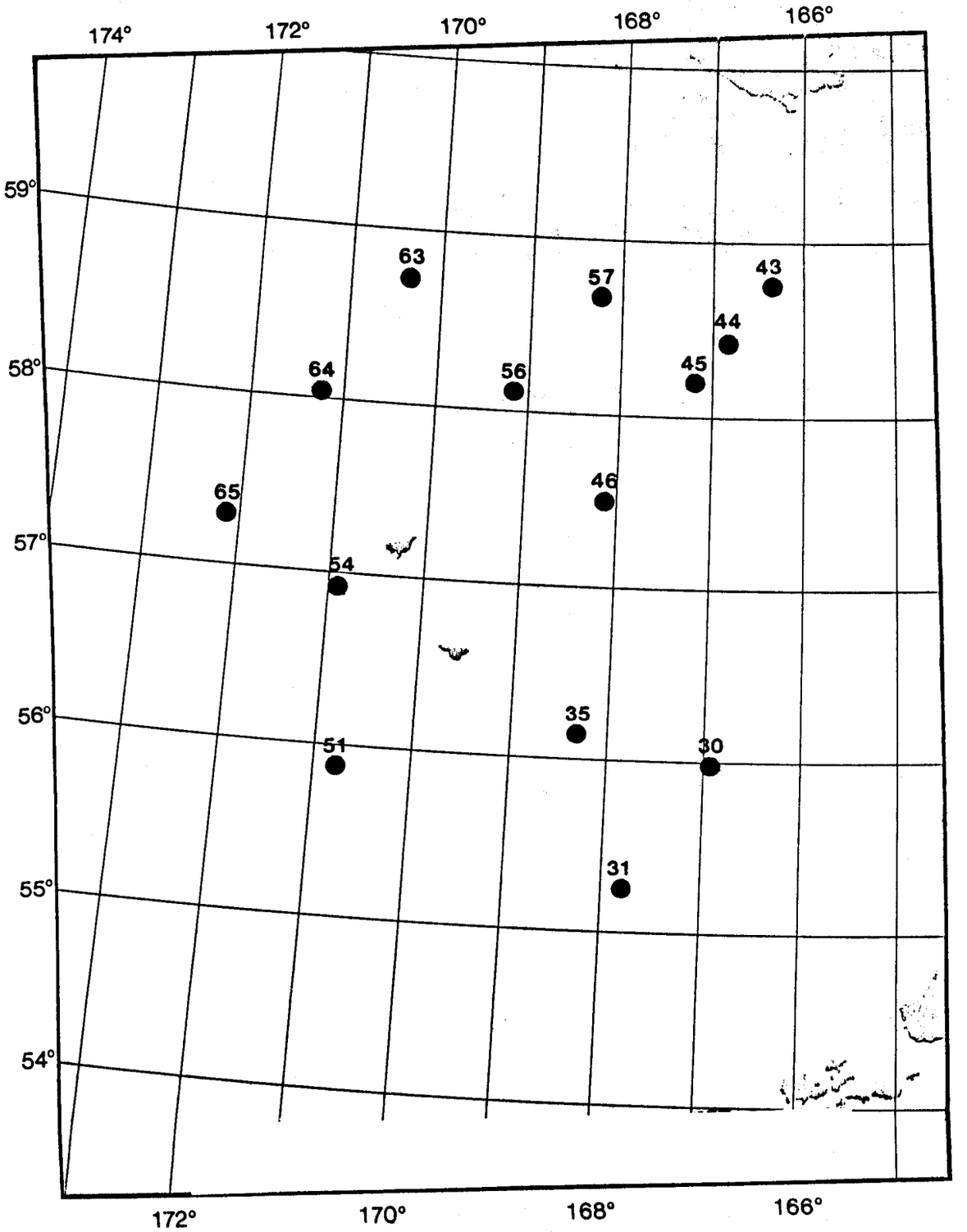

Fig. 6. Fourteen sediment grab stations reported for 1975 extractable metals sampling in the St. George Basin planning area by Burrell (1977, 1978). Numbers represent OSS Discoverer station labels.

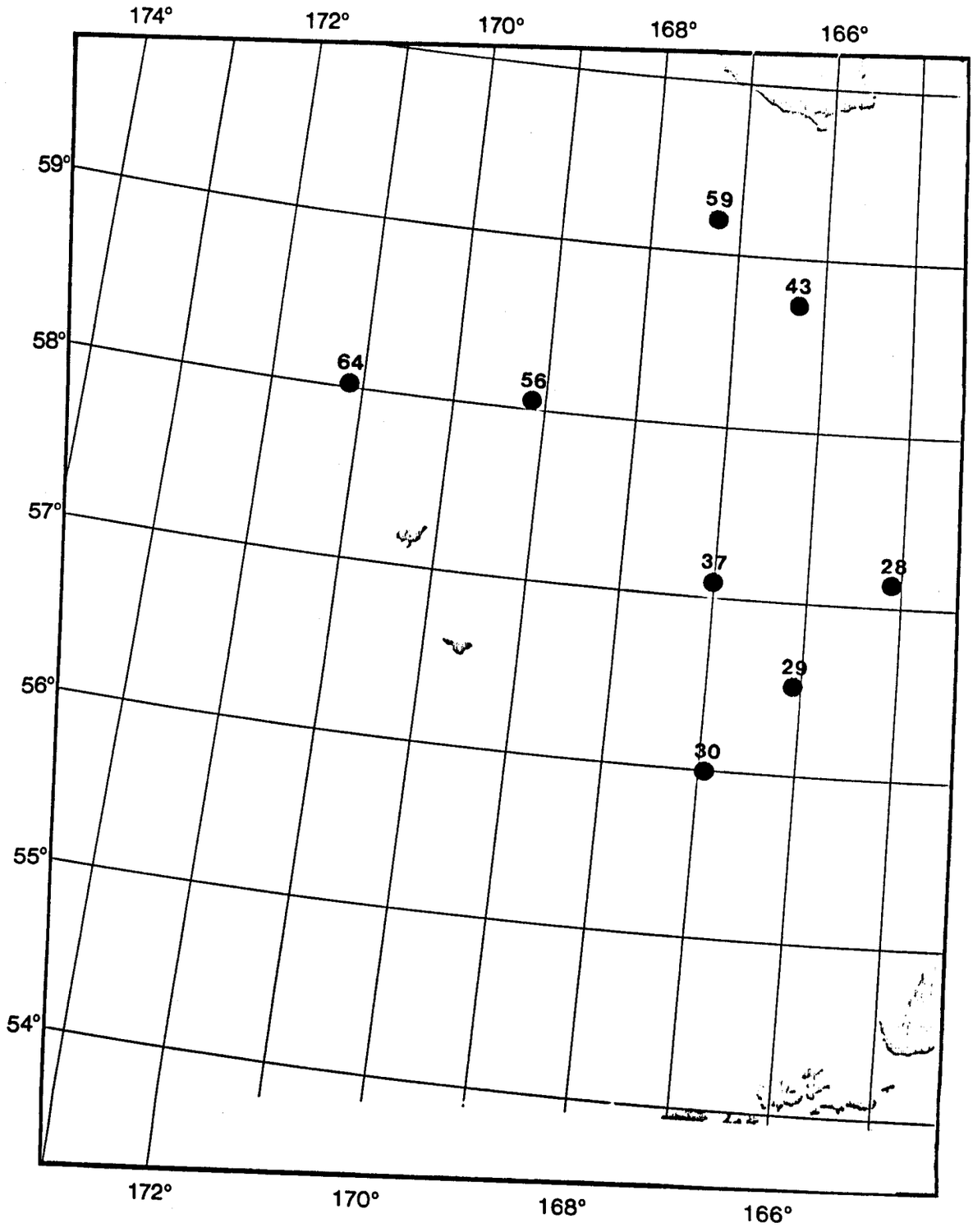

Fig. 7. Eight sediment grab stations reported for 1975 trace metals sampling in the St. George Basin planning area by Robertson and Abel (1979). Numbers represent OSS Discoverer station labels.

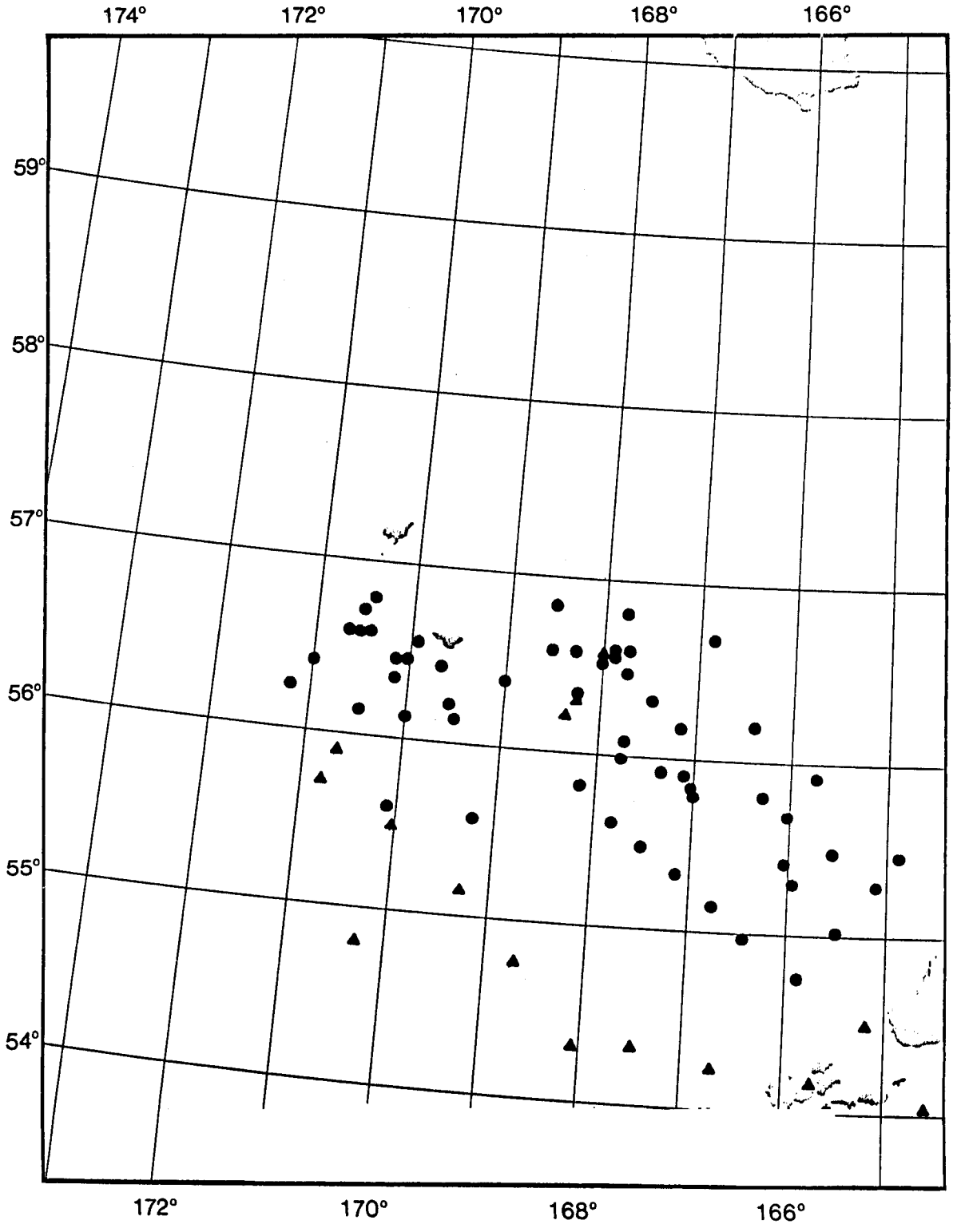

Fig. 8. Location of sediment collections for concentrations of elements in 1976 (circles) and 1977 (triangles) reported by Gardner, et al (1978b). Latitude and longitude are from Gardner (pers. comm., 1988).

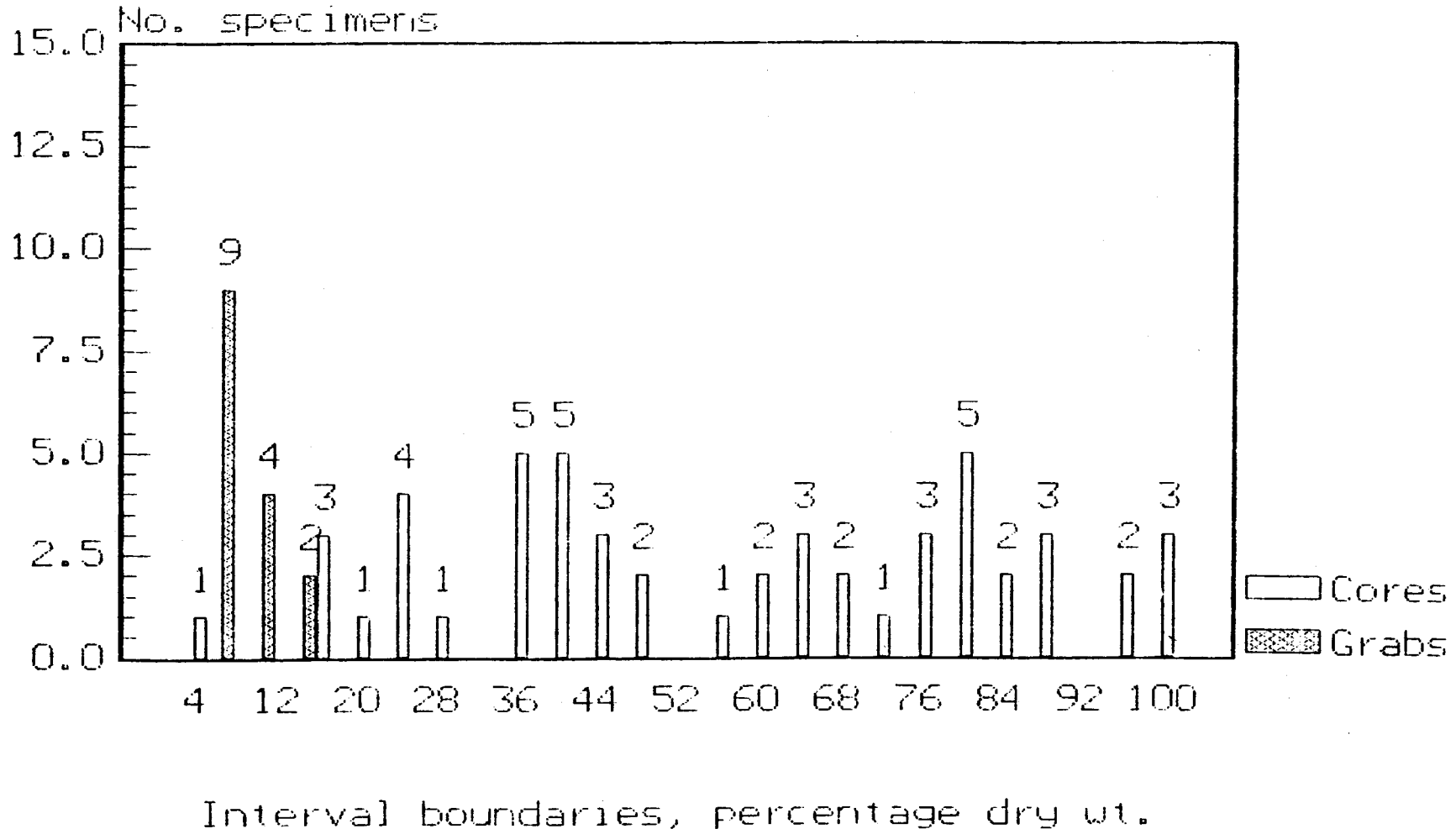

Fig. 9. Frequency of percent silt-clay in surface sediment of St. George Basin. Sample pooled for 1976 and 1977. Based on data in Gardner, et al (1978a).

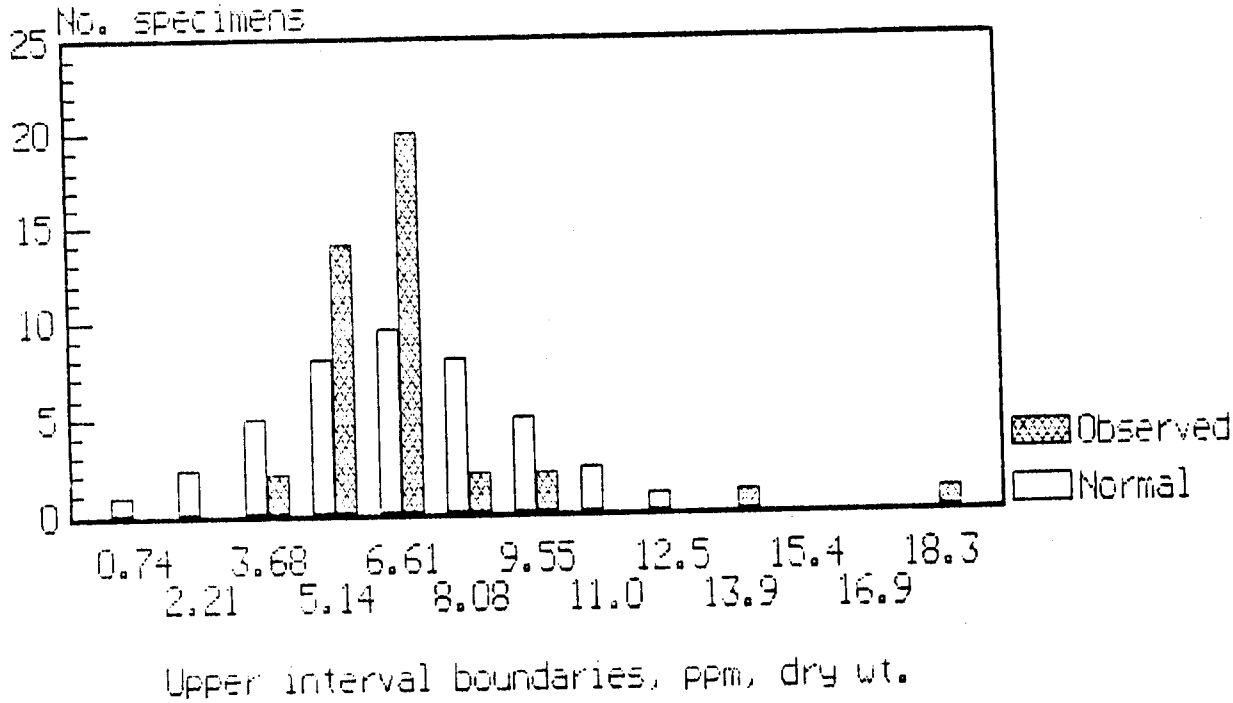

Fig. 10. Frequency distribution of arsenic in surface sediment of St. George Basin. Based on Gardner, et al (1978a).

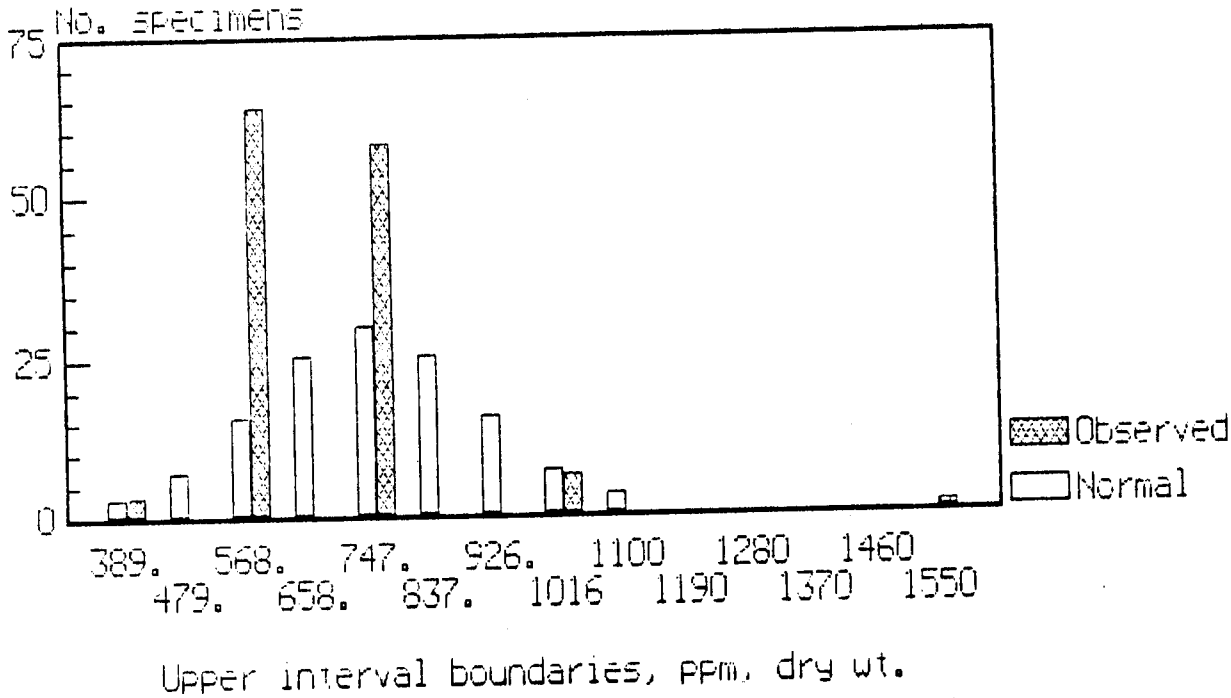

Fig. 11. Frequency distribution of barium in surface sediment of St. George Basin. Based on Gardner, et al (1978a).

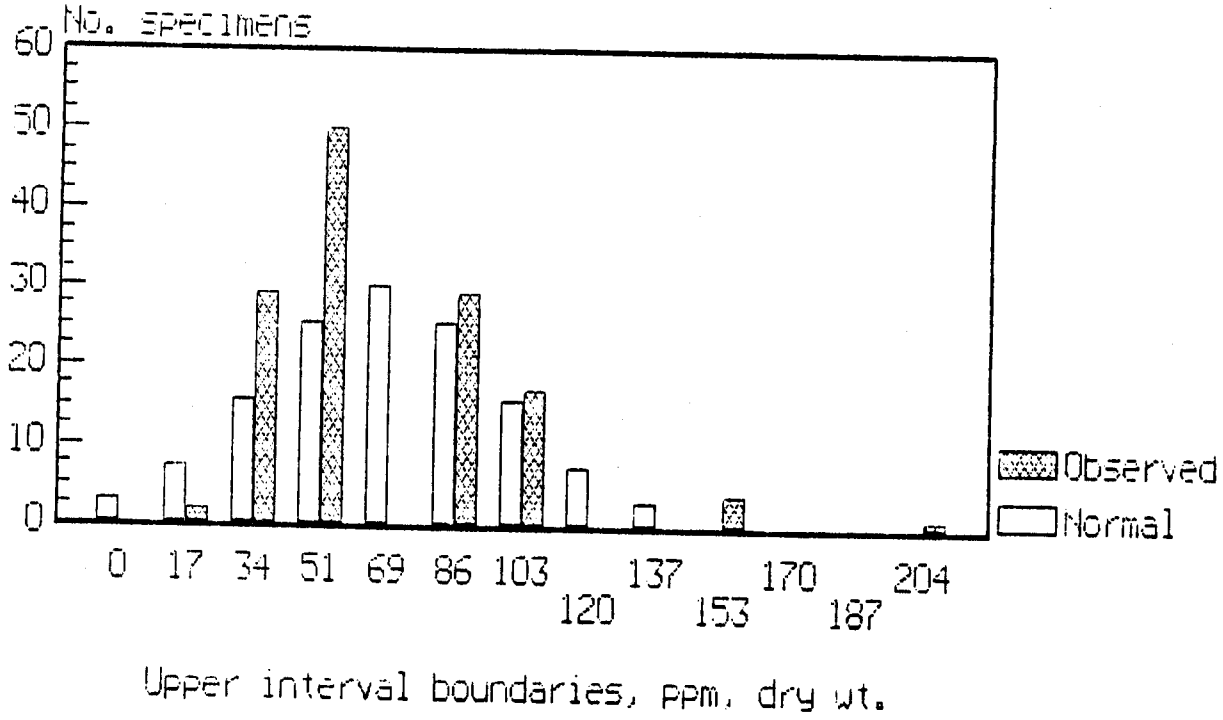

Fig. 12. Frequency distribution of chromium in surface sediment of St. George Basin. Based on Gardner, et al (1978a).

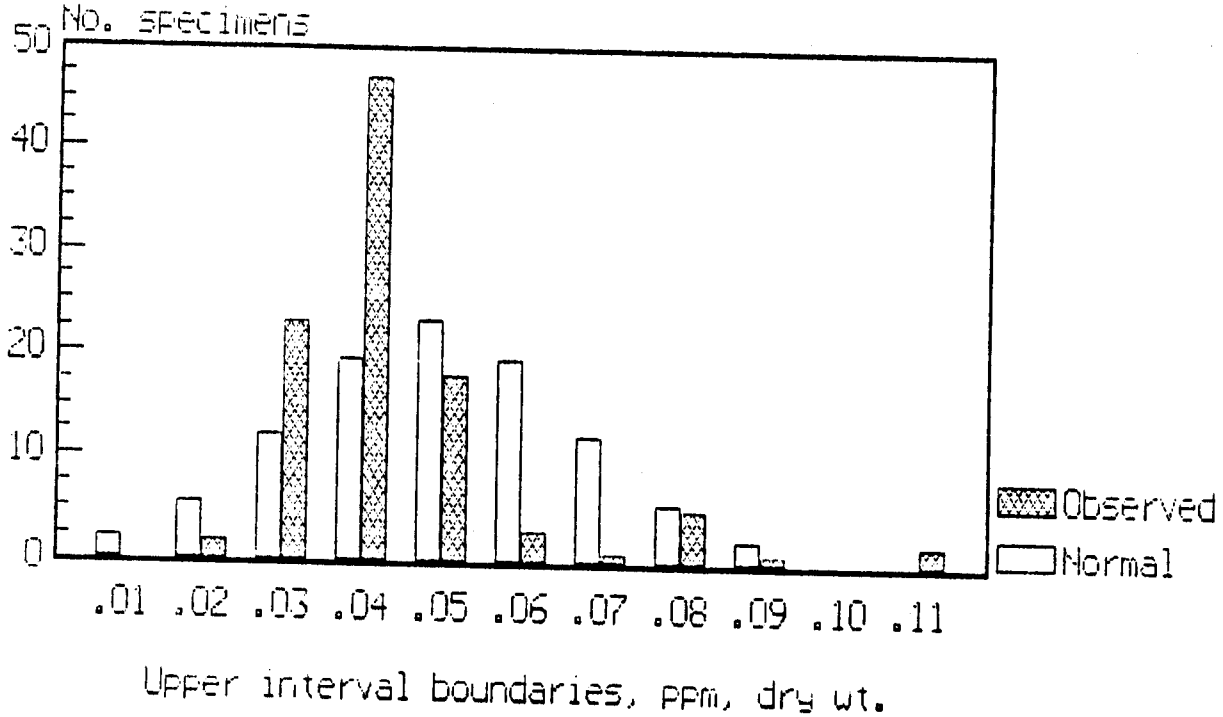

Fig. 13. Frequency distribution of mercury in surface sediment of St. George Basin. Based on Gardner, et al (1978a).

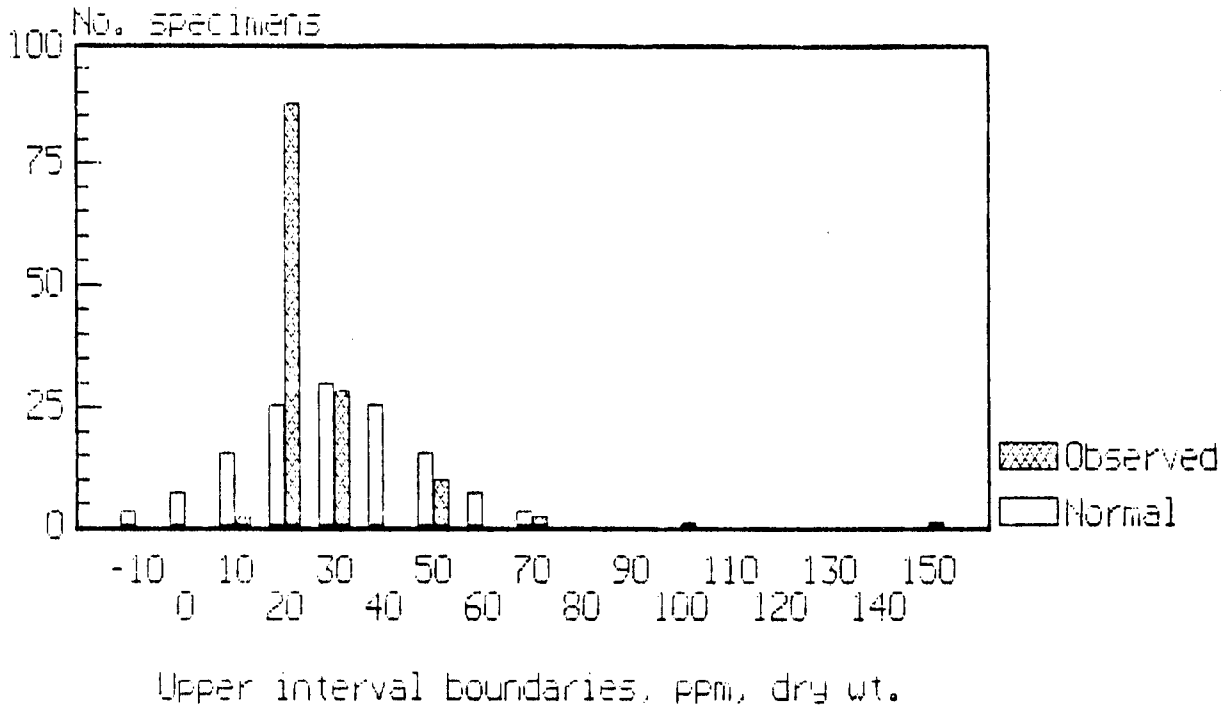

Fig. 14. Frequency distribution of nickel in surface sediment of St. George Basin. Based on Gardner, et al (1978a).

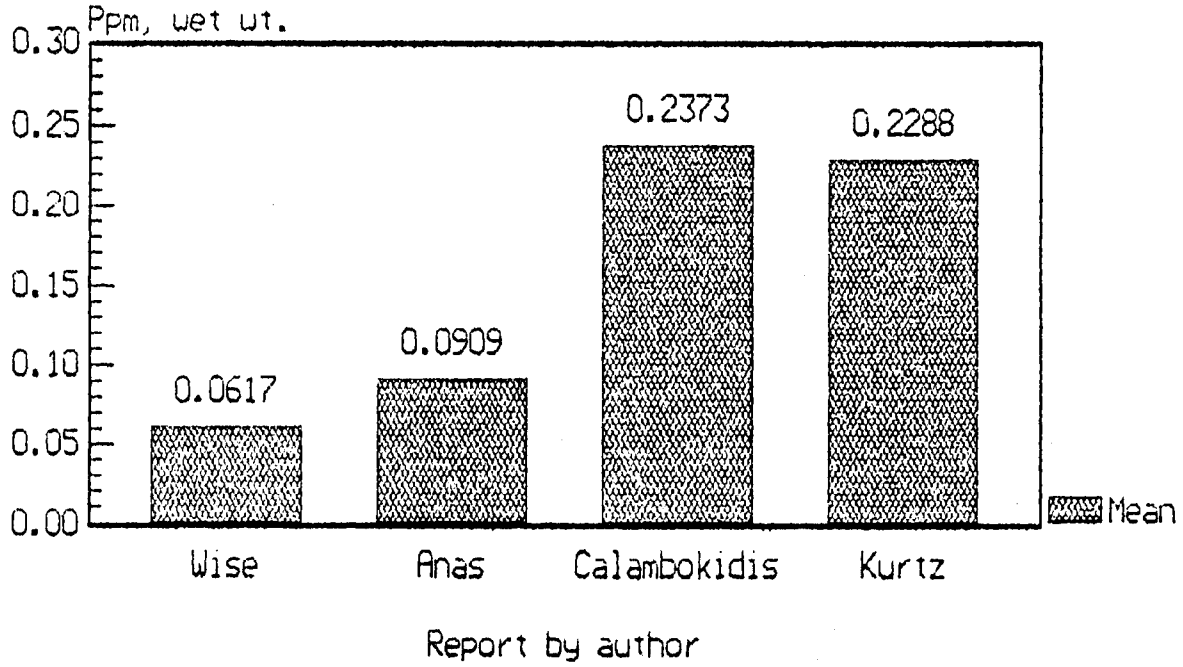

Fig. 15. Concentrations of DDE in livers of subadult male northern fur seals on Pribilof Islands.

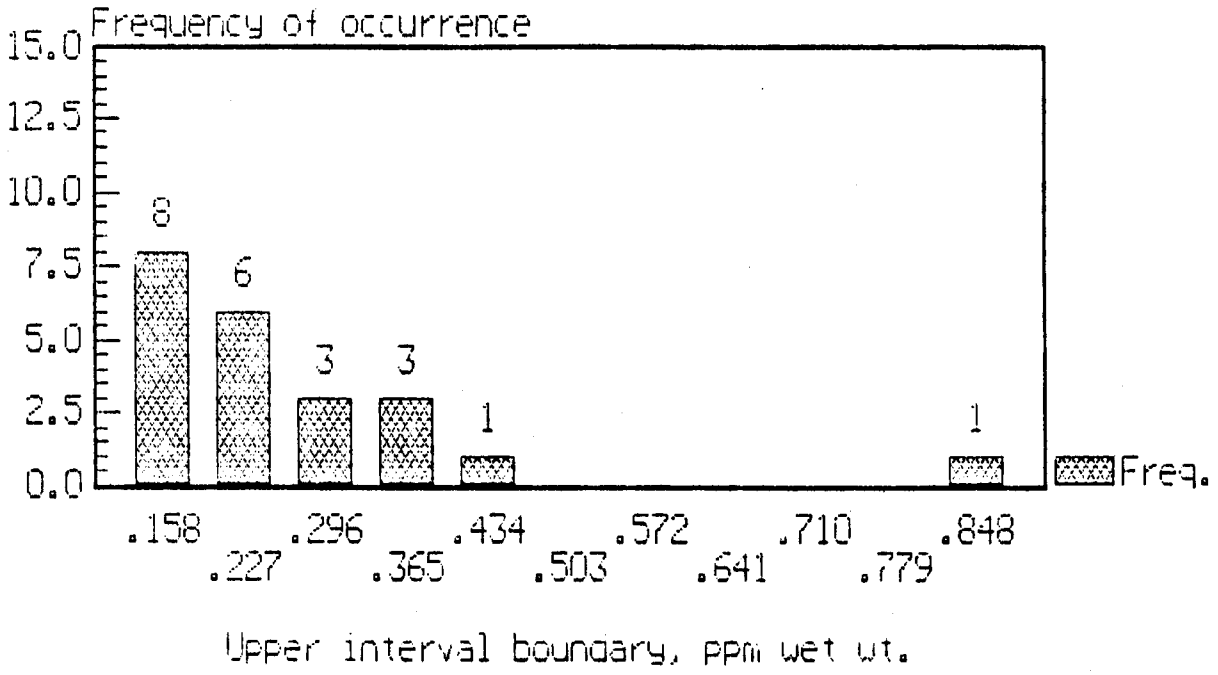

Fig. 16. DDE concentrations in liver of subadult male northern fur seals on Pribilof Islands. Combined from Kurtz (no date) and Calambokidis and Peard (1985).

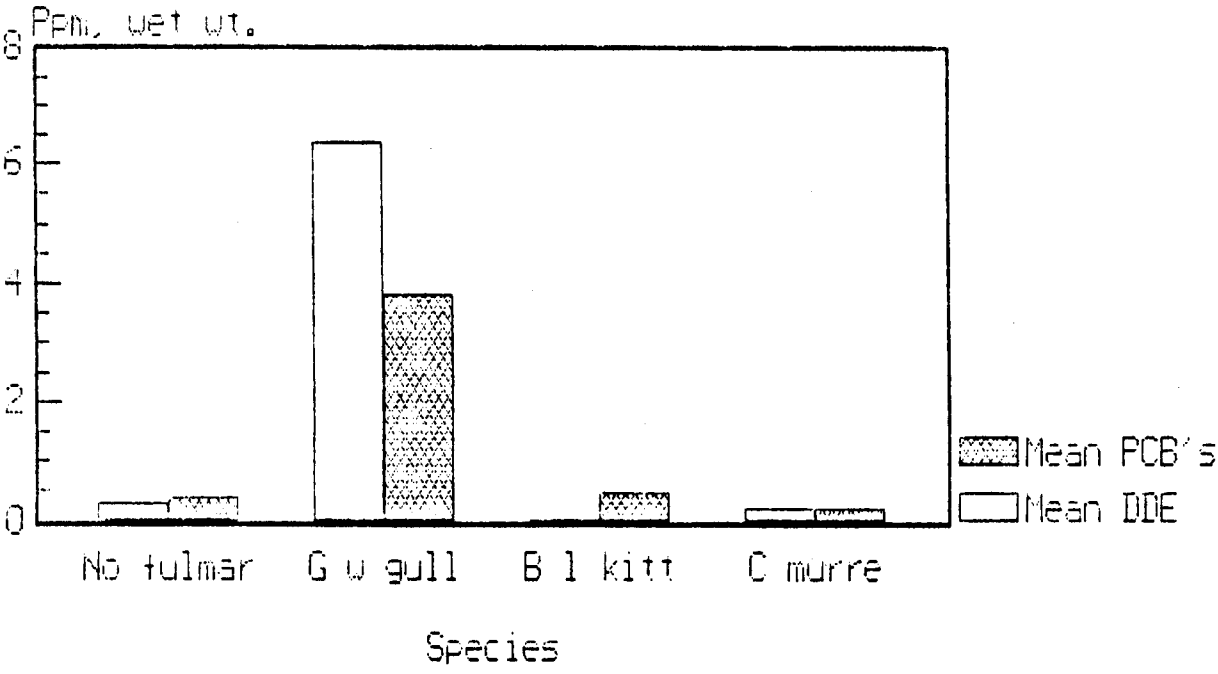

Fig. 17. Organochlorine residues in seabird eggs from islands in greater St. George Basin area. Based on unsummarized data from H. M. Ohlendorf (pers. comm., 1988).

Appendix

Tables of data from the original reports

Table A1. Concentrations of pesticides in liver and brain of subadult male northern fur seals (ppm, wet weight basis) at Pribilof Islands, July 2, 1968. Based on Anas and Wilson (1970: Table 1).

Concentrations are not corrected for percent recovery. Recovery rates are as follows: p,p'-DDE, 80-85%; p,p'-DDD (TDE), 82-95%; p,p'-DDT, 91-95%; and dieldrin, 85-90%. PCB's were not in the samples. ND means not detected at lower limit of sensitivity <0.010 ppm, dry weight. Concentrations are unsummarized, single determinations.

Tissue & field no.	Age (years)	DDE	DDD	DDT	dieldrin
Liver					
R-6683	3	0.075	ND	0.025	ND
R-8317	3	0.083	ND	0.038	ND
R-9514	3	0.042	ND	0.031	ND
Q-17766	4	0.044	ND	ND	ND
Q-19800	4	0.30	ND	ND	ND
Q-21025	4	0.068	ND	0.025	ND
Q-21777	4	0.061	ND	ND	ND
Q-24993	4	0.054	ND	0.021	ND
Brain					
R-6683	3	0.019	ND	ND	ND
R-8317	3	0.029	ND	ND	ND
R-9514	3	0.017	ND	ND	ND
Q-17766	4	0.015	ND	ND	ND
Q-19800	4	0.079	ND	ND	ND
Q-21025	4	0.019	ND	ND	ND
Q-21777	4	0.023	ND	ND	ND
Q-24993	4	0.018	ND	ND	ND

Table A2. Mercury concentrations (ppm, wet weight) in northern fur seals in 1970 and in harbor seals on Aug. 17, 1971, at Pribilof Islands. Concentrations are means of four replicates from each tissue specimen. Recoveries were over 90%. Based on Anas (1973, 1974: Tables 1 and 3).

Age (years)	Sex	No. seals	Tissue	Ppm, mercury mean	range
Fur seals:					
0.3 (pups)	mixed	10	liver	0.20	0.1-0.3
0.3 (pups)	mixed	5	muscle	0.06	0.05-0.11
2-3	male	29	liver	10.80	3.0-19.0
2-3	male	29	muscle	0.25	0.1-0.4
Harbor seals:					
-	male	1	liver	0.6	-
-	female	1	liver	3.2	-
-	male	1	liver	0.9	-

Table A3. Concentrations (ppm, dry weight) of heavy metal contents of the soft tissue of legs and claws of tanner crab and soft tissue of Neptunea snails in the St. George Basin planning area. Collected in April, 1976, from Miller Freeman vessel. From OCSEAP report by Burrell (1977: Tables 25 and 26).

Sample no.	Cd	Cu	Ni	Zn
Tanner crab:				
16	<1.3	30.3	<1.3	138
29	<1.3	25.0	<1.3	182
33	<1.3	27.5	<1.3	169
37	3.8	20.4	<1.3	158
48	<1.3	21.4	<1.3	155
Neptunea:				
15	13	215.9	<0.63	72.8
31	<1.3	111.2	0.7	56.8
50	2.5	155.8	0.63	84.8

Table A4. Concentrations (ppm, dry weight) of heavy metals in seals collected in St. George Basin planning area, March 31 to April 27, 1977, from Surveyor vessel. Based on OCSEAP report by Burrell (1979: Tables 3 and 5). Concentrations which are expressed plus or minus 1 SD are for sample sizes of n=2 from duplicate determinations. b=duplicate determinations. c=single determinations.

Specimen	Latitude	Longitude	Species	Sex
Muscle:				
4	58deg 45.6min	172deg 55.4min	Spotted	M
30	58deg 34.8min	169deg 28.8min	Spotted	M
28	58deg 54.2min	169deg 13.6min	Spotted	F
6	58deg 53.0min	173deg 7min	Ribbon	M
3	58deg 56min	172deg 40min	Ribbon	M
2	58deg 51.0min	173deg 8.0min	Ribbon	M
29	58deg 54.2min	169deg 40.3min	Ribbon	M
1	58deg 51.0min	173deg 8.0min	Ribbon	F
7	58deg 43.9min	169deg 32.9min	Bearded	M
8	58deg 48.5min	169deg 41.3min	Bearded	M
Liver:				
4	58deg 45.6min	172deg 55.4min	Spotted	M
30	58deg 34.8min	169deg 28.8min	Spotted	M
28	58deg 54.2min	169deg 13.6min	Spotted	F
6	58deg 53.0min	173deg 7min	Ribbon	M
3	58deg 56min	172deg 40min	Ribbon	M
2	58deg 51.0min	173deg 8.0min	Ribbon	M
29	58deg 54.2min	169deg 40.3min	Ribbon	M
1	58deg 51.0min	173deg 8.0min	Ribbon	F
7	58deg 43.9min	169deg 32.9min	Bearded	M
8	58deg 48.5min	169deg 41.3min	Bearded	M
Kidney:				
4	58deg 45.6min	172deg 55.4min	Spotted	M
30	58deg 34.8min	169deg 28.8min	Spotted	M
28	58deg 54.2min	169deg 13.6min	Spotted	F
6	58deg 53.0min	173deg 7min	Ribbon	M
3	58deg 56min	172deg 40min	Ribbon	M
2	58deg 51.0min	173deg 8.0min	Ribbon	M
29	58deg 54.2min	169deg 40.3min	Ribbon	M
1	58deg 51.0min	173deg 8.0min	Ribbon	F
7	58deg 43.9min	169deg 32.9min	Bearded	M
8	58deg 48.5min	169deg 41.3min	Bearded	M

Table 4. con't

Specimen	Cd Mean	Cd SD	Ni Mean	Ni SD	Cu Mean	Cu SD	Zn Mean	Zn SD
Muscle:								
4	0.14	0.01	3.0	0.2	6.7	1.3	51	9
30	0.16	0.04	<0.5		4.0	0.1	133	0
28	0.11	0.01	<0.5		6.4	0.05	68	1
6	0.47	0.01	5.8	0.0	6.8	0.8	18	6
3	0.25	0	8.3	1.0	5.5	0	54	2
2	0.3	c	1.3	c	4.4	0.6	50	0
29	0.7	0.03	<0.5		1.7	0	74	2
1	0.13	0.01	2.5	0.4	6.7	0.5	37	12
7	0.57	0.04	2.8	0.2	<5	b	147	20
8	1.26	0	1.2	0.1	7.6	0	40	1
Liver:								
4	0.4	0.1	2.5	0.2	25	2.5	116	c
30	7.3	0.2	<0.5		18.5	0.2	160	0
28	4.5	0.05	<0.5		16.4	0.1	136	1
6	11.4	0.1	0.9	0.2	29	2.5	100	10
3	6.4	0.1	2.2	0.4	26.9	1.3	140	15
2	8.7	1.2	1.3		16.5	3.5	8	2
29	17.0	0.3	<0.5		5.2	1.4	130	3
1	6.4	0.1	2.6	0.9	16.5	0.2	169	7
7	22.2	1.3	0.8		22.8	0.2	170	17
8	41.1	0.9	0.5	0	44.1	2.4	87	3
Kidney:								
4	16.7	0.2	2.4	0.4	44.0	13.0	113	23
30	34	5	<0.5	b	15.0	2.5	120	17
28	-	-	-	-	-	-	-	-
6	33.4	0.0	1.2	0.2	17.5	0.3	48	0
3	34.5	c	3.0		16.0	c	98	c
2	20.1	4.5	0.5	0.0	16.5	3.5	102	22
29	37	5	<0.5	b	5.2	1.3	92	14
1	53.0	0.3	2.8	0.2	19.4	0.1	149	1
7	22.5	2.0	1.3	0.3	40.0	6.0	160	15
8	17.4	0.1	1.5	0.1	28.1	0.6	110	1

Table A5. Concentrations (ppm, dry weight) of heavy metal contents in extracts of surface sediment in the St. George Basin planning area. Collected with HAPS corer from Discoverer vessel in 1975. Based on OCSEAP report by Burrell (1977: Tables 34, 38, 39; 1978: Table 43). nd=not detected.

Sta.	Lat. Deg/Min	Long. Deg/Min	Mud % silt& clay	June 2-19: Cd	Cu	Ni	Zn	Fe	Mn	Cd	Cr	Sep. 25 -Oct.3: Al	Se
30	55 59	166 53		<0.25	2.5	17.3	23.9						
31			23.1	0.25	<2.5	<2.5	7.1	637	9.0				
35	56 12.4	168 20.4									0.4	102	0.09
43	58 42.5	166 16.0	14.7	0.25	<2.5	2.5	6.3				1.7	55	nd
44			14.9	0.25	<2.5	<2.5	5.9	1040	16.2				
46	57 34.5	168 4.5								1.7	0.5	84	nd
51	55 49	170 47									0.9	122	nd
54	56 56.4	170 54.8									0.3	211	.02,.0
56	58 6.5	169 5.4	37.6	0.25	9.9	8.2	19.3					60	nd
57			19.2	0.25	<2.5	<2.5	6.8						
63			49.5	0.25	<2.5	<2.5	13.3	1756	27.3				
64	58 1.5	171 17.0	43.5	0.25	<2.5	<2.5	12.0	1350	20.9	2.8			
65	57 24.9	172 4.6	40.4	0.25	<2.5	<2.5	10.5	915	18.8	2.9	1.9	138	nd
69			41.9	0.25	<2.5	<2.5	12.5	985	21.3				

Table A6. Concentrations (ppm, dry weight) of heavy metal contents in intertidal benthic tissues in the St. George Basin planning area, collected in the summer of 1976. Expressed as the means of duplicate determinations. Based on Burrell (1978: Tables 52 and 53).

	Eider Pt. 53d 57.5m N 166d 35.1m W	Otter Is. 57d 3m N 170d 23.8m W	Makushin Bay 53d 44m N 166d 45.8m W
Mytilus (blue mussel)			
Cd	4.0	4.6	6.0
Cu	9.8	6.0	6.0
Ni	1.3	1.8	1.4
Zn	122	156	81
Fucus (seaweed)			
Cd	5.5	3.1	3.8
Cu	1.5	5.0	0.8
Ni	4.9	5.1	7.1
Zn	17	8	10

Table A7. Concentrations (ppm) of metals in northern fur seals collected on St. Paul Island in the summer of 1975 (Goldblatt and Anthony, 1983). The authors state that the means for each metal which share a common letter are not significantly different (P>.05) by Student-Newman-Keul's test, and that they transformed all data to common logarithms for statistical analysis to ensure homogeneity of variance.

	Liver	Kidney	Muscle	Bone
Dry weight:				
Cadmium				
Mean	55.63a	266.92b	0.90c	0.09c
Range	22.50-153.72	127.0-567.76	0.372-3.70	0.035-0.26
SD	27.8	97.7	0.641	0.045
n	37	37	39	39
Zinc				
Mean	233.67a	277.91b	139.15c	119.89d
Range	183.80-331.68	187.74-420.45	60.57-221.99	92.34-142.81
SD	38.8	60.5	38.4	12.9
n	37	36	39	39
Lead				
Mean	1.13a	0.27b	0.26b	1.78c
Range	0.23-14.76	0.02-0.97	0-2.44	0.15-10.30
SD	2.42	0.22	0.48	2.24
n	36	36	38	38
Nickel				
Mean	0.411a	0.556b	0.530b	1.220c
Range	0.0-3.38	0.10-2.45	0-3.38	0.47-1.65
SD	0.32	0.57	0.63	0.27
n	36	36	38	39
Wet weight:				
Mercury				
Mean	10.74			
Range	4.09-42.94			
SD	6.53			
n	37			
Cadmium	16.13	56.05	0.271	0.08
Zinc	67.76	58.36	42.16	108.38
Lead	0.328	0.057	0.081	1.61
Nickel	0.119	0.117	0.161	1.1

Table A8. Proportion of the variation in cadmium and mercury concentrations among 37 northern fur seals which is accounted for by age of seals (Goldblatt and Anthony, 1983: Table 3). The squared correlation coefficients (R-square) are calculated from the significant (P<.05) regressions of concentrations with age.

Metal	Tissue	R-square
Cadmium	liver	0.4516
Cadmium	muscle	0.6593
Cadmium	bone	0.8724
Mercury	liver	0.8427

Table A9. Concentrations of selected elements and auxiliary variables in samples of surface sediment in the St. George Basin, from OCSEAP report by Gardner, et al (1978a: Appendix A and B) and personal communication of latitude and longitude (1988). The investigators state that the upper 30 cm of cores were homogenized by mixing with sea water as a result of the coring operations, and consequently, analyses from cores represent an average value for the upper 30 cm of sea floor. Samples collected by Soutar van Veen were undisturbed and representative of surface sediment to within a few centimeters below the sediment-water interface (Gardner et al, 1978b). Values were determined by x-ray fluorescence (SRF or X), atomic absorption spectroscopy (AAS or A), instrumental neutron activation (N), and emission spectroscopy (S) techniques. Percentage carbon is mean of three determinations of total carbon.

Sample label	Sampling method	Water depth (m)	Lat.	Long.	Top of interval (cm)
1976 cruise S4-76:					
g2	gravity core	248	54.736	165.883	15
g5	gravity core	118	55.037	165.486	0
g6	gravity core	118	55.037	165.48	3
g8	gravity core	109	55.281	165.129	7
g9	gravity core	109	55.279	165.125	4
g10	gravity core	101	55.504	164.835	0
g11	gravity core	101	55.501	165.837	13
g12	gravity core	101	55.498	164.839	4
g13	gravity core	109	55.899	165.701	14
g14	gravity core	109	55.900	165.703	4
g15	gravity core	108	56.226	166.441	4
g16	gravity core	108	56.227	166.448	7
g17	gravity core	91	56.700	166.921	4
g18	gravity core	91	56.698	166.92	4
g19	gravity core	90	56.789	166.921	0
g20	gravity core	95	56.786	167.836	6
g21	gravity core	95	56.789	167.803	4
g21	gravity core	95	56.789	167.803	4
g27	gravity core	98	56.789	168.605	14
g28	gravity core	98	56.794	168.601	cc
g29	gravity core	98	56.792	168.599	4
g29	gravity core	98	56.792	168.599	4
g32	gravity core	107	56.605	168.285	6
g33	gravity core	111	56.530	167.977	8
g34	gravity core	111	56.528	167.976	4
g34	gravity core	111	56.528	167.976	4
g36	gravity core	111	56.527	167.983	2
g41	gravity core	115	56.452	167.672	6
g42	gravity core	121	56.332	167.447	0

g43	gravity core	121	56.327	167.451	0
g46	gravity core	128	56.148	167.116	11
g47	gravity core	129	55.982	166.746	4
g48	gravity core	129	55.982	166.757	0
g49	gravity core	126	55.800	166.332	0
g49	gravity core	126	55.800	166.332	0
g50	gravity core	120	55.668	166.027	0
g50	gravity core	120	55.668	166.027	0
g51	gravity core	120	55.667	166.027	6
g52	gravity core	114	55.517	165.701	9
g53	gravity core	122	55.289	165.984	0
g54	gravity core	122	55.291	165.985	0
g55	gravity core	127	55.432	166.351	4
g55	gravity core	127	55.432	166.351	4
g56	gravity core	128	55.432	166.351	0
g57	gravity core	128	55.431	166.351	0
g59	gravity core	130	55.596	166.669	5
g60	gravity core	131	55.592	166.678	0
g61	gravity core	135	55.795	167.023	4
g62	gravity core	135	55.798	167.029	0
g63	gravity core	133	55.949	167.402	15
g64	gravity core	134	56.106	167.776	4
g65	gravity core	134	56.107	167.769	10
g66	gravity core	157	56.316	168.293	4
g67	gravity core	157	56.328	168.289	5
g69	gravity core	122	56.090	170.05	cc
g70	gravity core	400	56.105	170.559	0
g71	gravity core	400	56.105	170.558	2
g75	gravity core	125	56.405	170.972	6
g75	gravity core	125	56.405	170.972	6
g77	gravity core	113	56.620	170.669	0
g80	gravity core	108	56.690	170.563	0
g90	gravity core	105	56.486	170.067	2
g91	gravity core	110	56.371	170.148	0
g105	gravity core	320	56.134	169.543	10
g107	gravity core	411	56.131	169.544	0
g109	gravity core	135	55.790	168.214	3
g110	gravity core	135	55.800	168.208	4
g111	gravity core	132	55.616	167.84	1
g112	gravity core	133	55.616	167.833	4
g112	gravity core	133	55.616	167.833	4
g113	gravity core	138	55.449	167.481	3
g114	gravity core	138	55.450	167.483	0
g115	gravity core	140	55.289	167.111	4
g115	gravity core	140	55.289	167.111	4
g116	gravity core	140	55.291	167.111	0
g117	gravity core	144	55.132	166.76	0
g118	gravity core	144	55.139	166.76	6
g119	gravity core	145	54.984	166.431	0
g120	gravity core	145	54.983	166.423	4
g120	gravity core	145	54.983	166.423	4
g121	gravity core	57	54.132	165.748	0
v2	van Veen gra	75	57.013	168.265	0
v3	van Veen gra	74	57.121	168.558	0

v6	van Veen gra	82	56.884	168.903	0
v7	van Veen gra	122	56.097	170.048	0
v7	van Veen gra	122	56.097	170.048	0
v9	van Veen gra	60	57.024	169.548	0
v11	van Veen gra	68	56.937	169.414	0
v12	van Veen gra	68	56.861	169.521	0
v14	van Veen gra	126	56.232	169.827	0
v14	van Veen gra	126	56.232	169.827	0
v15	van Veen gra	145	56.326	169.693	0
v17	van Veen gra	85	56.707	169.18	0
v18	van Veen gra	100	56.569	168.907	0
v18	van Veen gra	110	56.569	168.907	0
v21	van Veen gra	101	56.536	168.79	0
v28	van Veen gra	57	54.130	165.744	0
p3	piston core	120	55.661	166.016	3
p5	piston core	135	55.790	167.015	0
p5	piston core	135	55.790	167.015	0
p6	piston core	133	55.944	167.415	6
p7	piston core	110	56.376	170.154	5
p8	piston core	320	56.121	169.554	3

S4-76 Misc. Seds., Pribilof Islands; EM only

g30	gravity core	107	56.638	168.637	1
g31	gravity core	108	56.635	168.637	4
g37	gravity core	107	56.579	167.904	2
g37	gravity core	107	56.579	167.904	2
g38	gravity core	107	56.607	167.862	0
g39	gravity core	107	56.607	167.862	0
g40	gravity core	100	56.678	167.774	6
g40	gravity core	100	56.678	167.774	6
g72	gravity core	300	56.252	171.203	4
g72	gravity core	300	56.252	171.203	4
g78	gravity core	111	56.666	170.6	0
g79	gravity core	111	56.664	170.598	0
g81	gravity core	103	56.745	170.483	30
g82	gravity core	97	56.807	170.399	20
g89	gravity core	96	56.564	169.94	0
g94	gravity core	123	56.379	169.624	cc
g103	gravity core	125	56.361	169.041	2
v4	van Veen gra	80	56.997	168.738	0
v5	van Veen gra	81	56.995	168.805	0
v10	van Veen gra	60	56.951	169.638	0
v19	van Veen gra	110	56.562	168.748	0
v20	van Veen gra	102	56.556	168.766	0
v22	van Veen gra	102	56.504	168.837	0
v22	van Veen gra	102	56.504	168.837	0
v23	van Veen gra	103	56.491	168.857	0
v23	van Veen gra	103	56.491	168.857	0
v25	van Veen gra	125	56.362	169.031	0
p10	piston core	2850	55.634	170.085	107
p13	piston core	2080	55.513	169.258	25

1977 cruise S6-77:

g14	gravity core	1309	54.213	166.637
g16	gravity core	825	54.336	167.515
g19	gravity core	1190	54.376	168.089
g20	gravity core	2230	54.763	168.707
g22	gravity core	2151	55.173	169.332
g23	gravity core	2030	54.839	170.37
g24	gravity core	2900	55.524	170.02
g25	gravity core	2900	55.514	170.028
g26	gravity core	3158	55.719	170.79
g29	gravity core	2648	55.944	170.673
v4	van Veen gra	166	56.200	168.34
v6	van Veen gra	76	54.804	164.975

1977 cruise S6-77 data, seawater corrected:

v5	62	55.041	164.512
v6	76	54.804	164.975
v6	76	54.804	164.975
v7	142	54.478	165.153
g7	109	54.478	165.153
g12	154	56.298	168.235
g12	154	56.298	168.235
g14	1309	54.213	166.637
g16	825	54.336	167.515
g19	1190	54.376	168.089
g20	2230	54.763	168.707
g22	2151	55.174	169.332
g23	2030	54.839	170.37
g24	2900	55.524	170.02
g25	2900	55.514	170.028
g25	2900	55.514	170.028
g26	3158	55.719	170.79
g29	2648	55.944	170.573

Table A9. con't

Sample label	Pct. silt &clay	Mean % carbon	Parts per million: Hg-a	Zn-a	As-x	Ba-s	Cr-a	Cu-a	Ni-s	V-s
1976 cruise S4-76:										
g2	18.88	0.39	0.03	116	4.065	500	15	70	15	150
g5	23.64	0.41	0.04	107		300	7	70	10	200
g6			0.03	119	3.773	500	30	70	15	300
g8	36.02	0.43	0.04	91	6.023	500	30	50	15	200
g9			0.03	97	4.520	500	30	70	15	200
g10			0.05	72		700	50	30	15	150
g11	24.39	0.32	0.04	71		700	50	30	15	150
g12			0.04	71	5.825	500	50	30	15	100
g13	57.18	0.72	0.03	83		500	50	30	20	150
g14			0.04	79	5.927	500	30	30	15	100
g15			0.08	77	5.612	700	50	20	30	150
g16			0.05	82		700	100	50	15	150
g17			0.04	70	6.289	700	30	20	15	70
g18			0.04	68		700	70	30	20	100
g19	36.61	0.48	0.03	65	5.719	700	50	15	30	150
g20	23.21	0.40	0.06	63		500	30	15	20	100
g21			0.04	63	6.084	700	70	15	20	70
g21			0.04	63		700	50	15	15	100
g27	24.48	0.39	0.03	62		700	50	15	20	100
g28			0.04	58		500	50	15	15	70
g29			0.04	58		700	50	20	20	70
g29			0.04	58		700	50	15	20	70
g32	18.09	0.31	0.03	58		700	50	15	20	100
g33	26.40	0.46	0.04	65		500	30	20	20	70
g34			0.03	57	4.697	700	50	15	30	100
g34			0.04	61		500	70	15	15	100
g36			0.04	55		700	70	15	20	70
g41	36.00	0.47	0.04	70	5.726	700	30	20	20	100
g42			0.04	85	4.566	700	100	30	20	150
g43	61.26	0.69	0.06	84		500	50	50	20	100
g46	81.83	0.97	0.04	94		500	50	30	30	150
g47			0.04	101	6.265	500	50	50	20	150
g48	86.65	0.98	0.04	100		500	50	50	20	150
g49	86.09	0.83	0.04	107		500	30	70	15	150
g49	86.09	0.83	0.05	98		500	30	50	15	150
g50			0.04	102		500	30	50	15	150
g50			0.08	115		500	30	50	15	200
g51	74.58	0.67	0.05	106		500	50	50	20	200
g52	78.94	0.61	0.00	96		500	30	50	10	150
g53			0.03	112	5.108	500	30	70	15	200
g54	63.07	0.56	0.05	108	5.843	500	50	70	15	200
g55			0.05	99	5.594	500	30	50	15	200
g55			0.04	99		500	30	50	20	200
g56	77.37	0.75	0.04	99	5.726	500	30	50	15	200

g57			0.04	101		500	30	50	15	200
g59	80.48	0.88	0.04	93		500	30	50	15	150
g60			0.06	99		500	50	50	15	150
g61			0.03	108	6.048	500	50	50	30	150
g62	71.86	0.94	0.04	94		500	50	50	15	150
g63	79.00	0.99	0.04	102	3.484	700	50	50	15	150
g64			0.05	68	4.278	500	50	20	15	100
g65	36.96	0.50	0.04	69		700	50	20	20	150
g66			0.04	73	4.945	700	70	30	30	150
g67	13.65	0.31	0.04	72		500	50	20	15	100
g69	15.22	0.34	0.04	58		700	50	15	15	100
g70			0.08	111	8.549	700	100	50	20	200
g71	79.98	0.70	0.07	118		500	70	50	20	150
g75	23.17	0.00	0.03	55		500	50	15	20	70
g75	23.17	0.00	0.04	59		500	50	15	20	100
g77	45.80	0.52	0.04	62	4.065	500	50	15	20	100
g80	62.06	0.82	0.05	72		700	70	20	20	100
g90	75.86	0.87	0.05	79		700	100	30	30	100
g91			0.04	79	4.049	700	100	20	30	150
g105	75.71	0.91	0.08	134	18.530	700	100	70	50	150
g107			0.11	140	13.310	1500	100	70	50	200
g109	12.53	0.34	0.02	57		700	70	30	15	100
g110			0.04	60	4.995	500	50	15	15	100
g111	32.81	0.43	0.04	66		700	50	30	15	150
g112			0.05	66	4.013	700	30	20	15	150
g112			0.04	65		500	50	20	15	150
g113	52.87	0.00	0.03	82	5.608	500	30	50	15	150
g114			0.05	82	3.816	700	70	50	15	150
g115			0.04	97	4.897	500	30	50	15	150
g115			0.05	104		500	30	50	15	150
g116	44.97	0.41	0.05	90		500	30	50	15	150
g117			0.03	110		500	50	70	15	200
g118	58.29	0.59	0.04	97		500	30	50	15	150
g119	66.46	0.55	0.05	99		500	30	70	15	200
g120			0.03	108		500	50	70	20	200
g120			0.05	108		500	30	50	15	150
g121	67.64	0.75	0.11	102		300	30	70	15	200
v2	7.19	0.25	0.03	45	5.191	500	70	7	15	70
v3	5.94	0.22	0.03	45	5.419	700	200	7	15	70
v6	8.26	0.00	0.02	46	6.358	700	50	7	15	70
v7	14.38	0.40	0.03	59		700	50	15	15	100
v7	14.38	0.40	0.04	113		500	70	20	20	70
v9	4.14	0.22	0.04	55		500	70	7	50	70
v11	5.74	0.29	0.04	55	6.700	700	70	15	30	100
v12	5.91	0.23	0.03	48	6.984	700	100	10	30	100
v14	8.76	0.31	0.04	61	5.257	500	50	15	20	100
v14	8.76	0.31	0.04	58		500	50	15	30	70
v15	5.02	0.22	0.03	68		500	150	15	.50	150
v17	7.23	0.28	0.04	71	5.639	500	150	20	150	100
v18	5.90	0.26	0.03	63	5.559	700	70	15	50	150
v18	5.90	0.26	0.03	62		500	100	15	30	150
v21	9.57	0.31	0.03	58	3.433	700	70	15	30	100
v28			0.08	102		300	30	100	70	200
p3			0.04	102		500	50	70	15	200
p5			0.03	109		700	50	50	20	150
p5			0.05	97		500	50	50	15	150

p6			0.05	96		500	50	50	20	150
p7	79.20	0.76	0.05	85		700	100	30	30	150
p8			0.09	130	8.331	700	70	50	30	200

S4-76 Misc. Seds., Pribilof Islands, EM only:

g30	700	70	15	30	100
g31	700	70	20	30	100
g37	1000	50	15	20	100
g37	700	50	15	15	70
g38	700	50	20	20	100
g39	700	100	30	30	150
g40	1000	50	15	20	100
g40	700	50	20	20	70
g72	700	100	50	50	150
g72	500	70	50	50	150
g78	700	70	15	20	70
g79	700	70	15	20	70
g81	700	70	30	30	150
g82	1000	70	30	30	150
g89	700	100	20	50	150
g94	500	150	70	100	200
g103	700	100	20	50	150
v4	700	70	10	15	70
v5	500	150	15	20	70
v10	500	70	10	70	70
v19	700	70	15	30	70
v20	700	100	15	30	100
v22	500	70	20	30	70
v22	700	100	15	30	100
v23	700	70	15	30	70
v23	1000	70	15	30	150
v25	700	100	20	50	200
p10	1000	50	70	30	150
p13	1000	50	100	30	100

1977 cruise S6-77:

g14	32.17	1.46
g16	33.24	1.13
g19	39.40	1.12
g20	39.04	1.52
g22	37.56	1.70
g23	33.99	1.56
g24	41.16	1.43
g25	42.44	1.22
g26	22.76	1.15
g29	43.40	1.45
v4	89.40	0.00
v6	91.43	0.37

1977 cruise S6-77 data, seawater corrected:

v5	0.04	135	14.000	300	50	20	30	300
v6	0.04	0	0.000	500	20	70	15	300
v6	0.01	107	4.600	500	15	70	15	150
v7	0.03	102	86.000	500	30	70	15	300
g7	0.04	56	4.900	700	70	15	30	150
g12	0.08	121	4.800	700	100	70	70	300
g12	0.09	126	9.000	700	70	70	70	150
g14	0.01	101	0.000	500	30	100	50	200
g16	0.04	119	5.200	500	30	150	30	200
g19	0.01	110	3.400	700	30	150	30	150
g20	0.04	95	0.000	1000	30	100	50	150
g22	0.01	88	0.000	1000	30	100	30	150
g23	0.01	0	0.000	1500	30	70	30	70
g24	0.08	89	0.000	1500	30	100	50	100
g25	0.12	83	0.000	700	30	70	30	150
g25	0.04	84	0.000	700	50	70	30	150
g26	0.10	105	0.000	700	50	100	30	150
g29	0.03	99	0.000	700	50	70	30	150

Table A10. Concentrations (ppm, dry weight) and ratio indices of hydrocarbons in surface sediment, 0-10 cm, of St. George Basin planning area. Bottom was sampled by steel van Veen grabs in 1975. From Venkatesan, et al (1981: Table 25-1) and OCSEAP report by Kaplan, et al (1977: Tables 1, 5, 7, 9). Total hydrocarbons = sum of hexane and benzene fractions. nd=not determined. nr=not resolved.

Station label	Latitude	Longitude	Water depth (m)
17	55deg. 26.4min.	165deg. 49.1min.	119
28	57deg. 10.4min.	165deg. 04.4min.	70
35	56deg. 12.4min.	168deg. 20.4min.	160
37	57deg. 05.3min.	167deg. 00.6min.	75
38	57deg. 40.1min.	166deg. 05.8min.	66
40	58deg. 07.3min.	165deg. 15.6min.	46
43	58deg. 42.5min.	166deg. 16.0min.	37
46	57deg. 34.5min.	168deg. 04.5min.	70
51	55deg. 49min.	170deg. 47min.	-
54	56deg. 56.4min.	170deg. 54.8min.	105
56	58deg. 06.5min.	169deg. 05.4min.	71
58	58deg. 43.5min.	167deg. 21.0min.	44
64	58deg. 01.5min.	171deg. 17.0min.	90
65	57deg. 24.9min.	172deg. 04.6min.	109

Aliphatic fraction	Aromatic fraction	Total hydrocarbons	Total n-alkanes	% organic carbon	Pristane/ phytane
13	5.2	18.2	1.09	0.76	3.97
8.7	4.1	12.8	2.93	0.59	10.2
180.1	60.8	240.9	nr	0.41	nr
5.8	4.0	9.8	0.76	0.41	1.76
4.9	10.6	15.5	1.64	0.66	5.18
1.9	2.6	4.5	0.61	0.32	3.37
2.4	2.7	5.1	0.52	0.30	2.26
4.3	7.5	11.8	0.74	0.42	17.90
2.8	0.6	3.4	0.77	nd	3.49
7.4	9.9	17.3	2.10	0.68	8.80
10.6	8.5	19.1	0.75	0.47	2.93
3.8	2.8	6.6	0.28	0.31	4.80
12.3	9.8	22.1	1.79	0.77	2.27
6.9	9.6	16.5	1.60	0.67	16.43

Table A10. con't

Pristane/ C-17	Phytane/ C-18	(Total hydrocarbons/ organic carbon) x 10exp4	(Total n-alkanes/ organic carbon) x 10exp4	Odd/even for C-15 to C-34
18.1	0.41	23.9	1.4	3.43
2.16	0.26	21.7	5.0	4.09
nr	nr	587.6	nr	nr
1.45	0.36	23.9	1.8	3.28
2.21	0.30	23.5	2.5	4.41
0.93	0.32	14.1	1.9	3.41
0.97	0.48	17.0	1.8	3.08
10.3	0.41	28.1	1.8	3.59
2.14	0.49	25.4	nd	2.56
3.06	0.36	25.4	3.1	2.57
3.34	2.71	40.6	1.6	3.78
1.26	0.32	21.3	0.9	3.33
0.96	0.96	28.7	2.3	2.75
7.74	7.74	24.6	2.3	3.77

Table A11. Trace element concentrations (dry weight) in surface sediment collected by HAPS corer from Discoverer vessel, June 12-19, 1975. From OCSEAP report by Robertson and Abel (1979: Tables C.1 and C.2). The authors did not provide labels for dispersion estimates accompanying each mean, nor the sample sizes.

Station (MB label)	Lat.	Long.	Water depth (m)	Aluminum percent Mean		Calcium percent Mean		Manganese ppm Mean	
28 (0-3cm)	57d 10m	165d 04m	69	1.05	0.03	2.31	1.03	524	50
29 (0-4cm)	-	-	-	5.90	0.02	2.09	0.33	572	45
30 (0-4cm)	55d 59m	166d 53m	134	6.10	0.03	2.97	1.34	571	43
37 (0-2cm)	57d 06m	167d 01m	75	5.50	0.03	2.32	1.00	358	42
43 (0-2cm)	58d 42m	166d 17m	38	5.05	0.07	1.70	0.25	400	13
56 (0-2cm)	58d 06m	169d 05m	71	5.01	0.10	1.73	0.50	341	7
59 (0-2cm)	59d 12m	167d 18m	38	5.10	0.02	2.08	0.47	366	42
64 (0-2cm)	58d 01m	171d 07m	85	5.10	0.03	3.73	1.25	397	48

Vanadium ppm Mean		Arsenic ppm Mean		Barium ppm Mean		Cobalt ppm Mean		Chromium ppm Mean		Iron % Mean		Antimony ppm Mean	
92	25	2.9	0.5	490	170	9	-	63	4	2.67	-	0.56	0.14
77	23			-		-				-	-		-
112	24	3.4	0.6	200	190	10	-	38	5	3.55	-	0.55	0.13
85	23	4.1	0.6	430	190	9.1	-	53	4	2.53	-	0.61	0.11
90	21	3.2	0.5	<420	-	7.0	-	61	5	2.06	-	0.57	0.1
85	17	0.7	0.6	<260	-	9	-	86		2.59	-	0.63	0.08
77	22	4.0	0.4	1070	340	9	-	107		2.52	-	0.73	0.08
82	24	2.7	0.8	1030	340	9	-	93		2.68	-	0.48	0.09

Table A12. Concentrations (ppm, wet weight) of metals in tissues of 62 male northern fur seals, aged 2 to 4 years, at 5 rookeries in the Pribilof Islands, 1985 (Skoch and Metzger, 1988).

These data have been entered by hand from tables of original lab determinations provided by the authors in a personal communication from Metzger (1987). Missing data are represented by blank spaces. Codes are m=muscle, k=kidney, l=liver, nda=no detectable amount.

Rookery & animal label	Tiss.	Parts per million: Titan.	Iron	Cadmium	Selenium
North East Point West Rookery					
14	m	nda	2100.50	17.14	237.19
14	k	nda	5230.84	259.56	192.06
14	l	nda	1350.69	163.68	191.67
10	l	nda	1085.81	56.80	184.44
10	k	nda	406.25	331.56	382.50
10	m	30.72	1066.27	4.76	386.75
21	l	13.86	2453.18	56.37	258.43
21	m	13.45	1098.65	7.31	286.10
21	k	35.11	336.41	138.85	565.65
24	k	10.44	1097.64	52.29	235.02
24	m	nda	1725.81	24.72	358.87
24	k	nda	432.31	343.80	nda
24	k	3.04	585.55	261.94	119.39
28	k	nda	192.31	105.00	171.98
28	l	5.77	1282.05	52.85	108.97
28	m	nda	1150.49	98.79	187.86
5	k	nda	255.32	159.57	160.00
5	l	9.64	2358.82	124.38	140.50
5	l	nda	1981.98	337.12	329.73
5	m	nda	1524.75	10.64	201.98
32	m	nda	3651.38	2.94	378.90
32	l	nda	2526.98	58.70	137.46
32	k	nda	896.00	331.84	183.60
20	l	nda	1317.16	166.04	179.85
20	m	nda	1661.65	4.81	393.23
20	k	nda	813.13	339.39	276.26
25	m	nda	1581.56	10.50	312.77
25	k	nda	613.73	674.68	227.47
25	l	nda	3244.87	215.71	180.11
31	l	nda	2607.73	70.77	330.94
31	m	nda	1286.38	1.07	130.52
31	m	nda	1632.43	0.76	144.86
31	k	nda	1026.92	173.85	111.15
31	k	nda	915.32	196.37	114.11
3	l	nda	1323.08	96.86	104.62
3	k	nda	1222.41	217.74	121.82
3	m	nda	1896.71	15.45	177.00
42	m	nda	5655.17	20.23	214.94

42	k	nda	1159.29	443.66	109.49
42	l	nda	2245.17	202.80	84.61
Polovina Rookery					
6	m	nda	1953.61	10.26	122.16
6	k	nda	1087.14	324.90	159.75
6	l	nda	3931.25	371.13	281.25
18	k	15.44	1007.72	271.01	145.80
18	l	36.78	2990.41	290.41	168.44
18	m	-	-	-	-
29	m	30.82	2731.66	323.94	375.48
29	k	65.39	743.93	343.77	99.84
29	l	nda	2851.08	55.55	142.39
21	l	nda	1967.36	90.79	137.93
21	k	nda	791.67	242.08	197.08
21	m	nda	3650.79	5.89	191.73
25	m	nda	1164.31	5.95	229.33
25	k	nda	597.74	373.99	180.53
25	k	nda	577.35	351.46	227.02
25	l	nda	1182.52	156.30	125.64
23	l	nda	1273.15	313.60	273.15
23	m	45.45	1097.56	8.76	465.63
23	k	nda	567.69	247.27	224.89
11	m	nda	376.17	2.23	137.82
11	k	nda	520.45	234.94	138.66
11	l	11.92	1248.01	28.75	187.60
4	k	68.15	685.19	202.59	84.81
4	l	-	1672.28	114.71	142.38
4	m	67.25	1822.13	3.15	136.66
10	l	-	-	-	-
10	m	13.09	737.53	30.79	172.25
10	k	71.26	408.91	821.86	72.87
14	m	56.06	1969.70	58.26	222.73
14	l	-	-	-	-
14	k	18.67	307.23	556.63	204.22
2	m	56.07	549.13	18.03	106.36
2	k	36.48	435.32	130.60	112.77
2	k	-	-	-	-
2	l	72.50	673.26	24.91	247.18
32	l	20.66	1368.23	40.86	149.68
32	m	nda	625.00	21.92	201.67
32	k	nda	506.85	218.68	118.72
5	k	nda	340.43	67.28	177.13
5	m	nda	334.19	35.58	171.59
5	l	nda	689.53	97.95	91.58
Gorbatch Rookery					
19	k	nda	1836.96	59.54	104.43
19	k	nda	1821.55	60.20	101.35
19	m	nda	785.05	10.33	83.64
19	l	nda	2188.17	57.20	162.37
36	k	-	-	-	-
36	l	nda	399.40	54.65	81.98
36	l	-	-	-	-

36	m	-	-	-	-
26	k	-	-	-	-
26	m	-	-	-	-
26	l	-	-	-	-
26	k	-	-	-	-
26	l	-	-	-	-
26	m	-	-	-	-
9	m	nda	nda	17.11	97.78
9	l	nda	1061.98	40.49	87.19
9	k	-	-	-	-
10	m	nda	291.89	23.03	116.76
10	k	-	-	-	-
10	l	-	-	-	-
12	m	-	-	-	-
12	l	-	-	-	-
12	k	-	-	-	-
4	l	-	-	-	-
4	k	-	-	-	-
4	m	nda	670.83	23.29	120.42
28	l	nda	1992.65	40.44	114.71
28	k	-	-	-	-
28	k	nda	84.97	205.72	132.83
28	m	-	-	-	-
22	l	-	-	-	-
22	l	-	-	-	-
22	k	-	-	-	-
22	m	-	-	-	-
30	k	-	-	-	-
30	k	-	-	-	-
30	m	-	-	-	-
30	l	nda	334.26	26.18	162.05

Zapadni Rookery

27	k	nda	386.53	10.89	97.52
27	m	nda	1633.99	16.47	114.87
27	l	-	-	-	-
27	l	-	-	-	-
28	l	nda	180.34	7.97	104.49
28	m	-	-	-	-
28	k	nda	266.72	9.30	99.61
20	l	-	-	-	-
20	m	nda	210.94	18.05	232.03
20	k	nda		9.08	116.80
4	k	nda	387.15	9.23	135.50
4	l	nda	4166.67	9.65	168.86
4	m	-	-	-	-
5	k	nda	74.51	8.51	103.53
5	l	nda	316.92	6.59	110.77
5	m	-	-	-	-
26	m	nda	315.53	10.29	139.81
26	l	-	-	-	-
26	k	-	-	-	-
16	l	nda	401.69	7.06	91.55
16	m	-	-	-	-
16	k	-	-	-	-

17	l	-	-	-	-
17	m	-	-	-	-
17	k	nda	28.97	725.99	162.67
3	l	-	-	-	-
3	l	-	-	-	-
3	m	-	-	-	-
3	k	nda	166.79	265.77	159.54
25	k	nda	nda	185.87	263.04
25	m	nda	1181.82	24.55	279.39
25	l	nda	1262.30	16.93	182.38
11	l	nda	2342.22	19.38	204.00
11	k	nda	nda	95.34	182.63
11	m	nda	411.03	2.08	206.56
2	m	nda	854.55	11.16	203.18
2	k	nda	nda	400.96	204.19
2	l	nda	2897.11	153.05	159.16
19	m	nda	44.78	244.28	200.00
19	k	nda	nda	298.75	174.17
19	l	-	-	-	-
18	k	nda	217.21	107.33	186.97
18	l	nda	3428.08	21.10	179.79
18	m	nda	699.45	4.75	253.55
13	m	nda	805.88	4.38	270.00
13	k	nda	nda	183.54	214.21
13	l	nda	340.98	87.85	152.20

Tolstoi Rookery

32	l	nda	232.82	37.48	195.80
32	m	nda	nda	6.48	344.12
32	k	nda	nda	5.63	317.36
19	l	nda	1466.44	48.83	208.40
19	m	nda	1250.00	5.44	239.48
19	k	nda	547.12	108.49	225.47
19	k	nda	529.91	144.02	200.43
5	m	nda	1943.82	10.34	285.39
5	k	nda	555.56	186.75	196.15
5	l	nda	1260.07	52.01	167.40
12	k	nda	478.63	122.65	198.72
12	l	nda	931.37	43.43	146.41
12	m	nda	907.69	9.23	393.08
14	m	-	-	-	-
14	k	nda	65.22	185.65	180.00
14	l	nda	2221.09	81.29	165.65
14	l	nda	1545.82	6.22	176.49
17	k	nda	535.86	166.67	184.39
17	m	nda	1669.81	2.03	243.87
17	l	nda	1750.00	38.40	162.85
15	l	nda	1766.69	44.44	133.51
15	k	nda	670.48	144.32	166.80
15	m	nda	1325.58	4.59	154.07
28	k	nda	539.42	368.46	101.24
28	m	nda	702.97	7.28	128.22
28	l	nda	555.98	44.86	191.12
2	k	nda	352.14	184.62	189.74
2	l	nda	916.40	21.00	151.45

2	m	nda	1567.25	3.63	266.67
29	m	nda	2601.23	4.05	324.54
29	l	nda	1981.35	29.22	198.91
29	k	nda	1179.49	147.01	227.35
31	l	nda	1614.46	33.13	225.30
31	k	nda	1324.00	181.60	198.80
31	m	nda	2103.31	2.77	206.61
9	l	nda	2692.31	42.95	217.09
9	k	nda	1722.66	213.67	201.56
9	m	-	-	-	-
41	l	nda	1642.86	35.06	179.55
41	k	nda	1197.37	164.47	235.96
41	m	nda	3492.19	6.02	414.84
Redo's Polovina Rookery					
10	l	nda	1281.55	91.77	212.07
10	k	101.22	934.20	894.86	358.22
10	m	103.32	1147.69	16.52	397.69
Zapadni Rookery					
16	l	171.41	1883.69	46.99	392.63
16	k	nda	591.77	492.85	94.63
16	m	nda	1775.60	6.93	558.06
20	l	69.06	1396.85	33.53	161.57
20	k	118.94	642.02	306.34	186.82
28	k	nda	892.40	184.06	186.22
28	l	nda	5189.98	32.96	144.73
28	m	119.94	334.73	2.08	245.96
19	k	69.26	66.64	388.93	119.35
19	l	395.09	54.64	19.40	346.82
26	m	nda	1050.28	4.37	374.01
26	l	33.88	nda	21.96	273.88
26	k	68.94	265.44	4.01	137.72
4	m	394.90	404.98	306.06	234.82
4	k	nda	202.65	49.67	73.67
4	l	120.22	2029.75	29.66	252.76
5	l	31.90	437.93	232.67	52.76
5	k	108.26	nda	266.87	161.03
27	k	nda	nda	4.16	106.49
27	m	nda	1608.22	22.20	63.89
27	l	196.84	2897.13	154.91	95.24
3	k	10.77	nda	3.29	144.81
3	m	253.68	578.95	35.68	38.42
3	l	nda	4325.38	356.41	75.01
17	k	nda	nda	46.59	159.29
17	l	683.56	598.00	46.59	193.33
17	m	nda	482.95	9.54	nda
Tolstoi Rookery					
14	k	nda	nda	316.83	144.36
14	l	60.11	nda	56.01	83.12

Gorbatch Rookery

30	k	150.18	565.84	174.38	64.59
22	m	nda	nda	3.26	186.16
22	l	nda	733.98	70.33	29.53
22	k	1526.21	nda	224.36	nda
28	l	nda	1109.94	33.00	nda
36	k	178.11	118.97	196.92	nda
26	k	nda	136.89	217.55	37.00
26	l	nda	637.39	49.47	42.44
24	m	314.14	nda	17.24	108.20
24	k	nda	125.66	755.45	nda
24	k	47.10	121.48	616.79	19.61
12	k	122.19	186.17	596.92	nda
10	l	nda	211.95	71.27	23.79
10	k	98.83	113.07	53.18	nda
10	k	nda	255.77	40.87	nda
9	m	nda	421.08	6.21	65.95
9	k	250.47	520.18	161.21	59.64
9	k	nda	nda	178.53	nda
4	m	134.67	430.88	21.35	95.76

North East Point West

32	k	108.34	296.22	134.28	nda
32	m	310.12	1331.33	2.39	nda
32	l	445.49		22.64	nda
14	k	nda	303.50	377.47	nda
14	m	58.24	306.82	14.20	nda
14	m	613.23	nda	3.30	113.74
14	l	nda	1513.08	22.00	nda
14	l	448.55	1540.39	21.94	93.76

Tolstoi Rookery

9	l	nda	1382.75	44.45	30.21
9	k	175.96	218.43	10.90	56.60
9	m	80.45	1258.87	5.85	95.52
15	m	nda	1087.40	3.05	31.25
15	l	271.56	1900.83	21.24	133.33
15	k	nda	643.68	143.98	104.32

Table A12. con't

Rookery & animal label	Tiss.	Nickel	Copper	Zinc	Chrom.	Lead	Alum.
North East Point West Rookery							
14	m	11.66	4.12	44.74	1.51	17.09	18.59
14	k	8.68	29.32	84.16	nda	10.16	7.85
14	l	11.22	52.10	60.52	0.80	9.72	6.25
10	l	7.36	58.18	31.62	1.22	9.24	6.60
10	k	12.81	24.44	56.06	1.81	18.13	nda
10	m	11.99	4.52	54.94	1.93	17.47	30.12
21	l	7.30	64.08	65.38	1.27	10.86	7.12
21	m	7.49	4.62	46.10	1.84	12.11	nda
21	k	15.14	30.70	56.34	2.06	20.61	9.16
24	k	8.11	65.25	56.90	0.91	8.08	8.42
24	m	9.35	12.82	34.52	1.77	10.89	nda
24	k	8.52	28.12	70.66	1.62	12.23	nda
24	k	8.10	26.84	57.38	1.52	10.65	20.91
28	k	14.40	25.93	54.18	2.14	15.38	29.12
28	l	4.36	59.42	55.29	0.99	8.33	15.06
28	m	7.62	7.86	28.83	1.80	12.62	11.65
5	k	9.40	29.10	75.62	1.62	11.49	20.00
5	l	1.00	48.80	55.75	1.34	7.92	10.33
5	l	12.97	56.31	50.45	3.24	22.52	24.32
5	m	3.12	3.91	26.73	2.23	13.86	nda
32	m	4.08	6.24	38.35	3.85	25.69	nda
32	l	4.54	65.05	53.94	1.56	13.33	nda
32	k	5.20	21.40	61.08	1.88	16.80	nda
20	l	3.43	108.51	77.87	2.24	14.55	nda
20	m	5.64	6.77	33.23	3.68	29.32	nda
20	k	4.75	28.99	100.96	2.37	20.20	nda
25	m	2.41	5.32	160.71	3.55	27.66	nda
25	k	5.56	29.27	99.83	2.23	16.74	nda
25	l	3.18	124.42	73.92	1.91	14.15	nda
31	l	1.66	45.64	61.27	2.43	22.65	nda
31	m	5.26	4.04	35.49	2.16	18.78	40.85
31	m	1.84	5.35	44.86	3.03	22.70	47.03
31	k	9.38	32.54	70.23	2.09	15.00	nda
31	k	8.99	33.99	71.98	2.14	15.73	7.66
3	l	6.06	67.82	62.95	1.60	11.69	11.69
3	k	19.06	36.97	103.61	4.91	18.25	42.02
3	m	9.15	4.79	29.06	2.82	19.81	nda
42	m	8.39	5.63	69.02	3.05	22.41	19.54
42	k	5.34	25.87	73.81	1.80	10.62	nda
42	l	5.10	53.40	62.23	2.30	10.66	nda
Polovina Rookery							
6	m	12.73	6.03	27.06	4.48	18.04	nda
6	k	7.84	30.33	95.06	2.16	17.01	17.43

	6 l	9.06	77.44	76.56	3.69	25.00	8.75
	18 k	8.49	32.72	103.17	2.40	18.87	67.75
	18 l	12.21	190.41	93.66	3.30	22.92	52.77
	18 m	-	-	-	-	-	-
	29 m	26.25	154.15	60.52	9.27	38.61	47.30
	29 k	2.74	20.44	87.55	2.82	12.92	56.77
	29 l	5.78	51.86	50.59	2.12	13.72	21.55
	21 l	5.39	79.00	47.44	1.85	12.93	11.39
	21 k	10.56	30.63	65.25	3.33	17.08	40.00
	21 m	10.74	8.19	62.55	3.34	17.13	53.47
	25 m	10.74	5.29	62.28	2.92	20.16	19.66
	25 k	8.36	30.65	63.61	2.75	16.16	17.77
	25 k	9.81	29.88	88.45	3.92	24.10	85.20
	25 l	7.42	99.55	50.13	2.25	12.85	16.07
	23 l	10.01	80.79	88.02	4.05	24.31	36.46
	23 m	22.39	9.98	174.61	8.54	51.00	210.64
	23 k	10.44	24.02	84.77	4.75	22.93	15.83
	11 m	6.99	7.99	36.42	4.16	13.32	34.95
	11 k	8.29	29.44	59.18	3.42	15.99	31.60
	11 l	39.67	191.02	116.93	14.55	31.00	62.80
	4 k	5.93	44.48	55.96	3.07	14.44	14.07
	4 l	9.98	69.92	66.55	4.47	17.69	32.86
	4 m	4.23	5.64	83.19	4.77	20.07	29.28
	10 l	-	-	-	-	-	-
	10 m	10.68	4.82	64.05	0.79	12.04	nda
	10 k	7.98	36.32	101.38	1.09	9.31	nda
	14 m	18.26	7.58	78.79	2.23	18.94	nda
	14 l	-	-	-	-	-	-
	14 k	15.00	27.29	134.64	2.29	14.46	nda
	2 m	10.06	5.38	48.38	3.47	14.45	nda
	2 k	6.88	20.02	85.32	2.28	9.95	nda
	2 k	-	-	-	-	-	-
	2 l	5.89	14.83	40.49	0.94	13.65	nda
	32 l	5.97	88.48	91.97	0.60	18.37	16.99
	32 m	18.00	6.92	61.50	2.92	23.33	31.67
	32 k	16.35	30.73	91.23	1.92	11.87	nda
	5 k	11.38	26.86	121.28	1.12	12.23	18.62
	5 m	13.43	4.69	72.69	0.64	16.71	nda
	5 l	-	-	-	-	-	-
Gorbatch Rookery							
	19 k	6.69	100.26	78.93	0.64	8.26	0.38
	19 k	6.50	87.34	74.95	1.31	7.41	nda
	19 m	8.32	7.52	48.22	2.29	10.28	nda
	19 l	11.34	101.83	118.92	1.45	13.44	18.28
	36 k	-	-	-	-	-	-
	36 l	4.08	144.59	67.57	0.87	6.91	nda
	36 l	-	-	-	-	-	-
	36 m	-	-	-	-	-	-
	26 k	-	-	-	-	-	-
	26 m	-	-	-	-	-	-
	26 l	-	-	-	-	-	-
	26 k	-	-	-	-	-	-
	26 l	-	-	-	-	-	-
	26 m	-	-	-	-	-	-

9	m	10.94	5.33	51.44	1.61	20.56	11.67
9	l	10.33	94.13	87.81	2.11	17.36	nda
9	k	-	-	-	-	-	-
10	m	10.22	6.00	56.11	3.19	21.08	19.46
10	k	-	-	-	-	-	-
10	l	-	-	-	-	-	-
12	m	-	-	-	-	-	-
12	l	-	-	-	-	-	-
12	k	-	-	-	-	-	-
4	l	-	-	-	-	-	-
4	k	-	-	-	-	-	-
4	m	8.96	6.00	60.29	1.33	6.34	nda
28	l	8.46	94.08	82.54	2.13	15.07	8.09
28	k	-	-	-	-	-	-
28	k	10.60	26.61	101.25	1.48	25.49	nda
28	m	-	-	-	-	-	-
22	l	-	-	-	-	-	-
22	l	-	-	-	-	-	-
22	k	-	-	-	-	-	-
22	m	-	-	-	-	-	-
30	k	-	-	-	-	-	-
30	k	-	-	-	-	-	-
30	m	-	-	-	-	-	-
30	l	5.79	74.46	62.37	1.03	11.98	nda

Zapadni Rookery

27	k	1.91	26.72	87.41	2.08	16.21	12.49
27	m	1.31	6.73	84.18	2.22	33.33	45.75
27	l	-	-	-	-	-	-
27	l	-	-	-	-	-	-
28	l	1.30	35.98	7.94	1.11	13.02	21.16
28	m	-	-	-	-	-	-
28	k	0.55	18.44	70.74	1.50	10.94	5.86
20	l	-	-	-	-	-	-
20	m	2.89	6.64	57.50	5.94	35.94	nda
20	k	2.20	32.96	85.73	3.32	15.60	nda
4	k	2.06	26.61	87.11	2.25	14.42	9.88
4	l	0.39	140.53	101.36	3.16	16.67	17.11
4	m	-	-	-	-	-	-
5	k	1.06	34.71	79.18	3.65	17.65	nda
5	l	0.62	185.54	68.65	2.52	12.31	11.38
5	m	-	-	-	-	-	-
26	m		6.17	56.12	4.90	18.45	nda
26	l	-	-	-	-	-	-
26	k	-	-	-	-	-	-
16	l	1.28	49.09	73.72	3.72	12.50	18.58
16	m	-	-	-	-	-	-
16	k	-	-	-	-	-	-
17	l	-	-	-	-	-	-
17	m	-	-	-	-	-	-
17	k	3.02	43.92	100.12	1.20	15.31	12.42
3	l	-	-	-	-	-	-
3	l	-	-	-	-	-	-
3	m	-	-	-	-	-	-
3	k	1.92	31.80	77.92	1.02	14.14	nda

25	k	1.36	28.21	110.05	1.30	20.11	11.96
25	m	3.33	5.45	111.33	1.39	22.42	33.33
25	l	1.11	92.21	73.77	1.23	15.16	nda
11	l	1.16	72.67	88.58	1.38	15.56	nda
11	k	2.88	20.89	88.52	1.06	14.83	9.32
11	m	3.54	5.05	75.70	1.30	18.21	9.89
2	m	2.73	4.82	67.27	1.36	16.82	nda
2	k	2.57	28.01	98.21	1.18	17.02	nda
2	l	5.14	201.61	75.63	0.90	12.54	nda
19	m	2.84	24.88	114.68	1.94	17.91	nda
19	k	2.13	27.08	92.71	1.46	15.00	nda
19	l	-	-	-	-	-	-
18	k	1.66	11.42	82.45	0.85	16.61	nda
18	l	1.27	65.14	81.22	1.20	14.04	31.51
18	m	1.09	6.83	76.39	1.91	24.59	nda
13	m	1.24	5.12	64.41	1.88	21.18	22.35
13	k	1.84	21.63	97.96	1.43	18.40	nda
13	l	0.90	73.90	64.63	1.12	11.78	5.58

Tolstoi Rookery

32	l	3.51	69.54	70.65	1.45	13.74	nda
32	m	2.43	6.18	86.25	2.35	25.74	22.79
32	k	1.68	4.79	99.74	2.07	24.61	36.27
19	l	0.87	113.42	75.12	1.38	15.10	8.72
19	m	1.61	8.62	67.74	1.86	17.14	16.13
19	k	1.42	20.14	93.65	1.84	18.40	nda
19	k	0.85	19.19	89.53	1.75	16.67	nda
5	m	9.10	4.94	57.70	2.13	30.34	nda
5	k	0.98	20.90	94.79	1.41	17.09	23.50
5	l	0.48	75.49	80.77	1.32	14.29	nda
12	k	0.26	24.36	77.52	1.37	14.96	10.26
12	l	3.95	54.71	68.92	1.27	12.75	nda
12	m	6.23	7.31	79.77	2.54	29.92	nda
14	m	-	-	-	-	-	-
14	k	4.43	21.00	92.26	1.65	15.65	nda
14	l	3.61	71.50	81.80	1.19	12.59	nda
14	l	5.50	78.57	60.28	1.27	13.94	1.20
17	k	5.27	27.05	92.78	2.07	16.46	nda
17	m	5.66	5.71	90.85	3.11	16.51	9.43
17	l	4.17	96.98	78.61	0.63	11.51	nda
15	l	4.05	95.25	68.61	0.94	12.14	nda
15	k	1.88	24.49	84.01	0.98	14.31	nda
15	m	2.79	4.77	58.76	1.04	28.49	nda
28	k	3.03	47.22	90.54	1.69	15.35	0.41
28	m	2.48	4.85	67.82	1.39	17.33	nda
28	l	1.97	133.32	79.58	0.89	18.92	8.11
2	k	2.09	30.94	94.32	1.28	21.79	nda
2	l	1.03	66.75	69.45	0.74	12.86	nda
2	m	0.99	6.26	66.08	1.35	22.81	nda
29	m	3.07	6.07	68.71	0.98	24.54	nda
29	l	0.85	74.98	84.15	1.01	15.54	nda
29	k	2.18	31.62	86.84	1.20	17.09	nda
31	l	0.75	60.12	73.22	0.96	17.17	nda
31	k	7.32	27.28	92.00	1.10	18.40	nda
31	m	-	-	-	-	-	-

9 l	1.32	129.19	92.91	1.37	20.09	10.68
9 k	1.33	27.73	96.64	0.86	19.14	13.28
9 m	-	-	-	-	-	-
41 l	1.95	83.46	72.37	0.78	16.23	nda
41 k	1.71	24.87	93.07	0.96	21.93	nda
41 m	2.11	6.33	77.97	2.27	39.84	nda
Redo's Polovina Rookery						
10 l	2.18	191.34	46.19	nda	39.56	6.69
10 k	4.46	34.77	49.40	nda	55.83	13.04
10 m	19.10	24.97	65.70	0.78	77.48	9.96
Zapadni Rookery						
16 l	39.84	69.19	72.22	0.80	77.32	51.71
16 k	10.96	26.46	28.70	0.43	26.16	14.58
16 m	15.45	39.23	94.35	1.65	166.40	47.89
20 l	6.26	400.77	60.55	8.47	64.90	76.82
20 k	4.42	37.75	38.67	0.72	42.84	12.91
28 k	7.73	36.97	67.68	0.26	71.28	nda
28 l	3.23	31.97	38.50	nda	38.82	nda
28 m	9.48	34.28	79.28	2.34	104.12	59.18
19 k	3.53	23.55	40.95	0.65	41.40	14.54
19 l	7.47	100.96	83.11	0.37	98.18	28.69
26 m	10.27	102.69	92.10	4.23	139.42	137.40
26 l	15.12	36.29	105.71	2.24	123.88	48.24
26 k	4.03	75.27	45.61	0.20	49.16	14.72
4 m	7.53	24.90	62.42	0.56	86.37	16.67
4 k	2.94	32.20	38.71	0.76	38.07	9.09
4 l	12.76	117.29	141.49	1.65	167.05	nda
5 l	3.45	331.38	35.14	0.38	30.52	6.55
5 k	5.16	31.28	56.40	nda	59.03	nda
27 k	12.15	36.33	110.09	1.77	120.05	nda
27 m	5.85	10.78	49.94	nda	61.73	nda
27 l	8.96	115.09	60.37	1.63	76.74	17.42
3 k	14.28	59.01	90.10	2.95	118.74	19.68
3 m	6.48	11.68	40.39	0.89	58.16	nda
3 l	2.85	382.37	23.68	1.38	26.55	9.13
17 k	11.48	71.75	129.64	1.24	158.77	nda
17 l	10.33	91.28	92.44	nda	127.44	0.56
17 m	3.88	10.57	46.69	nda	56.53	nda
Tolstoi Rookery						
14 k	13.43	32.97	138.03	1.48	167.72	nda
14 l	4.75	61.75	58.62	nda	64.83	nda
Gorbatch Rookery						
30 k	3.79	18.35	34.41	0.41	40.21	0.36
22 m	27.61	18.66	112.47	3.26	286.16	nda
22 l	3.69	273.26	27.41	0.45	28.97	nda
22 k	24.41	52.36	166.21	2.62	286.46	nda
28 l	14.99	78.82	115.31	1.28	168.90	nda

36	k	7.24	31.37	59.12	nda	73.94	nda
26	k	4.92	32.75	50.11	nda	56.23	nda
26	l	4.46	141.43	58.20	nda	64.82	nda
24	m	15.27	26.04	92.98	1.13	180.57	nda
24	k	3.88	41.10	49.81	nda	54.12	nda
24	k	3.79	36.98	41.84	0.45	44.97	nda
12	k	11.06	31.39	50.45	nda	55.26	nda
10	l	11.89	84.31	53.03	nda	61.31	nda
10	k	9.48	20.77	39.91	0.50	42.42	nda
10	k	4.66	14.22	46.34	0.55	52.91	nda
9	m	27.74	110.82	101.23	7.62	277.40	nda
9	k	7.83	26.84	43.36	0.78	49.78	nda
9	k	16.61	30.66	87.00	0.79	106.52	nda
4	m	15.66	19.35	73.19	0.63	104.52	nda

North East Point West

32	k	9.64	16.80	31.97	0.70	34.02	5.37
32	m	35.27	21.94	98.15	0.42	360.12	nda
32	l	14.71	65.72	99.97	0.21	137.62	nda
14	k	3.87	22.91	27.94	0.35	30.21	nda
14	m	7.45	10.23	50.77	0.77	60.80	nda
14	m	13.17	5.77	52.84	0.06	116.31	nda
14	l	5.41	37.48	55.92	0.68	67.78	nda
14	l	6.28	37.84	66.56	0.28	87.48	nda

Tolstoi Rookery

9	l	3.26	97.63	41.08	nda	50.37	nda
9	k	10.26	28.05	95.31	0.37	128.65	nda
9	m	4.57	7.62	58.51	nda	108.37	nda
15	m	6.15	6.96	38.16	0.46	63.01	nda
15	l	27.03	84.36	103.89	0.79	260.40	nda
15	k	15.70	29.32	93.80	1.16	145.13	nda

Table A13. Concentrations (ppm, dry weight) of elements in tissues collected in St. George Basin planning area, April, 1976, from Freeman Miller vessel. From OCSEAP report by Robertson and Abel (1979: Tables A.9, G.1 and G.2). The authors did not label the dispersion estimates accompanying the means, nor provide sample sizes.

Station	Latitude	Longitude	Water depth (m)	Taxon	Ag ppm Mean		As ppm Mean	
MF 3	54d 47.3m	165d 18.3m	161.9	king crab	0.82	0.03	<0.25	
MF 5	54d 43.6m	165d 17.2m	167.9	rock sole	<.034		21	1
MF 25	54d 50.4m	166d 35.8m	183.8	pollock	<.015		11	1
MF 27	55d 0m	166d 15.2m	112.8	rock sole	<.011		19	1
MF 29	55d 9.3m	166d 2m	134.6	king crab	0.93	0.01	34	1
MF 31	55d 32.1m	165d 26m	114.3	Neptunea	8.6		10	1
MF 39	56d 1.6m	166d 19.2m	124.2	pollock	0.032	0.01	4.6	0.2
MF 48	55d 18.3m	167d 28.9m	151	k. crab leg	1.20	0.02	57	1
MF 49	55d 15.4m	167d 37.7m	178.3	pollock	<.025		7.3	0.2
Otter Is.	57d 3.0m	170d 23.8m		Mytilus	0.12	0.02	6.2	0.7
Makushin Bay	53d 44.0m	166d 45.8m		Mytilus	0.075	0.03	4.4	1
Eider Pt.	53d 57.5m	166d 35.1m		Mytilus			1.0	1

Cr ppm Mean		Fe ppm Mean		Hg ppm Mean		Sb ppm Mean		Se ppm Mean		Zn ppm Mean	
<0.10		17	8	0.31	0.20	0.028	0.006	10.7	0.2	134	-
5.60	0.20	19	5	0.47	0.10	0.010	0.007	3.4	0.1	36	-
0.24	0.08	6	2	0.15	0.04	0.019	0.002	0.97	0.01	18	-
0.30	0.05	15	2	0.27	0.03	0.030	0.001	1.7	0.1	30	-
0.44	0.05	26	3	0.20	0.01	0.009	0.003	13	1	136	-
0.69	0.06	1130	10	0.61	0.03	0.110	0.005	3.7	0.1	870	-
<0.6		8	2	0.04	0.03	0.012	0.002	1.15	0.03	31	-
<0.06		<7.5		0.39	0.03	0.087	0.004	4.45	0.03	83	-
<0.10		14	2	0.16	0.04	0.008	0.005	1.5	0.1	27	-
1.60	0.10	230	10	0.12	0.03	0.008	0.006	2.3	0.1	77	-
4.70	0.20	530	10	0.31	0.05	0.084	0.010	2.5	0.1	77	-
1.20	0.10	150	10	0.19	0.04	<.009		2.5	0.1	170	-

Table A14. Concentrations of metals (ppm, dry weight) in subadult male northern fur seals collected on St. George Island in late summer, 1986. Based on Smith (1986: Tables 1 and 2). ND means not detected, i.e., below lower detection limit. Lower detection limits are <.005 ppm for Ag, and <.034 ppm for Pb. Concentrations are single, unsummarized determinations.

Animal label	Age (yr)	% moist.	Tissue	Cd	Zn	Hg	Ag	Cu	Pb
1	1	68.6	liver	118	276	50.73	0.37	46	ND
		74.4	heart	3.2	105	0.64	0.07	13	ND
		75.7	kidney	410	278	4.95	0.01	28	ND
2	2	76.5	neck muscle	1.4	97	0.89	0.01	4.5	ND
		69.1	liver	99	229	89.76	0.56	35	ND
		78.9	heart	2.9	174	0.63	0.02	26	ND
		75.1	kidney	297	291	5.59	0.01	22	ND
3	1	76.2	neck muscle	0.3	76	2.24	ND	5.6	ND
		69.6	liver	34	164	36.1	0.44	35	ND
		74.8	heart	0.6	111	1.01	0.01	18	ND
		73.6	kidney	146	185	6.67	0.01	22	ND
4	2	74.6	neck muscle	0.2	96	1.03	ND	5.0	ND
		68.9	liver	18	170	67.77	0.34	14	ND
		75.1	heart	0.4	105	0.84	0.01	15	ND
		75.2	kidney	144	194	4.62	0.01	18	ND

Table A15. Concentrations (ppm) of organic contaminants in four subadult male northern fur seals collected on St. Paul Island in 1980. From Calambokidis and Peard (1985: Table 26).

Tissue & specimen label	% lipids	Wet weight DDE	Wet weight PCB	Lipid weight DDE	Lipid weight PCB
Liver					
486	5.2	0.136	0.092	2.61	1.77
487	2.6	0.197	0.094	7.59	3.61
491	3.7	0.259	0.123	6.95	3.31
488	3.0	0.357	0.106	11.80	3.51
Mean	3.6	0.237	0.104	7.23	3.05
SD	1.1	0.094	0.014	3.74	0.86
Blubber					
486	83.8	2.69	1.51	3.21	1.80
487	78.6	7.77	2.21	9.89	2.81
491	70.3	7.13	2.24	10.10	3.19
488	71.5	12.50	4.00	17.50	5.60
Mean	76.1	7.52	2.49	10.20	3.35
SD	6.3	4.01	1.06	5.84	1.61

Table A16. Concentrations (ppm) of organic contaminants in four northern fur seals collected on St. George Island, 1986. Trace levels of DDD, DDT, and lindane were also detected but were below quantifiable levels. Based on Calambokidis (1987: Tables 1, 2 and appendix data sheets).
Smith (1986) analyzed these four animals for metals and catagorized them as subadult males.

Dry weight:

Sample label	Rookery	Age (yr)	Tissue	% moist.	4-4'-DDE
303	Zapadni	1	heart	74	0.067
304	Zapadni	-	muscle	76	0.220
305	Zapadni	1	liver	69	0.083
306	Northeast	1	muscle	75	0.061

Wet weight:

Sample size	Tissue	DDT	PCB	dieldrin	lindane
1	liver	0.026	<.06	<.005	trace
2	muscle	0.034	<.06	<.005	trace
1	heart	0.017	<.06	<.005	trace

Table A17. Concentrations (ppm, wet weight) of organic contaminants in northern fur seals collected at Pribilof Islands, July, 1972. From Kurtz and Kim (1976: Tables 1 and 2).

The range of recoveries of DDT and metabolites was 55 to 66 percent from seal fat and 56 to 58 percent from blood. Analyses for all fat residues except dieldrin and o,p'-TDE were corrected for recovery. TR = trace (approx. 0.01 ppm). ND = no detectable residue, <.003 ppm.

Specimen	Aroclor 1254	diel-drin	o,p'-TDE	o,p'-DDT	p,p'-DDE	p,p'-TDE	p,p'-DDT	Sum p,p'-DDT's
Fat tissue:								
nursing cow #2	6.8	0.16	0.4	1.5	3.8	1.0	2.2	7.0
newborn pup #2	3.8	0.12	0.2	1.0	3.3	0.6	1.4	5.3
nursing cow #3	4.7	0.07	0.1	0.6	2.0	0.4	0.9	3.3
newborn pup #3	7.2	T	0.3	1.0	3.9	0.6	1.3	5.8
mean of cows	5.8	0.12	0.3	1.1	2.9	0.7	1.6	5.2
mean of pups	5.5	0.06	0.3	1.0	3.6	0.6	1.4	5.6
Two-month old								
pup #13	16	ND	TR	0.6	98	4.7	3.1	106
pup #14	81	TR	TR	2.0	70	3.3	3.2	77
pup #15	1.3	TR	ND	TR	5.1	0.1	0.1	5.3
mean of pups	33	TR	TR	0.9	58	2.7	2.1	63
Blood tissue:								
nursing cow #2	T	0.02	ND	ND	ND	ND	ND	ND
newborn pup #2	T	0.02	ND	ND	ND	ND	ND	ND
nursing cow #3	T	0.02	ND	ND	ND	ND	ND	ND
newborn pup #3	T	0.02	ND	ND	TR	ND	ND	ND
Two-month old								
pup #13	T	0.07	ND	ND	2.8	0.2	TR	3.0
pup #14	T	0.06	ND	ND	0.6	0.1	TR	0.7
pup #15	3.4	0.05	ND	ND	10	0.3	0.1	10
mean of pups		0.06			4.5	0.2		4.6

Table A18. Concentrations (ppm, wet weight) of organic contaminants in northern fur seals on St. Paul Island. Six seals, whose sex is unreported, were collected in July in each of three years. Collections were at Northeast Point Rookery in 1975, Reef Rookery in 1978, and Tolstoi Rookery in 1981. Seals collected in 1975 and 1981 were 3 to 4 years old. Based on Kurtz (no date: Tables 2 to 5).

Tissue, animal & year	p,p' DDE	p,p'- TDE	p,p'- DDT	o,p'- DDT	Total DDT	Aroclor 1242	Aroclor 1254
Fat, 1975:							
FS-2	5.30	0.27	0.28	0.11	5.96	0.10	3.00
FS-7	4.17	0.31	0.53	0.29	5.30	0.07	3.29
FS-8	3.33	0.21	0.29	0.11	3.94	0.12	2.94
FS-10	2.83	0.23	0.39	0.16	3.61	0.07	3.34
FS-12	5.33	0.57	0.67	0.41	6.98	0.14	5.84
FS-14	4.11	0.50	0.72	0.16	5.49	0.15	3.68
1978:							
K78-9	2.51	0.17	0.25	0.10	3.03	0.06	1.63
K78-11	4.33	0.40	0.62	0.17	5.52	0.18	4.62
K78-13	2.43	0.36	0.35	0.33	3.47	0.12	2.31
K78-15	6.70	0.40	0.51	0.23	7.84	0.11	4.21
K78-17	16.2	0.96	1.38	0.72	19.3	0.25	9.38
K78-19	5.90	0.41	0.50	0.66	7.47	0.08	3.17
1981:							
81-M-1	1.41	0.19	0.23	0.11	1.94	0.06	1.29
81-M-2	3.54	0.36	0.39	0.10	4.39	0.09	3.65
81-M-3	3.84	0.46	0.54	0.32	5.16	0.10	3.47
81-M-4	3.26	0.39	0.51	0.24	4.40	0.09	2.71
81-M-5	6.13	0.58	0.67	0.39	7.77	0.21	5.14
81-M-6	3.44	0.27	0.33	0.15	4.19	0.09	3.02
Liver, 1975:							
FS-2	0.17	0.02	<.01	<.01	0.19	<.05	0.14
FS-7	0.19	0.04	<.01	<.01	0.23	<.05	0.22
FS-8	0.28	0.02	0.01	<.01	0.31	<.05	0.39
FS-10	0.32	0.05	<.01	<.01	0.37	<.05	0.48
FS-12	0.35	0.06	<.01	<.01	0.41	<.05	0.05
FS-14	0.15	0.03	<.01	<.01	0.18	<.05	0.22
1978:							
K78-9	0.12	0.02	<.01	<.01	0.14	<.05	0.16
K78-11*	0.19	0.03	<.01	<.01	0.22	<.05	0.29

K78-13	0.11	0.02	<.01	<.01	0.13	<.05	0.17
K78-15	0.19	0.03	0.02	<.01	0.24	<.05	0.15
K78-17	0.78	0.07	0.02	<.01	0.87	<.05	0.50
K78-19	0.37	0.03	<.01	<.01	0.40	<.05	0.31
1981:							
81-M-1	0.09	0.02	0.01	<.01	0.12	<.05	0.15
81-M-2	0.16	0.03	0.02	0.01	0.22	<.05	0.27
81-M-3	0.13	0.03	0.90	<.01	0.18	<.05	0.20
81-M-4	0.14	0.03	0.03	0.01	0.21	<.05	0.19
81-M-5	0.23	0.03	0.02	0.01	0.29	<.05	0.30
81-M-6	0.15	0.02	0.01	<.01	0.18	<.05	0.21
Brain, 1975:							
FS-2	0.06	<.01	<.01	<.01	0.06	<.05	0.06
FS-7	0.06	0.01	0.01	0.01	0.09	<.05	0.10
FS-8	0.04	0.01	<.01	<.01	0.05	<.05	0.07
FS-10	0.03		<.01	<.01	0.03	<.05	0.06
FS-12	0.08	0.01	<.01	<.01	0.09	<.05	0.11
FS-14	0.03	0.01	<.01	<.01	0.04	<.05	0.06
1978:							
K78-9	0.03	0.01	<.01	<.01	0.04	<.05	0.05
K78-11	0.05	0.01	<.01	<.01	0.06	<.05	0.08
K78-13	0.03	0.01	<.01	<.01	0.04	<.05	0.05
K78-15	0.09	0.01	<.01	<.01	0.10	<.05	0.09
K78-17	0.23	0.02	0.02	<.01	0.27	<.05	0.14
K78-19	0.06	0.01	<.01	<.01	0.07	<.05	0.07
1981:							
81-M-1	0.02	<.01	<.01	<.01	0.02	<.05	0.03
81-M-2	0.05	0.01	0.01	<.01	0.07	<.05	0.08
81-M-3	0.04	0.01	0.01	0.01	0.07	<.05	0.07
81-M-4	0.04	0.01	0.01	<.01	0.06	<.05	0.07
81-M-5	0.06	0.01	0.01	<.01	0.08	<.05	0.06
81-M-6	0.03	<.01	0.01	<.01	0.04	<.05	0.06
Blood, 1975:							
FS-2	0.014	<.0013	<.0013	<.0013	0.014	<.013	0.03
FS-7	0.008	<.0013	<.0013	<.0013	0.008	<.013	<.013
FS-8	0.007	<.0013	<.0013	<.0013	0.007	<.013	<.013
FS-10	0.009	<.0013	<.0013	<.0013	0.009	<.013	<.013
FS-12	0.005	<.0013	<.0013	<.0013	0.005	<.013	0.02
FS-14	0.006	<.0013	<.0013	<.0013	0.006	<.013	<.013
1978:							
K78-9	0.008	<.0013	<.0013	<.0013	0.008	0.02	0.02
K78-11	0.012	<.0013	<.0013	<.0013	0.012	<.013	0.02

K78-13	0.012	<.0013	<.0013	<.0013	0.012	<.013	<.013
K78-15	0.039	<.0013	<.0013	<.0013	0.039	<.013	0.03
K78-17	0.046	0.002	<.0013	<.0013	0.048	<.013	0.05
K78-19	0.028	<.0013	<.0013	<.0013	0.028	<.013	<.013
1981:							
81-M-1	0.004	<.0013	<.0013	<.0013	0.004	<.013	0.02
81-M-2	0.01	<.0013	<.0013	<.0013	0.01	<.013	0.02
81-M-3	0.009	<.0013	<.0013	<.0013	0.009	<.013	<.013
81-M-4	0.009	<.0013	<.0013	<.0013	0.009	<.013	0.02
81-M-5	0.015	<.0013	<.0013	<.0013	0.015	<.013	<.013
81-M-6	0.006	<.0013	<.0013	<.0013	0.006	<.013	<.013

*Approximate losses of 15% in extraction.

Table A19. Percent frequency of occurrence of organochlorine residues in eggs of Pribilof Island seabirds, 1973-1976. In addition to compounds listed here, DDE was found in all samples and PCB's were detected in all eggs. Frequency index is computed as total occurrences/possible occurrences. Total occurrences = no. times an organochlorine was present in eggs; possible occurrences = no. clutches from that species. From Ohlendorf, et al (1982: Table 2).

Species	N	DDD	DDT	Dieldrin	Hepta-chlor epoxide	Mirex
Northern fulmar	6	83.3	100	83.3	50	33.3
Black-legged kittiwake	10	0	0	10	50	0
Common murre	21	52.4	47.6	61.9	95.2	0

	N	Oxy-chlor-dane	cis-chlor-dane	cis-nona-chlor	HCB	Toxa-phene
Northern fulmar	6	100	33.3	33.3	100	100
Black-legged kittiwake	10	100	0	0	100	100
Common murre	21	100	4.8	9.5	100	81

Table A20. Geometric means of DDE and PCB residue concentrations (ppm, wet weight) in eggs of seabirds at Pribilof Islands. Asterisk denotes species significantly different ($P<.05$) within a compound. Species were included only if 5 or more eggs were collected. From Ohlendorf, et al (1982: Table 5).

	DDE	PCB's
Black-legged kittiwake	0.033*	0.472
Common murre	0.205	0.239*
Northern fulmar	0.307	0.387

oxychlordane		
St. Geo. Is.	0.018	B
St. Paul Is.	0.026	B
Bogoslof Is.	0.005	C
cis-chlordane		
St. Geo. Is.	not determined	B
St. Paul Is.	<.001	B
Bogoslof Is.	<.001	B
cis-nonachlor		
St. Geo. Is.	not determined	C
St. Paul Is.	0.080	B
Bogoslof Is.	0.066	B
toxaphene		
St. Geo. Is.	0.037	A
St. Paul Is.	0.019	AB
Bogoslof Is.	not determined	B
PCB's		
St. Geo. Is.	0.270	B
St. Paul Is.	0.205	B
Bogoslof Is.	0.126	B

Table A22. Concentrations of organochlorine residues (ppm, wet weight) in eggs of seabirds in St. George Basin area, 1973-1976. Chemicals not listed were not detected. ND = not detected. N = sample size, i.e., no. eggs. From Ohlendorf, et al (1982: Appendix III).

Northern fulmar St. George Island N=6; 1975	No. eggs	Geometric mean	95% confid. interval	Range
DDE	6	0.307	0.19-0.44	.14-.45
DDD	5	0.008	0.002-0.013	nd-.015
DDT	6	0.015	.001-.029	.006-.041
dieldrin	5	0.008	.003-.013	nd-.015
heptachlor epoxide	3	0.005	0-.011	nd-.013
Mirex	2	0.002	0-.006	nd-.008
oxychlordane	6	0.067	.021-.12	.007-.14
cis-chlordane	2	0.001	0-.004	nd-.005
cis-nonachlor	2	0.003	0-.007	nd-.008
HCB	6	0.055	.033-.077	.028-.089
toxaphene	6	0.051	.028-.074	.029-.081
PCB's	6	0.387	.19-.61	.26-.81
Glaucous-winged gull Bogoslof Island N=3; 1973				
DDE	3	5.16	0-42.0	1.6-11.0
DDT	2	0.037	0-.13	nd-.073
dieldrin	3	0.214	0-1.1	.049-.58
Mirex	3	0.036	.013-.59	.025-.042
oxychlordane	3	0.251	0-1.1	.054-.56
HCB	3	0.058	0-.12	.030-.073
PCB's	3	3.55	.38--14.0	1.8-6.3
Black-legged kittiwake St. Paul Island N=10; 1975				
DDE	10	0.033	.022-.044	.014-.066
dieldrin	1	<.001	0-.002	nd-.006
heptachlor epoxide	5	0.003	0-.006	nd-.013
oxychlordane	10	0.034	.029-.039	.023-.043
HCB	10	0.043	.033-.054	.015-.060
toxaphene	10	0.025	.021-.030	.019-.036
PCB's	10	0.472	.35-.60	.23-.68
Common murre Bogoslof Island N=7; 1973				
DDE	7	0.119	.11-.13	.10-.13
DDD	1	0.001	0-.004	nd-.008
dieldrin	6	0.034	0-.073	nd-.12

heptachlor epoxide	4	0.004	0-.008	nd-.009
oxychlordane	6	0.005	.002-.008	nd-.009
cis-chlordane	1	<.001	0-.003	nd-.005
cis-nonachlor	4	0.008	0-.016	nd-.020
HCB	6	0.066	.034-.098	nd-.096
PCB's	7	0.126	.092-.16	.08-.18
St. George Island				
N=11; 1975				
DDE	11	0.273	.14-.43	.084-.79
DDD	10	0.035	.022-.047	nd-.068
DDT	10	0.013	.007-.019	nd-.023
dieldrin	7	0.009	.002-.016	nd-.025
heptachlor epoxide	11	0.012	.009-.015	.005-.019
oxychlordane	11	0.018	.012-.024	.004-.032
HCB	11	0.079	.059-.098	0.048-0.16
toxaphene	9	0.037	.003-.072	nd-.19
PCB's	11	0.270	.22-.32	.12-.35
St. Paul Island				
N=10; 1975				
DDE	10	0.135	.098-.17	.069-.26
DDD	1	<.001	0-0.002	nd-.006
dieldrin	6	0.005	.001-.008	nd-.015
heptachlor epoxide	9	0.011	.005-.016	nd-.024
oxychlordane	10	0.026	.020-.033	.012-.041
cis-chlordane	1	<.001	0-.002	nd-.006
cis-nonachlor	2	0.002	0-.004	nd-.013
HCB	10	0.08	.062-.098	.044-.11
toxaphene	8	0.019	.008-.029	nd-.044
PCB's	10	0.205	.16-.25	.11-.31

Table A23. Concentrations of organochlorine residues (ppm, wet weight) in individual eggs of seabirds in St. George Basin planning area. Based on the unpublished, raw data of H. M. Ohlendorf (personal communication, 1988). These data are published in a summarized form in Ohlendorf, et al (1982).

	DDE	DDD	DDT	dieldrin	heptachlor epoxide	Mirex
Northern	0.26	0.0052	0.0076	0.0067	0.0079	-
fulmar	0.30	0.0070	0.0086	0.0086	-	-
St. George Is.	0.44	0.0110	0.0160	0.0150	0.0079	0.0081
1975	0.45	0.0080	0.0110	0.0110	0.0130	0.0040
	0.14	-	0.0057	-	-	-
	0.28	0.0150	0.0410	0.0074	-	-
Glaucous-winged	6.5	-	0.073	0.580	-	0.040
gull	11.0	-	0.038	0.080	-	0.042
Bogoslof Is.	1.6	-	-	0.049	-	0.025
1973						
Black-legged	0.028	-	-	-	-	-
kittiwake	0.028	-	-	-	-	-
St. Paul Is.	0.014	-	-	-	-	-
1975	0.033	-	-	-	0.0047	-
	0.035	-	-	-	0.0048	-
	0.036	-	-	-	0.0051	-
	0.019	-	-	-	0.0043	-
	0.020	-	-	-	-	-
	0.066	-	-	0.0062	0.0130	-
	0.052	-	-	-	-	-
Common	0.13	0.0075	-	0.120	0.0092	-
murre	0.12	-	-	0.012	-	-
Bogoslof Is.	0.11	-	-	0.033	0.0073	-
1973	0.13	-	-	-	0.0057	-
	0.12	-	-	0.059	0.0075	-
	0.12	-	-	0.011	-	-
	0.10	-	-	0.011	-	-
St. George Is.	0.180	-	0.004	0.0250	0.0160	-
1975	0.150	0.068	-	0.0210	0.0190	-
	0.700	0.048	0.021	0.0055	0.0150	-
	0.410	0.016	0.007	-	0.0057	-
	0.140	0.025	0.011	-	0.0092	-
	0.084	0.025	0.081	-	0.0052	-
	0.790	0.045	0.022	0.0048	0.0120	-
	0.200	0.048	0.023	0.0190	0.0170	-
	0.160	0.036	0.014	0.0044	0.0120	-
	0.160	0.043	0.023	0.0190	0.0120	-
	0.220	0.026	0.013	-	0.0084	-

Table A23. con't

St. Paul Is.	0.150	-	-	-	0.0068	-
1975	0.150	-	-	-	0.0081	-
	0.160	-	-	0.0088	0.0064	-
	0.130	-	-	-	0.0060	-
	0.120	-	-	0.0044	0.0095	-
	0.140	-	-	0.0082	0.0170	-
	0.260	-	-	0.0150	0.0240	-
	0.093	-	-	-	0.0070	-
	0.087	-	-	0.0039	-	-
	0.069	0.0064	-	0.0062	0.0230	-

oxy-chlordane	cis-chlordane	cis-nonachlor	HCB	toxaphene	PCB
0.0074	-	-	0.063	0.052	0.28
0.0530	0.0048	-	0.052	0.036	0.27
0.1400	-	0.0081	0.089	0.081	0.81
0.1000	-	0.0081	0.028	0.075	0.48
0.0600	0.0042	-	0.057	0.029	0.26
0.0490	-	-	0.041	0.033	0.30
0.560	-	-	0.030	-	6.3
0.190	-	-	0.073	-	3.6
0.054	-	-	0.072	-	1.8
0.026	-	-	0.031	0.028	0.28
0.043	-	-	0.044	0.019	0.65
0.028	-	-	0.029	0.019	0.23
0.036	-	-	0.060	0.020	0.68
0.038	-	-	0.050	0.029	0.48
0.033	-	-	0.056	0.024	0.60
0.023	-	-	0.058	0.019	0.27
0.034	-	-	0.015	0.026	0.47
0.043	-	-	0.045	0.032	0.53
0.040	-	-	0.046	0.036	0.62
0.0042	-	0.0130	0.070	-	0.160
0.0048	-	0.0046	0.050	-	0.110
0.0086	-	0.0180	0.096	-	0.084
0.0042	-	-	0.063	-	0.140
0.0089	0.0054	0.0200	-	-	0.180
0.0044	-	-	0.088	-	0.130
-	-	-	0.096	-	0.080

0.0160	-	-	0.077	0.1900	0.33
0.0320	-	-	0.068	0.0660	0.34
0.0250	-	-	0.078	0.0310	0.26
0.0094	-	-	0.160	0.0071	0.15
0.0160	-	-	0.053	0.0150	0.27
0.0110	-	-	0.081	-	0.12
0.0044	-	-	0.048	-	0.32
0.0320	-	-	0.094	0.0360	0.35
0.0170	-	-	0.074	0.0150	0.26
0.0170	-	-	0.070	0.0390	0.26
0.0190	-	-	0.065	0.0210	0.33
0.0377	-	-	0.100	0.0340	0.25
0.0410	-	-	0.082	0.0440	0.28
0.0270	-	-	0.110	0.0270	0.16
0.0270	-	-	0.100	-	0.13
0.0200	-	-	0.062	0.0110	0.19
0.0290	-	-	0.100	0.0150	0.31
0.0310	0.0064	0.0025	0.093	0.0250	0.25
0.0120	-	0.0130	0.065	0.0061	0.11
0.0140	-	-	0.044	-	0.19
0.0260	-	-	0.044	0.0270	0.20

Table A24a. Concentrations (ppb, wet weight) of PCB's in two male northern fur seals collected at North East Point Rookery, St. Paul Island, July 29, 1987. Ages of Animal Nos. 1 and 2 are 3 and 2 years, respectively. Based on Wise (pers. comm., 1988).

Means of two tissue extracts analyzed in triplicate; concentration value is the mean value, and numbers in parentheses are one standard deviation. The < values indicate the minimum detectable level for a compound in a sample.

IUPAC PCB #	MM1L013 Liver	MM1K014 Kidney	MM1M015 Muscle	MM1B016 Blubber
Animal No. 1:				
8 (2,4')	<1	0.2 (0.0)	0.1 (0.0)	1.8 (0.0)
18 (2,2',5)	0.1 (0.0)	0.2 (0.0)	0.1 (0.0)	0.9 (0.0)
28 (2,4,4')	0.4 (0.0)	0.9 (0.0)	0.5 (0.0)	11.5 (0.7)
52 (2,2', 5,5')	1.3 (0.0)	1.2 (0.0)	0.8 (0.0)	21.7 (0.4)
44 (2,2',3,5')	<1	<1	<1	2.8 (0.1)
66 (2,3',3,5')	2.7 (0.0)	1.4 (0.0)	1.2 (0.0)	29.7 (0.2)
101 (2,2',4,5,5')	0.4 (0.0)	0.8 (0.0)	0.4 (0.0)	7.8 (0.2)
77 (3,3',4,4')	<1	<1	<1	<1
118 (2,3',4,4',5)	1.4 (0.0)	0.9 (0.0)	0.8 (0.0)	31.3 (1.9)
153 (2,2',4,4',5,5')	5.7 (0.1)	5.2 (0.1)	4.7 (0.3)	120 (6.0)
105 (2,3,3',4,4')	0.5 (O.0)	0.6 (0.0)	0.4 (0.0)	15.2 (0.7)
138 (2,2',3,4,4',5')	4.3 (0.2)	3.6 (0.1)	3.2 (0.1)	17.5 (0.9)
126 (3,3',4,4',5)	<1	<1	<1	<1
187 (2,2',3,4',5,5',6)	<1	<1	<1	<1
128 (2,2',3,3',4,4',)	<1	<1	<1	<1
180 (2,2',3,4,4',5,5')	1.1 (0.0)	1.4 (0.1)	1.1 (0.0)	1.5 (0.0)
170 (2,2',3,3',4,4',5)	0.4 (0.0)	0.6 (0.0)	0.4 (0.0)	12.0 (0.2)
195 (2,2',3,3',4,4',5,6)	<1	<1	<1	<1
206 (2,2',3,3',4,4',5,5',6)	<1	<1	<1	<1
209 (deca)	<1	<1	<1	<1
Animal No. 2:				
8 (2,4')	<1	<1	<1	<3
18 (2,2',5)	<1	0.3 (0.0)	<1	<3
28 (2,4,4')	0.8 (0.0)	2.3 (0.0)	0.7 (0.0)	13.5 (0.4)
52 (2,2', 5,5')	1.0 (0.0)	1.8 (0.1)	0.5 (0.0)	12.5 (0.3)
44 (2,2',3,5')	<1	<1	<1	<2
66 (2,3',4,4')	5.2 (0.3)	7.8 (0.3)	3.1 (0.1)	111 (3.7)
101 (2,2',4,5,5')	0.9 (0.1)	3.0 (0.1)	0.8 ((0.1)	8.5 (0.9)
77 (3,3',4,4')	<1	<1	<1	<3
118 (2,3',4,4',5)	6.7 (0.2)	9.0 (0.1)	1.3 (0.1)	95.5 (5.0)
153 (2,2',4,4',5,5')	15.8 (0.9)	30.8 (0.5)	12.4 (1.0)	191 (6.1)
105 (2,3,3',4,4')	1.3 (0.1)	3.9 (0.1)	1.3 (0.0)	18.6 (1.0)
138 (2,2',3,4,4',5')	10.8 (0.3)	20.4 (0.7)	7.1 (0.1)	91.6 (1.8)
126 (3,3',4,4',5)	<2	<2	<2	<10
187 (2,2',3,4',5,5',6)	<1	<1	<1	<3
128 (2,2',3,3',4,4',)	<1	<1	<1	<3
180 (2,2',3,4,4',5,5')	3.7 (0.1)	5.9 (0.1)	2.3 (0.1)	32.6 (1.2)
170 (2,2',3,3',4,4',5)	1.4 (0.1)	1.8 (0.1)	0.9 (0.0)	11.6 (0.4)
195 (2,2',3,3',4,4',5,6)	<1	<1	<1	<2
206 (2,2',3,3',4,4',5,5',6)	<1	<1	<1	<2
209 (deca)	<1	<1	<1	<2

Table A24b. Concentrations (ppb, wet weight) of pesticides in two male northern fur seals collected at North East Point Rookery, St. Paul Island, July 29, 1987. Ages of Animal Nos. 1 and 2 are 3 and 2 years, respectively. Based on Wise (pers. comm., 1988).

Means of two tissue extracts analyzed in triplicate; concentration value is the mean value, and numbers in parentheses are one standard deviation. The < values indicate the minimum detectable level for a compound in a sample.

Pesticide	MM1L013 Liver	MM1K014 Kidney	MM1M015 Muscle	MM1B016 Blubber
Animal No. 1:				
Hexachlorobenzene	<1	0.2 (0.0)	<1	1.8 (0.0)
Aldrin	<1	<1	<1	<1
2,4'-DDE	<1	<1	<1	1.1 (0.1)
4,4'-DDE	36.6 (0.4)	34.4 (1.4)	36.0 (1.4)	1330 (46.9)
2,4'-DDD	1.2 (0.0)	<1	<1	12.1 (0.5)
4,4'-DDD	3.5 (0.1)	3.0 (0.1)	2.9 (0.1)	118 (4.2)
2,4'-DDT	<1	<1	<1	<1
4,4'-DDT	2.8 (0.1)	1.9 (0.1)	1.8 (0.1)	34.8 (2.0)
Lindane	1.0 (0.0)	1.4 (0.1)	1.0 (0.0)	25.7 (0.6)
Heptachlor epoxide	1.1 (0.1)	2.0 (0.1)	2.3 (0.1)	34.1 (0.8)
alpha-chlordane	0.2 (0.0)	0.2 (0.0)	0.2 (0.0)	4.3 (0.1)
Trans-nonachlor	5.9 (0.2)	8.0 (0.2)	8.8 ((0.3)	302 (13.6)
Dieldrin	0.9 (0.0)	1.1 (0.0)	0.7 ((0.0)	26.3 (0.7)
Heptachlor	<1	<1	<1	<1
Mirex	<1	<1	<1	<1
Animal No. 2:				
Hexachlorobenzene	<1	<1	<1	<2
Aldrin	<1	<1	<1	<2
2,4'-DDE	<1	<1	<1	<3
4,4'-DDE	85.1 (4.3)	187 (6.7)	72.0 (4.6)	1050 (42.4)
2,4'-DDD	0.9 (0.0)	0.5 (0.0)	0.2 (0.0)	0.4 (0.0)
4,4'-DDD	4.2 (0.2)	9.2 (0.4)	3.3 (0.1)	19.0 (1.2)
2,4'-DDT	<1	<1	<1	<1
4,4'-DDT	3.3 (0.1)	7.2 (0.3)	2.9 (0.1)	16.5 (0.7)
Lindane	0.4 (0.0)	1.9 (0.1)	0.5 (0.0)	2.8 (0.2)
Heptachlor epoxide	2.4 (0.1)	4.3 (0.2)	1.8 (0.1)	14.7 (0.4)
alpha-chlordane	<1	<1	<1	<1
Trans-nonachlor	6.8 (0.2)	32.7 (0.9)	11.3 ((0.4)	64.8 (2.7)
Dieldrin	0.3 (0.0)	0.8 (0.0)	0.3 (0.0)	1.2 (0.0)
Heptachlor	<1	<1	<1	<2
Mirex	<1	<1	<1	<2

MERCURY IN ALASKA MARINE SURFACE SEDIMENTS: A REVIEW OF THE REGIONAL DATA

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ABSTRACT

Mercury concentrations reported by eight studies of surface sediments varied significantly among regions of the Alaska shelf. Chukchi Sea data indicated the lowest mercury geometric means, .0121ppm and .0127ppm, for sand and mud, respectively. One Beaufort Sea study reported the highest concentrations, with means of .0615ppm and .0877ppm, for sand and mud, respectively.

Mercury levels did not differ significantly between the mud and sand fractions when data were combined among studies. Laboratory and collection methods differed among the studies and may have affected the mercury estimates, but no clear relationship emerged from a comparison of the reports.

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INTRODUCTION

Offshore mineral and petroleum developments which disturb surface sediments may increase heavy metal pollution in Alaska marine areas. Gold dredges off Nome and drilling pads in Arctic waters, for example, currently introduce toxic metals into the water column. Whether these activities represent a significant pollution problem is an issue of continuing research in Alaska.

Past sampling data on concentrations of heavy metals in Alaska marine sediments may contribute to an understanding of the source and extent of such pollution. First, the likelihood that development will cause significant pollution varies from place to place as a consequence of geographical differences in heavy metal concentrations. In addition, past estimates of these toxic elements can serve as a basis for measuring future effects of development.

This paper examines mercury concentrations reported by past investigators of Alaska shelf regions. The review establishes estimates for mean mercury levels in several regions and tests whether the samples are adequate for indicating patterns of variation in mercury among regions.

METHODS

Reported concentrations of mercury in surface sediments off the Alaska coast were characterized statistically.

Non-proprietary reports, identified in a search of published and unpublished literature, were selected for examination in this review. Only those reports providing ten or more mercury concentrations exceeding the lower detection limit were selected. Mercury samples which may have been affected by specific industrial activity were omitted from consideration in this review for the two studies which reported such activity, i. e. NORTEC (1982) and Rusanowski et al (1988). For these two local studies, only "control" mercury samples known to be unaffected by dredging and effluent disposal are included here.

Each sediment specimen was classified as mud, sand, or gravel by applying the grain-size classification criteria of its report. These grain-size classes were then assigned to the individual mercury values from each report. Subsequent statistical treatments of mercury concentrations were carried out within the grain-size classes. Mud is defined as silt and clay combined.

The mercury concentrations were first summarized as geometric means and confidence intervals by back-transforming from natural logarithms. The log values were examined for departure from an expected normal frequency distribution using tests for skewness and kurtosis. Bartlett's test of homogeneity of variances was applied to the samples using the method described by Sokal and Rohlf

(1969:370). Where heterogeneity of variances precluded parametric analysis of variance, a Kruskal-Wallis rank test among studies was performed. Statistical calculations, except Bartlett's test, were carried out with Complete Statistical System, a micro-computer application distributed by Statsoft, Inc., Tulsa, Oklahoma.

All the data reviewed here were taken at face value from the original reports. Data on grain size and mercury concentrations were selected without regard to methods of collection, storage, or laboratory analysis, and were subjected to no modifications other than log transformation.

Mercury concentrations are expressed as parts per million on a dry weight basis. For purposes of statistical calculations, concentrations reported as lower than the lower detection limit were assigned a value equal to the product of the lower detection limit times 0.7.

The alpha level of significance is $P<.05$ for statistical tests.

RESULTS

The reports

Eight reports with unreduced data on concentrations of mercury in sediment were identified for Alaska shelf areas.

Barnes et al (1974) collected sediment with a variety of instruments in 1971 in the Beaufort Sea. The sampled area lay between 143 and 155 degrees west longitude and extended from the coast to approximately 2,000 meters water depth. It encompassed lagoonal areas and depths less than 10 meters. Barnes and his USGS colleagues provided sediments analyzed by Weiss et al (1974) for Beaufort Sea waters outside lagoons, from approximately 10 meters to 2,000 meters depth.

Barnes and Leong (1971) reported mercury levels from the Chukchi Sea collected in 1970. The sampled area extended from Cape Lisburne northward to 70.5 degrees north latitude and westward from Icy Cape to approximately 168 degrees west longitude.

Nelson et al (1972) sampled mercury in the northern Bering Sea, including Norton Sound, St. Lawrence Island, St. Matthew Island, and offshore Seward Peninsula. The investigation collected sediments at various depths with several instruments. For this review, only the material indicated as surficial sediment by the authors was considered.

Gardner et al (1979) collected surface sediments from the greater St. George Basin area of the southeastern Bering Sea employing three collection methods. The area extended from around the Pribilof Islands southeastward to Unimak Pass in the Aleutian Island archipelago, and lay east of the continental slope. The report associated mercury

concentration values with a grain-size distribution in 1976 and only that year's data are reviewed here.

Burrell (1978) reported mercury concentrations determined by H. V. Weiss for the shelf area of northeastern Gulf of Alaska, lying between 140 and 150 degrees west longitude. Although no grain size data were reported for the cruise which collected the mercury samples, the mercury values can be associated with the grain sizes for eight of the stations occupied by the vessel Silas Bent earlier in the year (Burrell, 1978: Table 22).

Two studies measured the affects of artificial perturbations on the sea floor. NORTEC (1982) experimented with drilling mud disposal on sea ice east of the Sagavanirktok River delta in 1980. Rusanowski et al (1988) studied mercury concentrations near the Bima dredge off Nome. This review considered only the sediment collected at Endeavor and Resolution Islands before NORTEC's experimental work, and upstream of the dredge at Nome.

Methods differences

Collection methods varied among the seven studies which reported methods of collecting sediment. There was no indication that any of the studies collected sediment from the same depth range below the sediment surface (Table 1). The three studies which reported the collection depth each sampled from unique ranges. Four studies did not report the depth range for collected sediment, and one study (Rusanowski et al, 1988) reported mercury concentrations from stations unassociated with the grain-size collections.

Storage also differed among the studies. For example, Weiss et al (1974), NORTEC (1982), and Burrell (1978) reported that sediment specimens were frozen (Table 1).

Six of the eight studies measured mercury concentrations by means of atomic absorption spectrometry. In contrast, H. V. Weiss employed neutron activation to determine mercury levels reported by Burrell (1978) and by Weiss et al (1974).

Grain-size criteria

Five reports shared similar grain-size classification criteria for the mud and sand fractions (Table 2). Sand and mud were separated at .062mm to .063mm diameter for the Beaufort Sea (Barnes et al, 1974; Weiss et al, 1974), the Chukchi Sea (Barnes and Leong, 1971), the St. George Basin (Gardner et al, 1979), and the northeastern Gulf (Burrell, 1978). Because Weiss et al (1974) did not report grain sizes, their mercury concentration data are associated in

Table 1. Reported methods for estimating whole-rock concentrations of mercury in surface sediment collected from Alaska shelf areas.

Area & citation	Methods summarized
Beaufort Sea Barnes et al (1974)	Upper 2cm of surface sediment. Stored unfrozen in plastic 4-6 months. Sieved and air dried at room temp. Gentle disaggregation with mortar and pestel. AAS (Vaughn and McCarthy, 1964). Lower detection limit is inferred as .01ppm from the lower boundary of the range.
Beaufort Sea Weiss et al (1974)	Sediments provided by Barnes. Frozen. Neutron activation analysis. No lower detection limit reported.
Chukchi Sea Barnes & Leong (1971)	2-10cm. Sieved and air dried. Gentle disaggregation with mortar and pestel. AAS (Vaughn and McCarthy, 1964). Lower detection limit .01ppm.
No. Bering Sea Nelson et al (1972)	0-10cm. Air dried. Gentle disaggregation with mortar and pestel. AAS (Vaughn and McCarthy, 1964). Lower detection limit .01ppm.
St. Geo. Basin Gardner et al (1979)	0-30cm. Stored moist, air tight at 3 deg C. Air dried, ground to <.149mm. AAS. No lower detection limit reported.
Sag Delta NORTEC (1982)	Pipe dredge. Frozen in plastic bags. Digested with K-permanganate, aqua regia, and K-persulfate; cold vapor AAS. Lower detection limits varied .001 to .003ppm.
Nome Rusanowski et al (1988)	Refrigerated. Digested by EPA method 3050. Perkin-Elmer 603 AAS and EPA method 7471. Lower detection limits varied .002 to .035ppm.
NE Gulf Burrell (1978)	Frozen in polyethylene jars. Neutron activation analysis. No lower detection limit reported.

this review with grain sizes shown on the sediment-type map of Barnes et al (1974) for the same region.

For the three other studies, grain-size classes were defined by unequal criteria. NORTEC (1982) expressed grain-

Table 2. Criteria for assigning grain-size classes to mercury concentrations in surface sediment collected from Alaska shelf areas.

Area & citation	Maps	Station labels	Percentage wt. in the diameter class
Beaufort Sea Barnes et al (1974)	Sed. type & [Hg]		Mean diam.: silt and clay <.062 sand .062-2.5mm gravel >2.5mm
Beaufort Sea Weiss et al (1974)	[Hg]		None reported. (Criteria are imposed for this review from Barnes (1974).)
Chukchi Sea Barnes & Leong (1971)	Sed. type & & [Hg]		mud >50% <.062mm sand >50% .062-2mm gravel >25% >2mm
No. Bering Sea Nelson et al (1972)	Sed. type	Lat/lon for each [Hg]	Undefined grain diam. classes are mapped as: silt 0%-50% gravel >50% gravel
St. Geo. Basin Gardner et al (1979)	Gr. size classes & [Hg]	Lat/lon for each [Hg] & gr. size	mud >50% <.063mm sand >50% >.063mm
Sag Delta NORTEC (1982)		labels for each [Hg] & gr. size	mud >50% <.045mm sand >50% >.045mm
Nome Rusanowski et al (1988)		labels for each [Hg]	Not applicable
NE Gulf Burrell (1978)		labels for each [Hg]	Grain size for 8 of 28 stations. mud <.062mm

Table 3. Kruskal-Wallis non-parametric rank tests for grain size affect and study affect on mercury concentrations in mud and sand of the Alaska shelf.

Grain size affect for five studies

Fraction:	Mud	Sand
Sample size:	213	181
Sum of ranks:	43765	34049

Degrees of freedom:	1, 394
Test statistic:	H = 2.320
Probability:	P = .1236 NS

Study affect for seven studies

Study	Sample size	Sum of ranks
Beaufort Sea Barnes et al (1974)	172	38964
Chukchi Sea Barnes & Leong (1971)	51	4283
No. Bering Sea Nelson et al (1972)	49	11311
St. George Basin Gardner et al (1979)	100	28300
Sag Delta NORTEC (1982)	22	4314
Nome Rusanowski et al (1988)	22	3696
NE Gulf Burrell (1978)	28	7921

Degrees of freedom:	6, 444
Test statistic:	H = 96
Probability:	P < .0001

Table 4. Mean mercury concentrations in mud and sand fractions of surface sediment collected from Alaska shelf areas. Mud and sand are defined in the original reports. Sample size is number of sediment specimens. The geometric means and confidence bounds are back-transformed from mean and confidence bounds of the natural logs of the original values. Transformed values of the St. George Basin mercury samples indicated significant skewness (1.04) for mud and significant kurtosis (1.88) for sand. No other samples showed significant departures from normal. Expressed as ppm dry weight of mercury in whole-rock digests.

Area & citation	Fraction	Sample size	Geom. mean	95% Conf. Int.
Beaufort Sea	mud	119	.0293	.0251-.0341
Barnes et al	sand	53	.0362	.0304-.0431
(1974)	gravel	7	.0157	.0133-.0221
Beaufort Sea	mud	42	.0877	.0777-.0990
Weiss et al	sand	5	.0615	.0343-.1104
(1974)	gravel	1	.036	---
Chukchi Sea	mud	19	.0127	.0100-.0161
Barnes & Leong	sand	32	.0121	.0101-.0145
(1971)	gravel	12	.0178	.0134-.0237
No. Bering Sea	mud	17	.0369	.0246-.0554
Nelson et al	sand	32	.0277	.0205-.0373
(1972)	gravel	53	.0253	.0206-.0313
St. George Basin area	mud	48	.0464	.0424-.0508
Gardner et al	sand	52	.0381	.0354-.0410
(1979)				
Sag Delta	mud	10	.0384	.0281-.0524
NORTEC (1982)	sand	12	.0166	.0104-.0266
Nome				
Rusanowski et al	-	22	.0147	.0078-.0278
(1988)				
NE Gulf	-	28	.0402	.0344-.0470
Burrell (1978)				

Heterogeneity of variances

Bartlett's test of the five studies which reported grain sizes indicates significant heterogeneity among the variances within sediment fractions (Table 5).

Figures 2 and 3 show confidence intervals which reflect these regional differences in variance. Figure 4 illustrates the proportion of the total sample contributed by each of the studies.

DISCUSSION

Means

The reported mercury concentrations varied widely among the investigations, although the sources of the variation could not be determined. Proportions of mud and sand were shown to have no significant affect on mercury concentrations, and as a result offer little explanation for the regional differences in mercury levels. Similarly, collection depths, storage methods, and analytical procedures showed no clear relationship with variation in mean mercury levels. Consequently, the variation in mercury concentrations among the studies was not attributable to particular factors, including geographic affects.

Variances

Significant heterogeneity of variances placed additional limits on an attempt to measure regional differences in mercury concentrations. The inequality of variances among studies violated an assumption of parametric methods. As a result, analysis of variance cannot be employed to partition total mercury variation into its components and to estimate the relative strength of geographic and grain-size affects.

Furthermore, because the variances must be considered as representing independent "statistical populations" of mercury, the studies' samples cannot be pooled to achieve a single estimate of an overall mean.

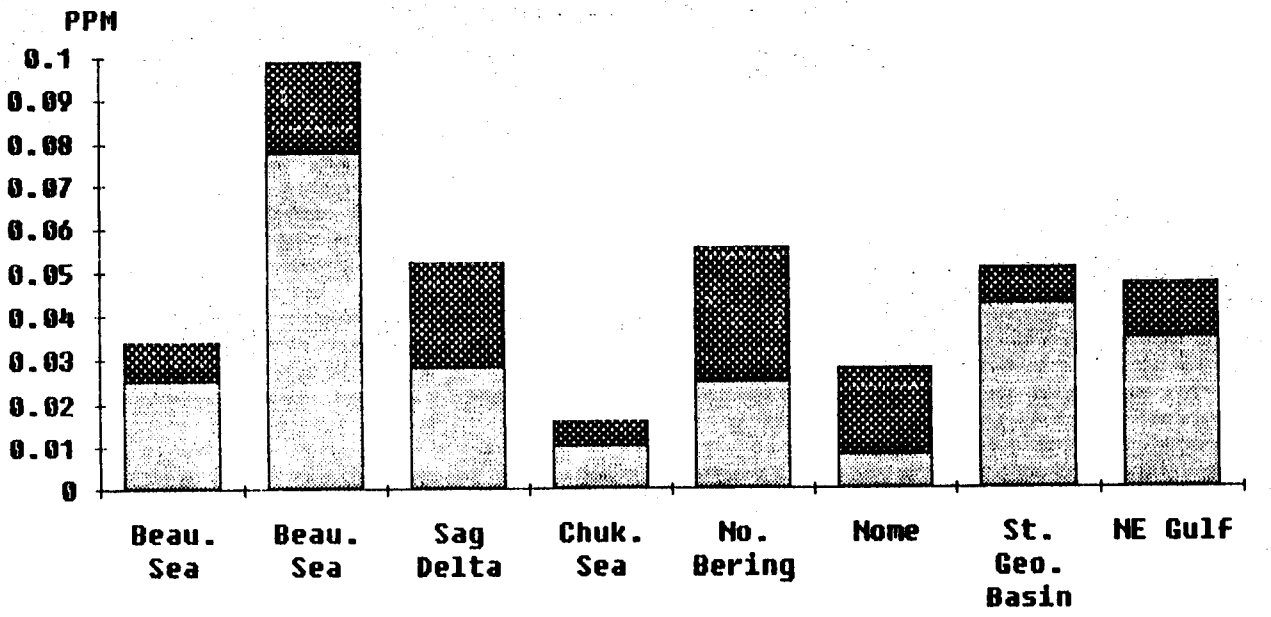

Fig. 2. Confidence intervals (95%) for geometric means of mercury in surface sediments of Alaska shelf areas. Nome and NE Gulf samples are all grain size fractions combined. Other area samples are mud fraction.

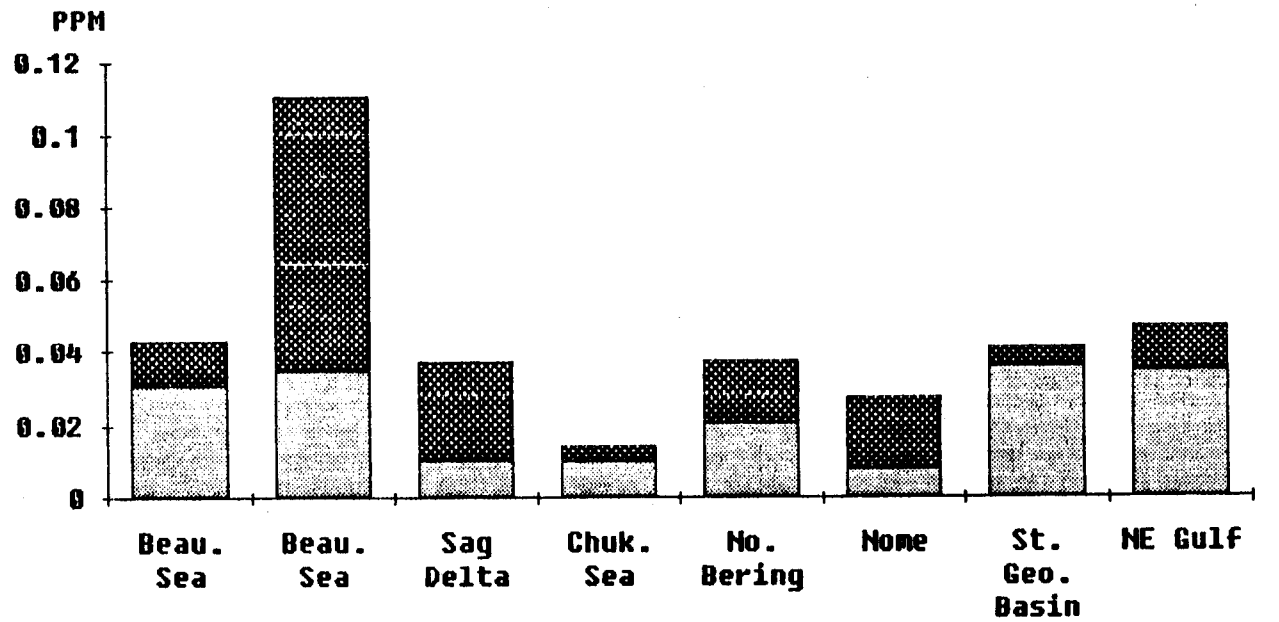

Fig. 3. Confidence intervals (95%) for geometric means of mercury in surface sediments of Alaska shelf areas. Nome and NE Gulf samples are all grain size fractions combined. Other area samples are sand fraction.

Fig. 4. The proportions of total mud-sand samples for mercury in Alaska shelf areas.

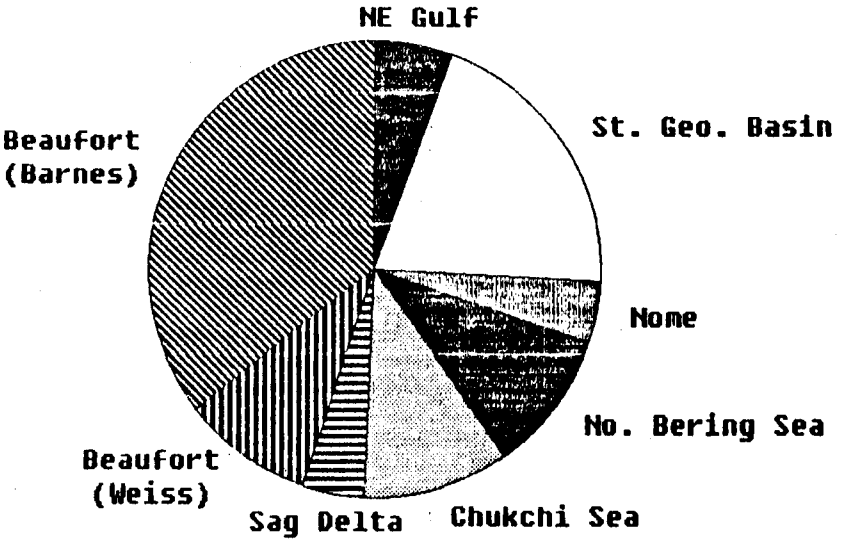

Table 5. Bartlett's test of homogeneity of variances among five studies of mercury concentration in surface mud and sand from the Alaska shelf. Calculations follow Sokal and Rohlf (1969:370). Significant differences in variances are inferred from the test statistics which exceed the critical chi-square of 9.5 for alpha=.05 and df=4.

Individual studies

	Degrees of freedom	SD
Mud:		
Beaufort Sea	118	.83188
Chukchi Sea	18	.51107
No. Bering Sea	16	.81169
St. Geo. Basin	47	.30995
Sag Delta	9	.49149
Sand:		
Beaufort Sea	52	.62918
Chukchi Sea	31	.50898
No. Bering Sea	31	.83122
St. Geo. Basin	51	.26156
Sag Delta	11	.77887

Studies combined

	Degrees of freedom	Weighted avg. var.	Test chi-square	
Mud	208	49.8	52.2	S
Sand	176	34.2	55.0	S

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NATURAL DISTRIBUTION AND ENVIRONMENTAL BACKGROUND OF TRACE HEAVY METALS IN ALASKAN SHELF AND ESTUARINE AREAS

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SUMMARY

Data are presented which help describe the natural distribution and environmental background of trace metals in Alaskan shelf and estuarine areas selected for future offshore oil exploration and recovery. This baseline information will provide a basis for assessing any future environmental perturbations of the trace metal distribution in the Alaskan shelf environment by the oil production operations. The suite of trace metals which have been emphasized in our phase of the overall Outer Continental Shelf Environmental Assessment Program (OCSEAP) are those most amenable to measurement by neutron activation analysis and include V, As, Sb, Zn, Co, Ba, Mn, Fe and Cr. These analyses complement the measurements of other investigators using atomic absorption spectrometry and X-ray fluorescence techniques. In addition to the above elements we have also measured other major and trace elements automatically detected by the instrumental neutron activation methods which we employ. This multielement approach is extremely valuable because much additional information is available to more completely characterize the biogeochemistry and history of the many samples which have been analyzed.

Between June, 1975 and September 1978, we have participated in five separate cruises off the Alaskan shelf to collect sediments, suspended particulate matter and seawater for trace metal analyses. These cruises covered the Bering Sea, the Gulf of Alaska, Cook Inlet and the Shelikof Strait. In addition sediment samples from Norton Sound, the Chukchi Sea and the Beaufort Sea were supplied by Dr. David Burrell of the University of Alaska. Biological samples of shelf and intertidal marine organisms were supplied to us from the April-June, 1976 sampling set by Drs. David Burrell and Howard Feder. During the program field efforts 631 samples

ranging from sediments (300 samples), suspended particulates (109 samples), water (137 samples) and biota (85 samples) were collected from the various study areas. Of this total of 631 samples, analyses were conducted on 451 including 109 suspended particulate samples, 133 sediments samples, 124 water samples, and 85 biota samples. All samples including the remainder of those analyzed have been frozen and retained for archival purposes.

In general, the Alaskan OCS study areas are characterized by trace metal concentrations and distributions in the sediments, suspended particulates, seawater and biota which are quite typical of uncontaminated coastal regions at the mid-latitudes. Considerable variability in trace metal distributions in sediments, suspended matter, seawater and biota is evident. However, these variations fall within the expected range when compared with literature values for other mid-latitude locations.

This baseline data will be of value in assessing any future potential trace metal impacts due to offshore oil recovery. However, based on the data at hand we cannot conceive of any activities related to offshore oil recovery that could significantly alter or provide a detrimental impact upon the trace metal distributions in the lease areas. Any impact from these activities would likely be so small as to be masked by the natural geographical and temporal variations in trace metal distributions in the sediments, suspended matter, water and biota. The trace metal concentrations in the oil itself (with the possible exception of vanadium) are so low compared with the concentrations naturally present in the sediments, suspended particulates, seawater and biota that no foreseeable trace metal contamination could result directly from oil pollution. More probable trace metal impacts, although viewed as non-problems, might result from the

physical disturbances created by the platform construction, drilling operations and dredging that accompany the oil recovery operations. However, natural disturbances or processes such as storms, tidal cycles and river drainage would probably overshadow the small scale and localized perturbations in trace metal distributions which could possibly result from the oil related activities.

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I. INTRODUCTION

The projected recovery of crude oil from the Alaskan continental shelf carries with it the risk of altering this environment by physical perturbations or spillage of crude oil. Such disturbances could result in detrimental impacts on the natural cycling of trace metals in the shelf environment. It is therefore necessary to perform pre-development evaluations of the trace metal distributions and behavior in promising shelf areas so that any future contamination or perturbation may be identified, quantified and assessed.

The primary objective of this study is to determine environmental baseline concentrations of selected trace metals in seawater (both dissolved and suspended fractions), in sediments, and in selected marine "indicator organisms" of the Alaskan Outer Continental Shelf study area.

The research plan that has been formulated was designed to complement the University of Alaska's program under the direction of Dr. David C. Burrell by measuring those trace metals most amenable to neutron activation analysis. Of the total suite of elements measured in the overall program we have concentrated our efforts on the analyses of V, As, Sb, Co, Ba, Mn, Fe, and Cr in sediments, biota and seawater. We do, however, measure additional major and trace metals automatically detected by the instrumental neutron activation analysis methods which we employ, and these measurements are included in this report.

This final report includes results of all analyses performed during our research efforts associated with the Alaskan shelf program including first field efforts in June 1975 through final sampling in September, 1978. Areal coverage extends from the Gulf of Alaska to the Bering Sea, Norton Sound, the Chukchi Sea, and to the Beaufort Sea.

This report contains information detailing the elemental composition of sediments, biota, and within the water column (both soluble and dissolved) for extensive areas of the Alaskan continental shelf. This information is useful since for many of the areas covered herein, previous data concerning elemental composition was scant to nonexistent, and the data reported provides a benchmark against which alterations caused by anthropogenic activities, including petroleum and other mineral extraction, can be measured.

II. SOURCES, METHODS AND RATIONALE OF DATA COLLECTION

A. Sources of Samples

During our participation in the Alaskan OCS program from first field efforts in June, 1975 to final field sampling in September, 1978, sediments, suspended particulate matter, and seawater samples were obtained from the Bering Sea (OSS Discoverer, June, 1975), the Western Gulf of Alaska (OSS Discoverer, October, 1975), the Eastern Gulf of Alaska (OSS Discoverer, November-December, 1975), and Cook Inlet and Shelikof Strait (OSS Discoverer, May, 1978 and August-September, 1978). In addition, samples from cruises in Norton Sound (OSS Discoverer, September, 1976), the Chukchi Sea (OSS Discoverer, September,1976) and the Beaufort Sea (USCGC Glacier, August-September, 1976) were supplied to us by Dr. David Burrell of the University of Alaska Institute of Marine Science.

Biological samples of intertidal organisms were supplied to us from the May-June, 1976 sampling set by Drs. David Burrell and Howard Feder. Benthic biota samples from the South Bering Sea (OSS Miller Freeman, April, 1976) were likewise supplied to us by Drs. Burrell and Feder.

Information regarding geographical station locations, types of samples obtained, and sample disposition are shown in Tables A.1 through A.9 of Appendix A. Regional sampling grids are displayed in Appendix B, Figures B.1 through B.8. During the program field efforts 631 samples ranging from sediments (300 samples), suspended particulates(109 samples), water (137 samples) and biota (85 samples) were collected from the various study areas. Of this total of 631 samples, analyses were conducted on 451 including 109 suspended particulate samples, 133 sediments samples, 124 water samples, and 85 niota samples. All samples including the remainder of analyzed samples, as well as those unanalyzed have been frozen and retained for archival purposes as noted in the Tables A.1 through A.9.

B. Methods of Sample Collection

Water samples were obtained via the stern hydrowinch and rosette aboard the OSS Discoverer using Top Drop® Niskin Bottles during the 1975 field work and Teflon coated Go Flo® Niskin Bottles during 1978 field work. The Niskin Bottles were acid washed prior to use and kept closed until the last possible moment before water sampling to avoid potential contamination from the ships atmosphere. Water samples were filtered through 0.4μ Nuclepore filters using a specially designed all plastic filtration system. During filtration the

10ℓ Niskin bottle was pressurized using N_2 and the water forced through an in-line filter assembly which was attached to the Niskin bottle outlet by a short piece of acid-washed polyethylene tubing. The water sample for analysis was taken after approximately 4-5 liters of water had washed through the filter assembly; in this way potential contamination during filtration was minimized.

The 0.4μ Nuclepore filter was saved for suspended particulate analysis after 10 or more liters of seawater had been filtered. Where possible the filter was further rinsed with an aliquot of distilled deionized water to remove the sea salts and thus facilitate analysis by neutron activation.

Sediment cores were obtained using a HAPS corer of Danish design. Surficial sediment cores of up to 30 cms were obtained with very minimal disturbance of the sediment surface. These cores were then sectioned into 2 cm intervals on shipboard using all plastic tools, the core segments placed into wide mouth 500 ml plastic bottles and frozen for return to the laboratory for subsequent analysis.

Biota samples were placed in plastic bags and kept frozen until analysis.

C. Rationale of Data Collection

Since little or no information existed previous to these field efforts concerning trace metal distributions in the OCS Alaskan shelf study areas, the initial phases of the program were designed to give maximum geographical coverage and thus generate baseline information concerning as wide an area of the Alaskan shelf as possible. Since potential impacts from oil production and transportation were the primary concern and the top of the sediment column would be first likely effected by oil spills, sediment examinations focused upon shallow coring and examination of the upper few centimeters of sediment. Likewise, water sampling was conducted in the nearshore shelf areas. Here the water column is generally well-mixed in most locations excepting estuaries and thus only near-surface and near-bottom water and suspended matter samples were felt necessary. In locations less than 50M only a near-surface sample was taken.

Biological samples focused upon intertidal organisms such as mytilus, while benthic organisms such as Neptunia and crab and the fin fish, rock sole and pollock were analyzed from nearshore waters.

III. ANALYTICAL METHODS

A. Sediments - "Whole Rock" Analyses

Some 300 sediments were collected during the sampling activities. Of these, 133 samples were subjected to neutron activation analysis. Samples were thawed and homogenized, a subsample was then withdrawn and oven dried at 85°C, and the remainder of the original sample refrozen. A wet-to-dry weight ratio was obtained after oven drying and a further subsample taken for neutron activation after the dried sample had been ground in an agate mortar and pestle. The subsample for neutron activation (10-100 mg) was placed into a sealed polyethylene bag and neutron activated along with standard reference materials (NBS Orchard leaf) or well-characterized materials such as USGS standard rocks. Two irradiation intervals and three counting periods were employed for quantitative measurement of short, medium and long-lived activation products via Ge(Li) gamma-ray spectrometry. In this manner the following elements were measured: Al, As, Ba, Ca, Co, Cr, Cs, Eu, Fe, K, La, Mn, Sb, Sc, Ta, Tb, Ti, Th, and V. Although such elements as Al, Ca, Fe, Mn and Sc were not considered to be toxic metals, they do play important roles in various marine geochemical cycles which could potentially be altered by severe oil impaction. These elements are also good indicators of the origin and type of sediment, and their measurement is important in understanding the distribution and geochemistries of the more toxic trace metals of major concern.

Silver concentrations in selected sediment samples were measured by dissolution of the neutron activated sediments by lithium metaborate fusion and then separating the silver by solvent extraction with dithizone. The extracts were counted in an anticoincidence NaI(Tl) well crystal to measure the ^{110m}Ag activity for determining the silver concentrations.

B. Sediments - "Available Fraction" Analyses

In addition to the "whole rock" analyses performed during the earlier baseline survey of the Alaskan shelf, selective leaching experiments were performed to determine the fraction of metals which are presumed to be readily "available" from sediments for biological assimilation. This readily "available" fraction is thought to best represent the part of the total sedimentary repository which might be subject to alteration and/or release due to petroleum related activities.

The methodology settled upon for the determination of "available" metals is that published by Malo, 1977. Briefly, it involves sequential exposure to dilute hydrogen peroxide followed by exposure to 0.3M HCl. Elements investigated by us were V, Mn, Fe, Co, and Sc. Scandium was chosen since it should indicate whether any degradation of mineral matter took place during the weak acid leaching.

C. Suspended Particulate Matter

The suspended particulate matter collected on the Nuclepore filters was analyzed in essentially the same manner as the sediments. The filters were encapsulated in 2/5 dram polyethylene vials and irradiated, along with appropriate standards (NBS Orchard Leaf and USGS Standard Rocks), in the Washington State University Triga reactor. Two irradiation intervals and three counting periods were employed to measure the short, medium and long-lived neutron activation products

D. Seawater

Instrumental neutron activation analysis was employed to measure Zn, Co, Sb, U, Cs, Fe and Rb in selected OCS seawater samples. This was accomplished by evaporating 30 ml of seawater and transferring the salts into 2/5 dram polyethylene irradiation vials. The vials, together with appropriate standards, were neutron irradiated for 16 hours in the Hanford Reactor. Because of the large amounts of ^{24}Na (15 hr) and ^{82}Br (36 hr) which interfere with the measurement of other activation products, the samples were stored for 4 weeks following the irradiation to permit the decay of these interferences. The samples were then counted overnight (1000 minutes) on a Ge(Li) gamma-ray spectrometer.

Vanadium analyses require pre-separation from the seawater matrix to eliminate interferences. This was accomplished as follows: to 100 ml aliquots of seawater in precleaned polystyrene beakers was added 5 mg high purity iron solution and 250 µl of phenol red indicator (0.1 gm per 250 ml of 0.001M NaOH). High purity 1.5M NH_4OH was then added dropwise while stirring until the first permanent color change from yellow to red occurred at a pH of about 7.8 ± 0.3. The $Fe(OH)_3$ precipitates were allowed to settle for about 20 minutes and the precipitates were then centrifuged and washed 3 times with 0.5M ammonium acetate containing 1 g/ℓ of Magnifloc. The precipitates were then transferred to 2/5 dram precleaned polyethylene snap-top vials and were dried slowly under a heat lamp. The vials were then sealed in polyethylene bags and encapsulated in 2-dram polyethylene vials for neutron activation. Vanadium standards (14.2 µg) were prepared by pipetting 10 µl of standard solution onto discs of high purity IPC filter media, drying the discs and encapsulating them in the same manner as the $Fe(OH)_3$ precipitates. The samples and standards were neutron irradiated at

the Washington State University Triga reactor, one at a time, standards interspersed between samples, for 2.0 minutes each. Following the irradiation the samples were allowed to decay for 2.0 minutes and were then counted directly on a Ge(Li) diode detector for 10 minutes to measure the 1434 KeV γ-ray of ^{52}V (3.8 minutes).

The chemical recovery of vanadium for this procedure was 95.6 ± 1.4%, and the precision and accuracy were estimated to be less than 10%. The average procedural blank amounted to 0.11 ± 0.03 μg/ℓ.

Dissolved manganese concentrations in seawater were determined by neutron activation analyses. The manganese was pre-concentrated by solvent extraction of 500 ml of seawater with 8-hydroxy-quinoline. The organic extract was washed with high purity water and back extracted into dilute nitric acid. The acid was evaporated and transferred into 2/5 dram vials and activated with appropriate standards in the WSU Triga reactor for 6 hours. Several hours after the irradiation the samples were counted for 20 minutes on a Ge(Li) gamma-ray spectrometer to measure the ^{56}Mn (2.58 hr) activation product.

E. Biota

The instrumental neutron activation analysis of biological tissue samples consisted of encapsulating a 10-100 mg sample of dried tissue (fresh to dry weight ratios were obtained) in a cleaned plastic irradiation vial, and neutron irradiating the sample and appropriate standards to an integral thermal neutron exposure of about 10^{17} n/cm^2. After the irradiation, the samples and standards were transferred into standard counting geometries and counted on a Ge(Li) detector at optimum times following the irradiation to measure both short- and long-lived neutron activation products. Two to four days out of the reactor the major neutron activation products were ^{24}Na and ^{82}Br, but normally high enough concentrations of ^{42}K and ^{76}As were present for accurate measurements.

After the samples had been out of the reactor for about two weeks, most of the ^{24}Na and much of the ^{82}Br had decayed to tolerable levels, and a new suite of long-lived neutron activation products were instrumentally measured including Rb, Cs, Fe, Zn, Ag, Co, Cr, Hg, Se, Sb and Sc.

Muscle tissue from the rock sole and pollock were dissected from the dorsal muscle midway between the head and tail. The King Crab muscle tissue was removed from the leg joints which were directly adjacent to the body. The soft parts of the Neptunia were removed from the shell and the upper end of the digestive system was used for analysis. The mytilus soft parts were removed from the shell and analyzed whole.

IV. RESULTS AND DISCUSSION

A. "Whole-Rock" Analyses of Sediments

Table C.1 contains Al, Ca, Mn and V concentrations in Bering Sea and Northwest and Northeast Gulf of Alaska surficial sediments. Core segments down to 24 cm were analyzed and showed no systematic variability in trace metal distribution versus depth. Aluminum and calcium are good indicator elements of the sediment types encountered in these study areas.

Vanadium is an element of particular concern from a potential oil pollution aspect because it is contained in crude oils in relatively high concentrations, ranging from a few ppm to as high as 1200 ppm. The vanadium distribution in sediments within each region is normally rather uniform. However, two stations in the western Gulf of Alaska (GASS-105 and GASSW-122) exhibited unusually low vanadium concentrations in the sediments. Table C.2 contains As, Ba, Co, Cr, Fe, Sb, and Sc concentrations for these same locations. Again no systematic variability versus depth is noted, at least down to 24 cm. Because no variability was noted in the upper 20 cm, only surficial segments were analyzed in water samples from Cook Inlet, Shelikof Strait, the Chukchi Sea, Norton Sound, and the Beaufort Sea. Al, Ti, Mn, and V concentrations are shown for 0-2 cm segments in Table C.3 for these areas while Table C.4 caontains Na, K, As, La, and Sm concentrations, and Table C.5 contains Sc, Cr, Fe, Co, Sb, Ba, Cs, Eu, Tb, Ta, and Th concentrations.

Regional average surface sediment concentrations were calculated for the Eastern Bering Sea, the Northwest Gulf of Alaska, the Northeast Gulf of Alaska, Norton Sound, the Chukchi Sea, and the Beaufort Sea and are shown in Table C.6. The regional averages are in some cases based upon only a few samples, numbers ranging from 5 to 15, however certain conclusions can be made from the table. First, there is considerable variability within each region, perhaps best exemplified by calcium concentrations in the Northwest and Northeast Gulf of Alaska, where the standard deviation about the means are 119% and 54%, respectively. This might well be expected for calcium since its primary source to the sediments may be shells and other biological debris.

The Al and Fe variability are often much less than Ca, being on the order of 15-20% of the mean for most locations.

There appear to be differences in regional average concentrations in certain elements. For example, manganese appears to be lower in the Bering Sea, Norton Sound, Chukchi Sea and Beaufort Sea than in the Northwest or Northeast Gulf of Alaska. The Chukchi Sea appears to be lower in Al, Fe, Mn, Co, and Sc

than the other regions. The Beaufort Sea has a much higher regional average arsenic concentration than the other study areas and a somewhat higher iron average concentration.

Correlation matrices were run for the surficial sediments from the Northwestern and Northeastern Gulf of Alaska and the Bering Sea area. These are shown in Tables C.7 through C.9.

Correlations in the Western Gulf appear as expected between Fe and As, Co, Sc, Al, Mn, and V with an inverse Fe, Ca correlation. Calcium correlates negatively with Co, Cr, Fe, Sc, Al, which indicates its source is different, and undoubtely biologically related.

In the Eastern Gulf and Bering Sea,the correlations are not as strongly developed. In the Eastern Gulf, Fe correlates with Co, Cr, and Mn. Al correlates only with Mn, V and negatively with Ca.

In the Bering Sea,Fe correlates with Co, Sc, Mn, and V. Chromium correlates with Ba and negatively with Sc and Mn. Aluminum and calcium do not correlate at the 95% level with any other elements.

Silver concentrations were determined in surficial sediments in Bristol Bay and in the Northwestern and Northeastern Gulf of Alaska, and are shown in Table C.10. Mean values for the three areas were calculated and are also shown in the table. Additionally, the depth distribution of silver was determined in two cores, Bristol Bay Station MB-64 and Eastern Gulf Station 49. The silver concentrations versus depth to 24 cm at MB-64 and to 18 cm at GASSE-49 are shown in Table C.11, and no systemic variability with depth was noted.

The elemental concentrations versus station locations are shown on the geographical grid maps. These are Figures D.1 through D.11 for the Northwest Gulf of Alaska; D.12 through D.22 for the Northeast Gulf; D.23 through D.33 for the Bering Sea; D.34 through D.43 for Cook Inlet and Shelikof Straight; D.44 through D.55 for Norton Sound; D.56 through D.65 for the Chukchi Sea; and D.66 through D.75 for the Beaufort Sea.

B. "Available Metals" in Surficial Sediments

In addition to the "whole rock" analyses performed during the earlier baseline survey of the Alaskan shelf, selective leaching experiments were performed to determine the fraction of metals which are readily "available" from sediments. This readily "available" fraction is thought to best represent that part of the total sedimentary repository which might be subject to biological assimilation or to alteration and/or release of metals due to petroleum related activities.

Elements investigated by us were V, Mn, Fe, Co, and Sc. Scandium was chosen since it should probably indicate whether any degradation of mineral matter took place during the weak acid leaching. Table E.1 shows the peroxide leachable vanadium, weak acid leachable and total available vanadium based upon "whole rock"analysis of a separate sediment split. The fraction leached by the H_2O_2 treatment (supposedly organically bound vanadium) was usually small and ranged from 1.17 to 7.63 µg/g of dry sediments, or about 1 to 6% of the total vanadium present in the sediments. The 0.3M HCl treatment released significantly more vanadium than the H_2O_2, ranging from 7.7 to 28.3 µg/g dry sediment, or about 3 to 24% of the total vanadium present. The combined "available" fraction (H_2O_2 + HCl leachable) ranged from 5 to 29% of the total vanadium in the sediment. No systematic geographical trends in the amounts of "available" vanadium were observed from region to region, but considerable differences in "available" vanadium (by factors of 2 to 3) were often observed within regions. This is not unexpected, however, since sediment types and textures vary considerably within each Alaskan shelf region.

The "available" manganese fractions, determined by the same technique, are presented in Table E.2. The total "available" manganese was much higher than for vanadium, and ranged from 21 to 82% of the total manganese present in the sediments. Usually, less than 1% of the manganese was leached by the H_2O_2 treatment; the 0.3M HCl treatment removed, by far, the majority of the "available" manganese.

"Available" fractions of Fe, Co, and Sc were also determined and are shown in Table E.3. Peroxide exposure released very small fractions of these elements, well less than 1% in all cases, indicating minimal organic association in the sediments. However, differing behaviors are noticeable during the hydrochloric acid leaching. Only 1 to 10% of the scandium was available during hydrochloric acid leaching, in fact ranging from 1.63 to 4.97% in all cases except one where 9% was available. This indicates the weak acid exposure was minimally degrading the silicate minerals as should be the case. The Fe and Co fractions available via hydrochloric acid leaching ranged from 4.5 to 27.4%, and 10.6 to 59.1%, respectively.

The "available" Fe, Co, and Sc in Cook Inlet and Shelikof Strait were relatively uniform averaging 15.4% ± 1.6%, 33.1% ± 2.3% and 3.83% ± 0.79% for the elements, respectively, where the ± is one standard deviation. The variability in the available fraction of Fe, Co, and Sc in the Eastern Gulf, Bristol Bay,

and Western Gulf of Alaska areas was far higher; ranges to as much as approximately a factor of 4 within the study area for Fe, and to a factor of 5 for Sc were observed.

C. Suspended Particulate Matter

The suspended particulate matter in seawater sampled from the OCS study areas is composed of alluvial discharges from rivers, resuspended bottom sediments and planktonic matter or detritus. Thus, the relative trace metal composition of the suspended particulates, as well as the absolute amounts of particulate matter present in the seawater can vary substantially. Table F.1 contains Mn, Al, and V concentrations in µg/ℓ of seawater for samples from the Eastern Gulf, Western Gulf and the Bering Sea. Table F.2 contains concentrations of As, Ba, Co, Cs, Fe, Sb, Hg, Sc, Se, and Zn for these same locations.

Suspended matter concentrations for Cook Inlet sampled in May and August of 1978 and for the Shelikof Strait during 1978 are shown in Table F.3. The trace metal concentrations in suspended particulate matter (µg/ℓ of seawater) in Cook Inlet appeared similar on the two dates except for Station CB-1 where larger differences in Al and Mn concentrations are noted. The samples in Shelikof Strait were taken simultaneously with Dr. Feely during the August cruise in the near-bottom nepheloid layers. Dr. Feely had earlier reported anomalously high Mn concentrations in suspended particulate matter from the Shelikof Strait. We also observed elevated Mn concentrations (as well as Al and V) in suspended matter from these locations. There are noticeable differences in the Mn/Al ratios in the Cook Inlet and Shelikof Strait areas. The Cook Inlet averaged ratio of Al/Mn is 0.024:1 while in Shelikof Strait the ratio is 0.051/1, and at Stations SS-6 and SS-13 in the Shelikof Strait the suspended particulate samples show ratios as high as > 0.80/1.0. Thus it appears that the high Mn anomaly associated with the Shelikof Strait is a real phenomenon.

Suspended particulates were also analyzed at the time series station occupied at CB-10 in Cook Inlet during the August 1978 cruise leg. As shown in Table F.4 , only slight variability during the tidal cycle occurred during the sampling interval from t = 0 hr through t = 48 hr. However, the 1σ statistical error associated with the elemental concentration for most elements is generally greater than the differences observed in concentrations over the 8-hr sampling intervals, indicating the variability may not be statistically valid. It should be pointed out that fault does not lie in the analytical method being imprecise, for the 1σ errors for aluminum, manganese, arsenic, lanthanium, and samarium are 5% or less. Thus, this indicates changes in the suspended particulate

composition are approximately equal to or less than 5% over the sampling, intervals. The variability of the replicate samples at t = 0 hr. indicates that sample inhomogeneity is of similar magnitude to the water mass changes from sampling interval to sampling interval.

Table F.5 shows the type of variability in suspended matter concentrations which are encountered in Alaskan shelf waters. As can be seen variation of nearly two orders of magnitude occur indicating the shelf is a very dynamic and complex system with regard to suspended matter transport. Figure F.1, an Earth reconnaissance photograph of the Eastern Gulf of Alaska, gives further visual evidence of the extremely dynamic suspended matter system. The lightened areas represent fresh water plumes having high suspended sediment loads.

D. Biological Specimens

Intertidal and benthic biota, supplied by the principal investigators in the biological programs, have been analyzed for trace metal content. It was our objective to select "indicator" organisms which are ubiquitous in the shelf study areas and which might serve as early indicators of the impacts of potential oil pollution. To provide this baseline data for trace metals in the shelf biota, collections of the seaweed Fucus, unidentified seaweed samples, the bivalve Mytilus, the snail Neptunia, the finfish rock sole and pollock, and King crab specimens were analyzed for 16 trace elements by neutron activation analysis.

Table G.1 contains the resulting elemental concentrations for rock sole, Neptunia, pollock, crab, fucus, seaweed, and mytilus. Table G.3 shows the average concentrations and variance for some of the more toxic trace metals, including Ag, As, Cr, Hg, Se, and Zn. In general, the trace metal concentrations in the Alaskan shelf biota are very similar to the levels observed in organisms collected from lower latitudes and reflect a typically pristine environment. Several naturally high trace metal accumulation processes by certain animals are noteworthy. High Zn, Ag and As concentrations are found in King crab. Neptunia are remarkable concentrators of several heavy metals including As, Se, Zn, Hg, Fe, Sb, Co and V.

Because of their ubiquitous distribution throughout the Alaskan shelf, Mytilus are probably best suited as "indicator" organisms. Also, the fact that they are filter-feeders and would concentrate oil and other contaminants sorbed onto suspended particulate matter make them especially useful for this purpose. Fortunately, the variability in the trace metal concentrations in

Mytilus sampled over diverse areas does not appear to be too large to obviate their usefulness in establishing baseline values for assessing future potential perturbations. The variability of the truly assimilated trace metals, such as As, Hg, Se and Zn is indeed quite small. The large variability in the other elements appears to be due to the adsorption of suspended sediment particles on the Mytilus. This is easy to recognize because of the relatively high concentrations of trace elements which are rarely associated with biological tissues, such as Sc and Cr. This mineral contribution from sorbed sediment particles can be subtracted out of the truly biologically assimilated fraction, thus giving a more constant set of baseline data.

Vanadium concentrations were also determined by a chemical separation followed by neutron activation and are shown in Table G.2. The data are reported in nanograms per gram. The Pollock, Rock Sole and crab muscle tissue are less than 100 ng/g (0.1 ppm). However the Fucus, Mytilus and Neptunia are significantly higher. The Fucus ranging from 318 to 945 ng/g (0.3 to 0.8 ppm) and the Mytilus from 389 to 783 ng/g (0.39 to 0.78 ppm). The Neptunia are even higher; 2500 to 2700 ng/g or 2.5 to 2.7 ppm.

E. Dissolved Trace Elements in Seawater

The dissolved, or non-filterable fraction, of the following trace metals in Alaskan coastal waters have been determined by neutron activation analysis: V, Mn, Zn, Fe, Co, Sb, U, Cs, and Rb. With the possible exception of V, it is not anticipated that oil spills will directly alter the dissolved trace element concentrations in coastal waters. However, serious chronic or episodic releases of oil to coastal waters could possibly alter the chemical environment of the sediments by creating more reducing conditions at the sediment interface. Reducing sediments can release a number of dissolved trace elements to the water column causing significantly elevated concentrations.

Vanadium has been an element of focus in marine waters since there exists some slight potential for perturbation due to oil development. Therefore, dissolved vanadium concentrations were determined as a part of our baseline efforts. Table H.1 shows that the vanadium concentrations throughout the Alaskan shelf waters are quite uniform. Even in waters containing relatively large amounts of suspended matter, the filtered seawater does not show significantly elevated

concentrations of dissolved vanadium. Table H.4 shows that the Bering Sea and the Eastern and Western Gulf of Alaska average for vanadium concentrations are not significantly different, nor are surface water concentrations significantly different from these in bottom waters. An overall water column average for Alaskan shelf waters appears to be 1.42 $\pm$ 0.15 µg/ℓ. Vanadium concentrations in Cook Inlet appear to vary seasonally, being somewhat higher in spring, and lower during the high runoff period in August. This, coupled with the generally higher values observed in the Shelikof Strait in August, and the higher overall shelf average indicate that the riverine concentration of vanadium entering Cook Inlet may be lower than general shelf concentrations in Alaskan waters.

The natural conservative nature and uniform distribution of dissolved vanadium in Alaskan shelf waters should permit a rather sensitive assessment of vanadium contamination of seawater by large oil spills. A 1 µg/ℓ increase in dissolved vanadium concentration would be highly significant, and would only require the release of the vanadium contained in 0.1 ml of crude oil (assuming a vanadium concentration of 10 ppm in crude oil) to one liter of seawater to accomplish this increase.

Dissolved manganese concentrations were also determined in Cook Inlet and Shelikof Strait and are shown in Table H.3. Unlike vanadium, the dissolved manganese concentrations are elevated in waters with relatively high concentrations of suspended sediments. The manganese concentrations in these shelf waters are about 10 to 100-fold higher than in open ocean waters. Dissolved manganese in Cook Inlet waters is shown to be higher during the peak runoff period of August compared with earlier spring samples collected in May, 1978. The samples taken at depths in Shelikof Strait show extremely elevated dissolved Mn below a depth of 200 meters. This area has been shown to have anomalously high manganese concentrations associated with the particulate matter. Possible sources of the manganese could be releases from reducing sediments or effluents from hydrothermal vents.

The concentrations of Zn, Fe, Co, Sb, U, Rb and Cs in the shelf waters of the Eastern, Western and Southwestern Gulf of Alaska are presented in Table H.5. These data indicate baseline trace element levels in Alaskan shelf waters are similar to concentrations observed in coastal waters at lower latitudes. The concentrations of the conservative elements Sb, U, Rb and Cs are very uniform in the Alaskan coastal waters. However, the dissolved Zn, Fe and Co concentrations

are highly dependent upon the levels of suspended particulate matter in the water column, and are about tenfold higher than observed in open ocean waters.

No systematic geographical or vertical gradients for the dissolved Zn, Fe and Co were observed in the Alaskan coastal waters. The large variations are undoubtedly due to the relative quantities of suspended matter in the water and the degree of fresh water input (river drainage).

A major discrepancy in Zn and Fe concentrations at Station 121 in the Southwest Gulf of Alaska was observed. Surface seawater collected in polyethylene bottles from a Zodiac rubber raft contained significantly lower Zn and Fe concentrations compared to seawater collected approximately 10 meters below the surface in Niskin bottles. It is not certain that this is due to a real difference in the small-scale vertical distribution of these elements or if the Niskin bottles resulted in contamination of the water.

V. CONCLUSIONS

With the completion of the analysis of all sediment, water and biota samples from the major study areas, a more comprehensive picture of the ambient trace metal concentrations and distributions in the Alaskan coastal environment has been achieved. As expected, the trace metal distributions in the shelf environment are quite typical of mid-latitude regions. Considerable variability in trace metal distributions in sediments, suspended matter, water and biota is evident. However, these variations fall within the expected range when compared with literature values for other mid-latitude locations. These baseline data will be of great value in assessing any future potential impacts from offshore oil recovery. However, based on the data at hand we cannot conceive of any activities related to offshore oil production that could significantly alter or provide a detrimental impact upon the trace metal distributions in the lease areas. Any impact from these activities would likely be so small as to be masked by the natural geographical and temporal variations in trace metal distributions in the sediments, suspended matter, water and biota.

The following conclusions have been reached regarding the natural distributions and ambient background concentrations of trace metals in sediments, suspended matter, seawater and biota of the Alaskan shelf environment.

Sediments

- The geographical distributions of major and trace elements in surface sediments from the Bering Sea, Western GOA, Eastern GOA, Norton Sound, the Chukchi Sea and the Beaufort Sea show significant regional variability. In going from the Bering Sea → to the Western GOA → to the Eastern GOA, the regional average concentrations of Fe, Mn, V, Cr, Co and Sc increase by nearly 2-fold. The Norton Sound and Beaufort Sea sediments were characterized by intermediate trace metal contents, whereas the sediments of the Chukchi Sea normally had relatively low trace metal concentrations except as noted below.

- Several anomalies were observed such as the relatively high Ba concentrations in Bering Sea Stations MB-59 and MB-64. Relatively high As concentrations were observed at several stations in each region, and the Beaufort Sea, Chukchi Sea and Norton Sound sediments consistently contained 3 to 8 times higher As concentrations compared to the Bering Sea and the Western and Eastern GOA. High Cr concentrations were observed in the Chukchi Sea sediments. Shelikof Strait sediments contained high Mn concentrations.

- No systematic concentration gradients of major and trace elements between near-shore and deep water stations were observed. However, large variations in elemental concentrations occurred in patchy distributions within each region. This was particularly true for Ca. When highly calcareous sediments were encountered, such as at Sta. 122 in the Western GOA, most of the other elemental concentrations were very low. This can be seen by the high negative correlation coefficients between Ca and most other elements.

- No <u>systematic</u> vertical variations in elemental concentrations were observed in HAPS sediment cores. Although significant variability with depth was noted for all of the elements, it appeared to be of a random nature.

- "Available" metal concentrations, as determined by a sequential leaching technique, indicated the following order of availability or leachability: Mn > Co > V > Fe > Sc. "Available" Mn, Co, V, Fe and Sc ranged from 21-82%, 11-59%, 5-29%, 5-27% and 1-10%, respectively, of their "total" concentration in the sediments. The low Sc leachability

indicated that the crystalline structure of the sediments were not appreciably being attacked by the leachates. The H_2O_2 leaching removed very little (usually less than 1%) of the trace metals from the sediments, indicating little organically-bound metals associated with the sediments. The fraction leached by the 0.3M HCl is considered to be composed primarily of hydrous metal oxides.

Suspended Particulate Matter

- Suspended particulate trace metal concentrations in surface seawater from the Bering Sea, Western GOA and Eastern GOA generally show increasing concentrations in near-shore versus deep waters. The concentrations of these elements are usually much higher in near-bottom waters compared to surface waters, but significant, systematic exceptions have been noted. At Stations 44, 49, 50 and 59A in the Eastern GOA the particulate trace metal concentrations in surface waters are much higher than in near-bottom waters, indicating a surface plume of relatively high suspended sediment load or intense plankton blooms.

- Ranges in particulate trace metal concentrations in the Alaskan shelf waters are extremely variable and indicate a very dynamic shelf environment that reflects both fluvial input and transport of terrigenous materials, storm resuspension of sediments and biological processes. This extreme variability from station to station does not allow for meaningful comparison from one lease area to another.

- Elemental ratios in the particulate matter are very similar to those observed in surface sediments, especially in near-bottom samples where the ratios of Fe/Al and Fe/Mn appear identical for both suspended particulates and sediments. A notable exception are the Al/Mn ratios in the Shelikof Strait stations, which show substantial enrichments of Mn. It is likely that the excess Mn is derived from reducing sediments or submarine hydrothermal activity in this region.

- Trace metal concentrations in suspended particulate matter collected at a time series station in Cook Inlet to determine short-term temporal variations over tidal cycles showed very small fluctuations.

Dissolved Trace Metals

- Concentrations of dissolved V, Sb, U, Cs and Rb in Alaskan coastal waters appear to be very uniform and characteristic of open ocean waters. Their concentrations are essentially independent of the amount of suspended particulate matter in the water.

• Vanadium is a trace metal of special interest in this study because of its potential toxicity and its relatively high abundance in crude oil. The soluble vanadium concentrations in the Bering Sea, Western GOA and Eastern GOA appear to be very homogeneous. The average concentration for surface and near-bottom waters was 1.42 $\pm$ 0.15 µg/ℓ, and the total range in concentrations was from 1.0 to 1.7 µg/ℓ. The high concentrations of vanadium in suspended particulate matter in some of these waters had no effect or correlation with the soluble vanadium levels. The particulate vanadium concentrations ranged from 0.007 to 0.77 µg/ℓ but averaged about 0.05 µg/ℓ or approximately 3% of the total vanadium.

• The geographical and vertical distribution of Mn, Zn, Co and Fe in shelf waters is highly variable and greatly influenced by the amount of suspended matter. No systematic geographical or vertical concentration gradients were observed.

• Extremely high concentrations of dissolved Mn was observed in bottom waters at several stations in the Shelikof Strait. These elevated concentrations could be the result of either submarine hydrothermal venting or dissolution from reducing sediments. The former explanation appears most likely since: 1) high dissolved manganese concentrations are associated with hydrothermal effluents; 2) ferromanganese coatings containing up to 12% Mn were observed in rocks dredged from these areas; and 3) this area is highly volcanic and near recently erupted volcanoes.

Biota

• The trace element concentrations in Alaskan shelf biota are very typical of the ranges observed in similar species of mid-latitudes. No systematic regional variations for these metal contents of the organisms was observed. Thus, the baseline data generated here will be very useful for assessing any potential environmental impacts from any natural or manmade disturbances of the shelf areas.

• Because of their ubiquitous distribution and their inter-tidal habitat, which is an important repository of oil residues and other pollutants from oil impacted waters, and because of their filter feeding, the Mytilus are probably the best indicator organisms for the lease areas. The trace metal concentrations in the Mytilus from various locations show

a rather good standard deviation around the average. This indicates that Mytilus can be used as an effective indicator organism. Several metals, notably chromium, showed a somewhat large standard deviation from the average concentration. However, by examining the concentrations of geochemical indicator elements, such as Sc and Fe, it is obvious that the Mytilus from Boswell Bay, Cape Pasashak, Port Dick and Katalla contained appreciable amounts of mineral matter (probably suspended sediments). This sediment contribution seriously contaminates the Mytilus with such metals as Cr, Sb and Co, but when the sediment contribution is assessed the standard deviation associated with the average concentration of these metals becomes much smaller.

- The mercury concentrations are the most intercomparable with other areas of the world because of the large amount of baseline data now available for this toxic heavy metal. The mercury concentrations in the Alaskan biota studied here are very typical of those found in any uncontaminated shelf areas of the world. None of the edible animals exhibited mercury concentrations which exceed the 0.5 ppm FDA limit, although the internal organs of the snail, Neptunia, contained mercury levels as high as 3.9 ppm.

- Several interesting distributions of trace metals in the biota were observed. Arsenic concentrations are relatively high in King crab muscle tissue and in the internal organs of the Neptunia. Extremely high concentrations of zinc (up to 0.79% in dry tissue) were observed in the internal organs of the Neptunia. However, this ability to highly concentrate zinc is well known and not unusual for these animals.

- Vanadium concentrations of selected Alaskan shelf biological materials ranged from several tens of ng/g for rock sole, pollock and Alaskan King crab. Intertidal organisms, Fucus and Mytilus, showed considerably higher vanadium levels. These ranged from approximately 0.3 to 0.8 μg/g dry weight for Fucus and Mytilus. Neptunia (internal organs) showed much higher levels than either finfish or intertidal Fucus and Mytilus. The samples analyzed indicated levels of 2.5 μg/g dry weight.

APPENDIX A

Sample Inventory and Disposition

TABLE A.1

SEDIMENT AND WATER SAMPLING STATIONS
WESTERN GULF OF ALASKA - OSS DISCOVERER - OCTOBER 16, 1975

				WATER			PARTICULATE			SEDIMENT		
STATION	LATITUDE	LONGITUDE	DEPTH, m	COLLECTED	ANALYZED	ARCHIVED	COLLECTED	ANALYZED	ARCHIVED	COLLECTED	ANALYZED	ARCHIVED
GASW-156	54°29.2'	160°09.4'	160	2	2	2	2	2	2			
GASW-157	54°17'	164°58.8'	67	2	2	2	2	2	2			
GASW-158	54°04.5'	164°45.2'	101	2	2	2	2	2	2			
GASW-159	53°51.9'	164°34'	100	2	2	2	2	2	2			
GASW-160	53°43.3'	164°25.6'	143	2	2	2	2	2	2			
GASW-145	55°03.1'	161°24.4'	71	2	2	2	2	2	2			
GASW-146	54°49.4'	161°12.5'	73	2	2	2	2	2	2			
GASW-147	54°36.2'	161°00.7'	104	2	1	2	2	2	2			
GASW-148	54°23.5'	160°49.1'	110	2	2	2	2	2	2			
GASW-137	54°54.3'	157°59'	99	2	2	2	2	2	2			
GASW-135	55°20.3'	158°25.1'	150	2	2	2	2	2	2	5	3	5
GASW-134	55°33.4'	158°38.3'	154							9	5	9
GASW-133	55°46.3'	158°51'	73	2	2	2	2	2	2	1	1	1
GASW-124	56°07.1'	154°39.4'	112	2	2	2	2	2	2	5	3	5
GASW-122	56°31.3'	155°12'	45	2	1	2	2	2	2	2	2	2
GASW-121	56°43.2'	155°27.9'	230	2	2	2	2	2	2	6	3	6
GASW-120	56°55'	155°44.1'	290	2	2	2	2	2	2	10	4	10
GASW-119	57°06.9'	156°00'	207	2	2	2	2	2	2	6	3	6
GASW-110	59°19.8'	152°24.1'	89	2	2	2	2	2	2			
GASW-102	59°09.9'	152°04.1'	108	2	1	2	2	2	2			
GASW-103	59°00'	151°45.1'	135	2	2	2	2	2	2			
GASW-104	58°50'	151°26.4'	106	2	2	2	2	2	2	5	3	5
GASW-105	58°59'	152°51.6'	168							2	2	2

TABLE A.2

SEDIMENT AND WATER SAMPLING STATIONS
EASTERN GULF OF ALASKA - OSS DISCOVERER - NOVEMBER 24-DECEMBER 2, 1975

					WATER		PARTICULATE			SEDIMENT		
STATION	LATITUDE	LONGITUDE	DEPTH, m	COLLECTED	ANALYZED	ARCHIVED	COLLECTED	ANALYZED	ARCHIVED	COLLECTED	ANALYZED	ARCHIVED
EGA-29	59°34.6'	140°06'	76	1	1	1	1	1	1			
EGA-26	59°10.8'	140°38.9'	146	2	2	2	2	2	2	7	4	7
EGA-24	58°54.3'	141°00.5'	420	2	2	2	2	2	2			
EGA-33	59°17.5'	141°54.8	215	2	2	2	2	2	2	6	3	6
EGA-30	59°44.1'	141°27.9'	52	1	1	1	1	1	1	1	1	1
EGA-44	59°35'	143°54.2'	175	2	2	2	2	2	2	4	2	4
EGA-15	58°18.1'	145°00.5'	3700	2	2	2	2	2	2			
EGA-48	59°27.5'	145°11.5'	457	2	2	2	2	2	2	6	3	6
EGA-49	59°37.5'	145°10'	131	2	2	2	2	2	2	9	5	9
EGA-50	59°47.7'	145°09'	177	2	2	2	2	2	2	11	5	11
EGA-51	59°57.6'	145°07.8'	143	2	1	2	2	2	2	3	2	3
EGA-52	60°07.6'	145°06.5'	84	1	1	1	1	1	1	9	5	9
EGA-59A	59°17.1'	146°14'	381	2	1	2	2	2	2	1	1	1
EGA-58	59°36.2'	146°25.5'	92	1	1	1	1	1	1	5	3	5
EGA-57	59°45.6'	146°31'	77	1	1	1	1	1	1	3	2	3
EGA-56	59°55.2'	146°36.8'	68	1	1	1	1	1	1	4	4	4
EGA-55	60°04.5'	146°42.6'	120	2	2	2	2	2	2	8		8
EGA-54	60°13.9'	146°48.6'	212	2	2	2	2	2	2	7		7
EGA-53	60°23'	146°54'	294	2	2	2	2	2	2	5		5
EGA-11	58°23.2'	148°04.8'	1385	2	1	2	2	2	2			
EGA-110	57°55.8'	149°143.4'	183	2	1	2	2	2	2			
EGA-108	58°09.1'	150°09.1'	236	2	2	2	2	2	2			
EGA-106	58°28.1'	150°47.4'	91	1	1	1	1	1	1			
EGA-8	58°49.7'	148°30'	284	2	2	2	2	2	2	11		11
EGA-5	59°16'	148°56'	172	2	2	2	2	2	2	8	2	8
EGA-2	59°41.5'	149°22'	188	2	2	2	2	2	2	10	5	10

TABLE A.3

SEDIMENT AND WATER SAMPLING STATIONS
COOK INLET AND SHELIKOF STRAIT - MAY 4 - MAY 11, 1978
- AUGUST 25 - SEPTEMBER 5, 1978

	WATER			SEDIMENT		
STATION	COLLECTED	ANALYZED	ARCHIVED	COLLECTED	ANALYZED	ARCHIVED
CB-1	2	2	2	2	1	2
CB-2	1	1	1	1		1
CB-3	1	1	1	2	1	2
CB-4	2	2	2	1		1
CB-5	2	2	2	1		1
CB-6	2	2	2	1	1	1
CB-7	2	2	2	2	1	2
CB-8	2	2	2	2	1	2
CB-9	1	1	1			
CB-10	1		1			
SS-1				1		1
SS-2	1		1	1	1	1
SS-3						
SS-4	1		1	1	1	1
SS-5				1	1	1
SS-6	1		1	1		1
SS-7						
SS-8				1	1	1
SS-9						
SS-10				1	1	1
SS-11	1		1	1		1
SS-12						
SS-13	1		1	1		1

TABLE A.4

SEDIMENT AND WATER SAMPLING STATIONS
BERING SEA - OSS DISCOVERER - JUNE 2-19, 1975

				WATER			PARTICULATE			SEDIMENT		
STATION	LATITUDE	LONGITUDE	DEPTH, m	COLLECTED	ANALYZED	ARCHIVED	COLLECTED	ANALYZED	ARCHIVED	COLLECTED	ANALYZED	ARCHIVED
MB 53	56°29'	171°38'	139	2	2	2	2	2	2			
MB 48	56°19'	169°42'	155	2	2	2	2	2	2			
MB 34	55°53'	168°45'	255	2	2	2	2	2	2			
MB 14	54°39'	165°25'	162	2	2	2	2	2	2			
MB 02	55°51'	162°17'	45	2	2	2	2	2	2			
MB 08	58°17'	159°32'	24	2	2	2	2	2	2	7	4	7
MB 12	56°09'	162°56'	83							1	1	1
MB 19	56°40'	163°57'	77	1	1	1	1	1	1	2	1	2
MB 24	58°46'	162°29'	48	1	1	1	1	1	1	1	1	1
MB 28	57°10'	165°04'	69							1	1	1
MB 41	58°47'	164°15'	33	1	1	1	1	1	1	2	1	2
MB 43	58°42'	166°17'	38	1	1	1	1	1	1	4	2	4
MB 59	59°12'	167°18'	38	1	1	1	1	1	1	3	2	3
MB 64	58°01'	171°07'	85	1	1	1	1	1	1	10	6	10
MB 56	58°06'	169°05'	71	1	1	1	1	1	1	7	4	7
MB 37	57°06'	167°01'	75	1	1	1	1	1	1	5	3	5
MB 30	55°59'	166°53'	134	1	1	1	1	1	1	13	3	13
MB 17	55°29'	165°50'	121	1	1	1	1	1	1	9		9

TABLE A.5

SEDIMENT AND WATER SAMPLING STATIONS
BERING SEA - NORTON SOUND - OSS DISCOVERER - SEPTEMBER 8-24, 1976

	WATER		SEDIMENT		
STATION	COLLECTED	ARCHIVED	COLLECTED	ANALYZED	ARCHIVED
N-1			1	1	1
N-4			1		1
N-5	1	1	1	1	1
N-6			1		1
N-9			1	1	1
N-12D			1		1
N-13			1		1
N-15			1	1	1
N-17	1	1	1		1
N-20	1	1	1	1	1
N-21			1		1
N-23			1		1
N-25	1	1	1		1
N-26			1	1	1
N-28A			1		1

TABLE A.6

SEDIMENT AND WATER SAMPLING STATIONS
CHUCKCHI SEA - OSS DISCOVERER - SEPTEMBER 8-24, 1976

	WATER		SEDIMENT		
STATION	COLLECTED	ARCHIVED	COLLECTED	ANALYZED	ARCHIVED
C-3-S76			1	1	1
C-5-S76	1	1	1		1
C-6-S76			1		1
C-7-S76			1	1	1
C-7A-S76			1		1
C-9-S76			1		1
C-10-S76			1	1	1
C-12-S76			1		1
C-13-S76	1	1	1		1
C-14-S76			1	1	1
C-15-S76	1	1	1		1
C-16-S76			1		1
C-19-S76			1		1
C-20-S76			1	1	1
C-22-S76			1		1
C-23-S76			1	1	1
C-24-S76			1		1
C-25-S76			1	1	1
C-29-S76			1		1

TABLE A.7

SEDIMENT SAMPLING STATIONS
BEAUFORT SEA - USCGC GLACIER - AUGUST 7-SEPTEMBER 4, 1976

STATION	LATITUDE	LONGITUDE	DEPTH, m	SED	COLLECTED	ANALYZED	ARCHIVED
B-1	71°11'	153°09'	25	1	1	1	1
B-3	70°36'	148°12'	16	1	1	1	1
B-4	70°32'	147°33'	25	1	1		1
B-5	70°39'	147°37'	25	1	1		1
B-6	70°57'	149°33'	30	1	1		1
B-7	71°08'	151°19'	34	1	1	1	1
B-8	71°43'	151°47'	1700	1	1	1	1
B-9	71°22'	152°20'	75	1	1		1
B-10	71°19'	152°32'	52	1	1		1
B-11	71°08'	152°57'	22	1	1		1
B-12	71°23'	154°21'	30	1	1	1	1

TABLE A.8

BIOLOGICAL SAMPLING STATIONS FOR INTERTIDAL ORGANISMS
ALASKA OCS STUDY AREA - MAY-JUNE, 1976

LOCATION	ORGANISM								
	FUCUS			SEAWEED			MYTILUS		
	COLLECTED	ANALYZED	ARCHIVED	COLLECTED	ANALYZED	ARCHIVED	COLLECTED	ANALYZED	ARCHIVED
CAPE NUKSHAK	1	1	1	1	1	1	2	2	2
PORT DICK	1	1	1	1	1	1	1	1	1
SUNDSTROM ISLAND	1	1	1	1	1	1	2	2	2
LaTOUCHE	1	1	1	2	2	2			
UNIMACK ISLAND - CAPE LUPIN	1	1	1						
McLEOD HARBOR	1	1	1						
OTTER ISLAND	1	1	1				1	1	1
ANCHOR COVE	1	1	1	1	1	1			
UNALASKA ISLAND - EIDER POINT	1	1	1						
KAYAK ISLAND				1	1	1			
ZALKOF BAY	1	1	1						
SAINTS BAY	2	2	2				1	1	1
LaCOON POINT	1	1	1				1	1	1
CAPE PASSASHAK	1	1	1				1	1	1
UNIMACK ISLAND - SONNETT POINT	1	1	1						
KATALLA				1	1	1	1	1	1
CAPE HUPIT							1	1	1
SPECTACLE ISLAND				1	1	1			
MAKUSHIM BAY				1	1	1	1	1	1
PORT ETCHES							1	1	1
BOSWELL BAY							1	1	1
DAY HARBOR							1	1	1
SENNETT POINT							1	1	1
EIDER POINT							1	1	1
LaTOUCHE POINT							1	1	1

TABLE A.9

BIOLOGICAL SAMPLING STATIONS FOR BENTHIC ORGANISMS
SOUTH BERING SEA - OSS MILLER FREEMAN - APRIL, 1976

				ROCK SOLE			NEPTUNIA			POLLOCK			CRAB			CRAB LEG		
STATION	LATITUDE	LONGITUDE	DEPTH, m	COLLECTED	ANALYZED	ARCHIVED	COLLECTED	ANALYZED	ARCHIVED	COLLECTED	ANALYZED	ARCHIVED	COLLECTED	ANALYZED	ARCHIVED	COLLECTED	ANALYZED	ARCHIVED
3	54°47.3'	165°18.3'	161.9										1	1	1			
5	54°43.6'	165°17.2'	167.9	1	1	1				2	2	2						
7	54°40.4'	165°42'	409.5							1	1	1						
18	55°09.8'	163°44.1'	83.1										1	1	1			
25	54°50.4'	166°35.8'	183.8							1	1	1	1	1	1			
27	55°00'	166°15.2'	112.8	1	1	1	1	1	1				1	1	1			
29	55°09.3'	166°02'	134.6				1	1	1	1	1	1				1	1	1
30	55°20.1'	165°42.5'	104.6	1	1	1	1	1	1	1	1	1	1	1	1			
31	55°32.1'	165°26'	114.3							1	1	1	1	1	1			
32	55°41'	165°09.8'	119.9	1	1	1				1	1	1	1	1	1			
38	56°10.7'	166°08.6'	111				1	1	1									
39	56°01.6'	166°19.2'	124.2	1	1	1				1	1	1				1	1	1
48	55°18.3'	167°28.9'	151							1	1	1				1	1	1
49	55°15.4'	167°37.7'	178.3	1	1	1				1	1	1				1	1	1
56	55°35.7'	168°29.1'	167.4	1	1	1				1	1	1						
57	55°31.2'	168°21.2'	249.3	1	1	1				1	1	1						
58	55°31.2'	168°26'	338.5							1	1	1						
60	55°31.2'	168°17.6'	196.7	1	1	1												
64	55°48.2'	168°24.8'	143.7							1	1	1				1	1	1
80	54°59.8'	165°08.9'	116.4				2	2	2									

APPENDIX B

Sample Grids Utilized During Alaskan Shelf Studies

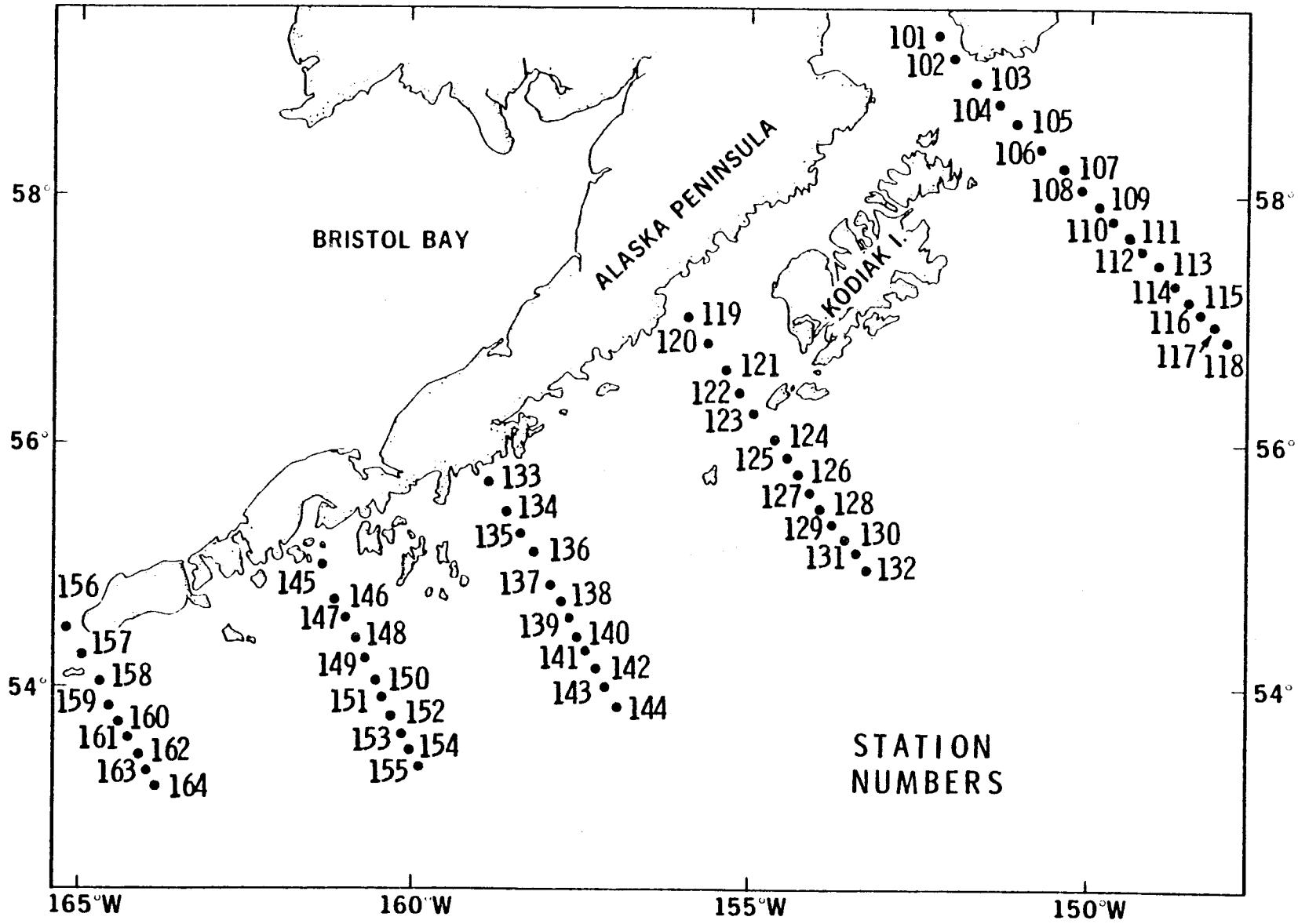


FIGURE B.1 Sampling Locations in the NW Gulf of Alaska

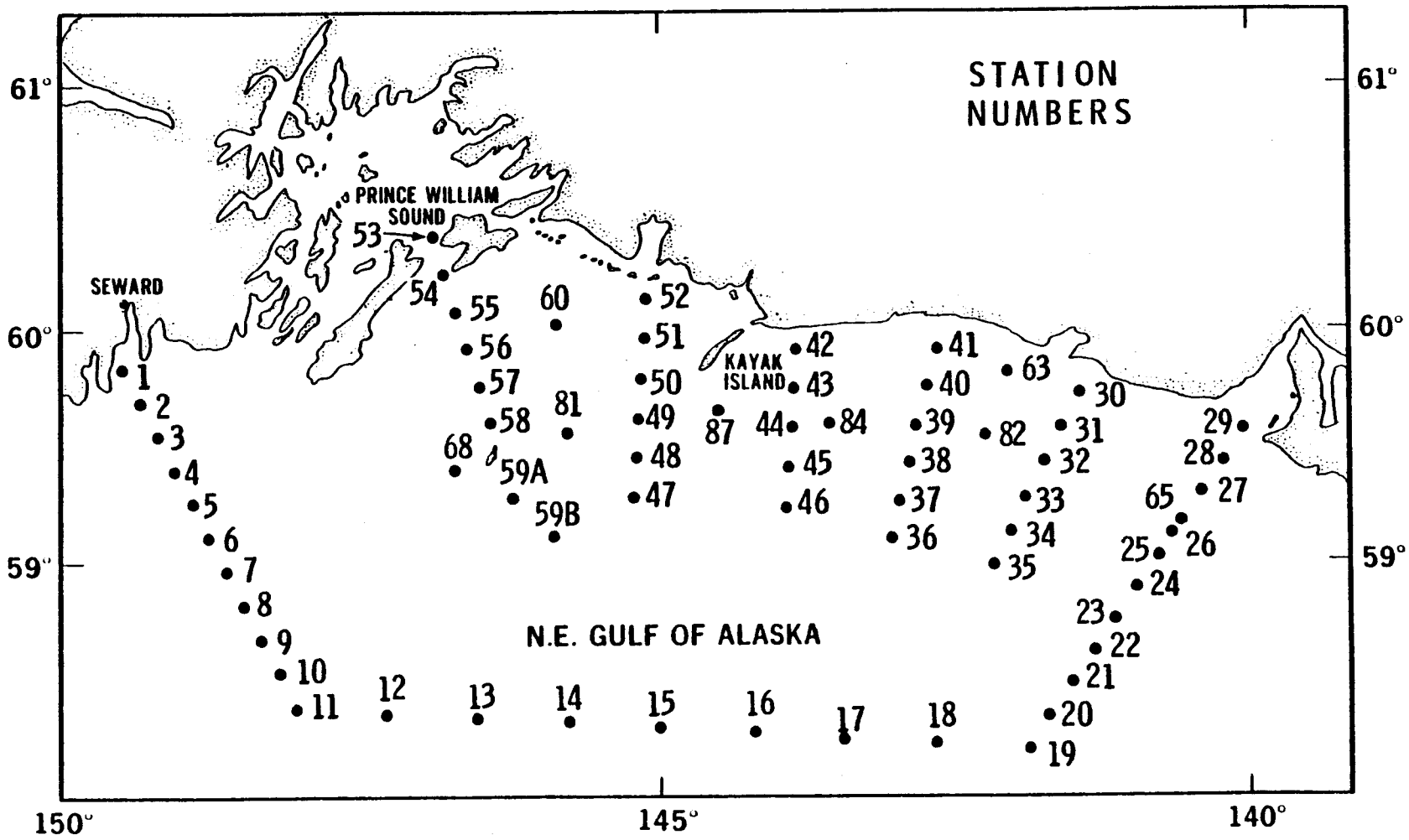


FIGURE B.2 Sampling Stations in the NE Gulf of Alaska

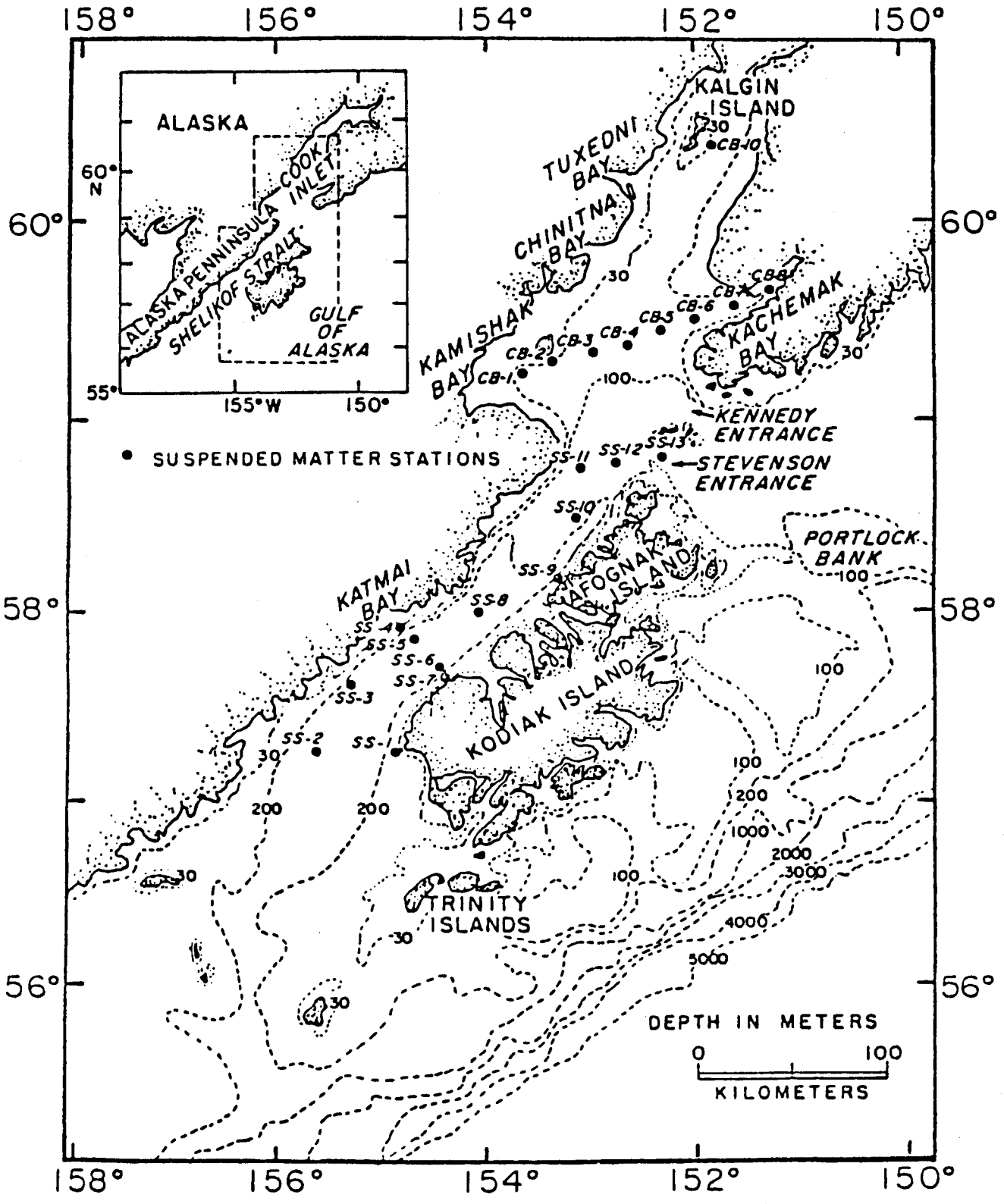


FIGURE B.3 Sampling Stations in Cook Inlet and Shelikof Strait Discoverer, August 1978

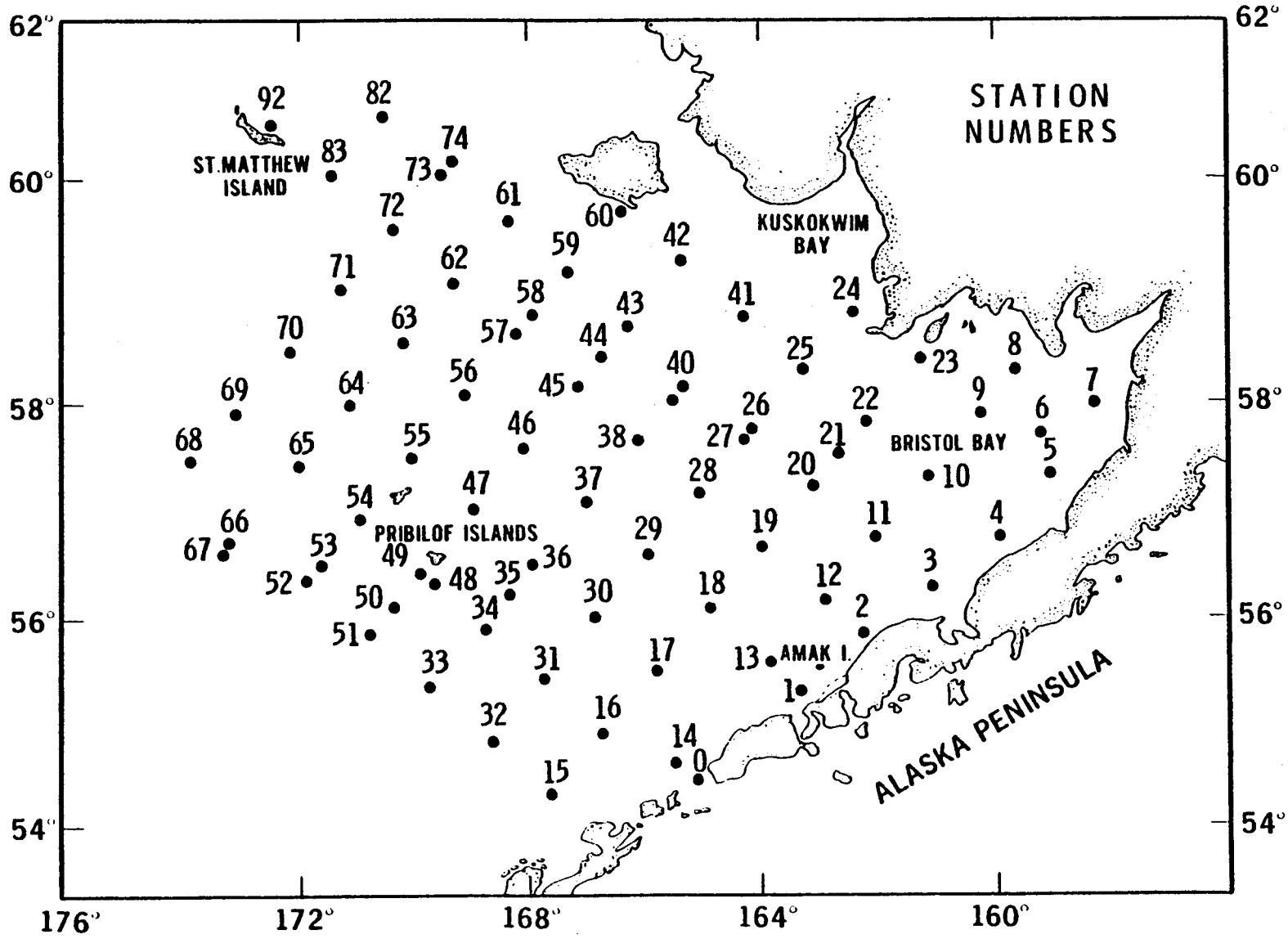


FIGURE B.4 Sampling Locations in the Bering Sea

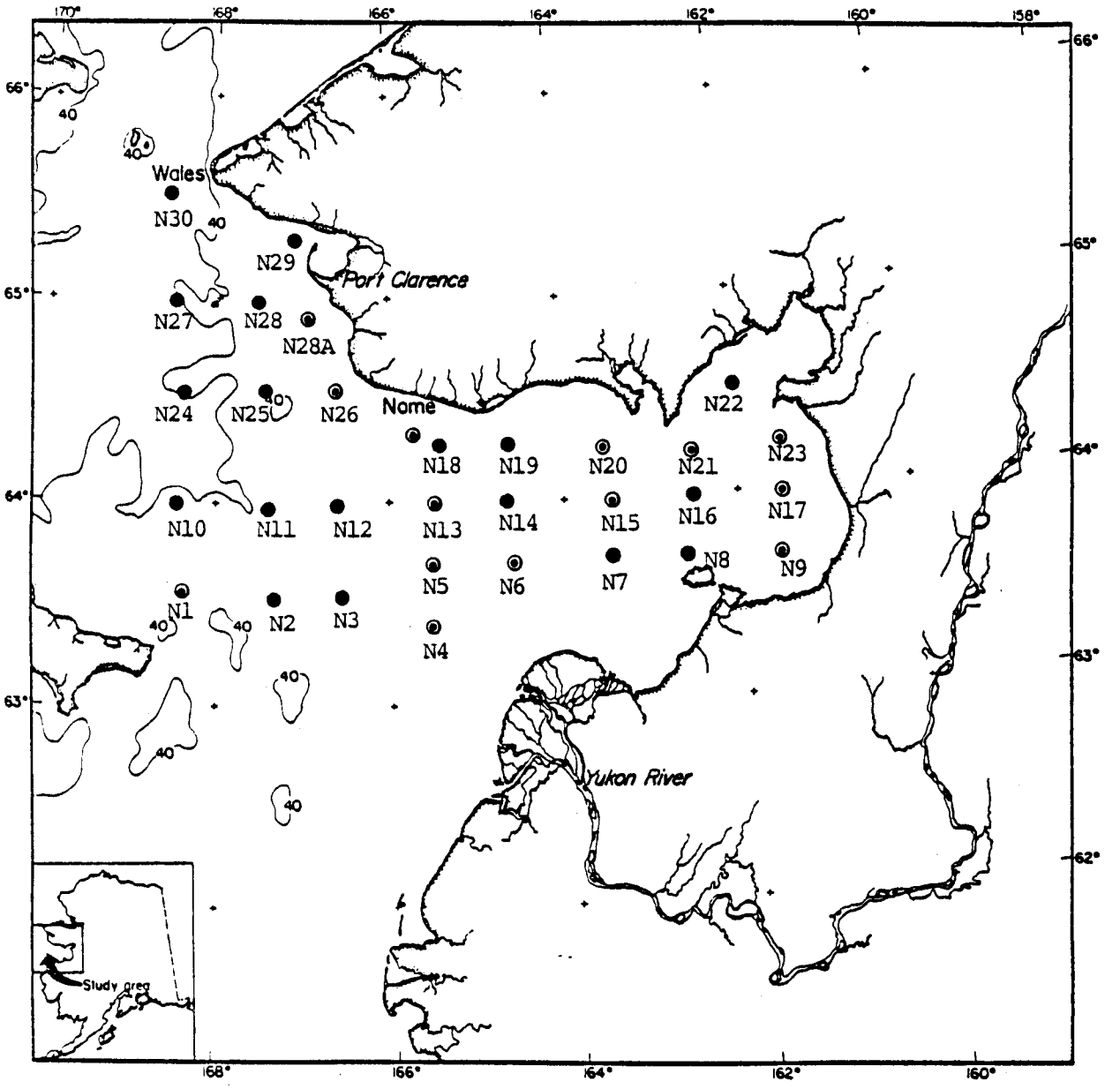


FIGURE B.5 Sampling Stations in Norton Sound
Discoverer, September 1976

FIGURE B.5 (continued)

NORTON SOUND (N. BERING SEA)

Discoverer Leg IV - September 8-24, 1976
Station localities and operations

Station No.	Depth	Latitude	Longitude	Sampling Operations
N 1	29 m	63°31.8	168°32.2	van Veen Grab, HAPS, water
N 2	29	63°30.6	167°29.0	van Veen Grab, water
N 3	26.5	63°29.9	166°29.7	van Veen Grab, water
N 4	21	63°19.7	165°29.9	van Veen Grab, HAPS water
N 5	22	63°39.5	165°32.1	van Veen Grab, HAPS water
N 6	13	63°38.4	164°31.0	van Veen Grab, HAPS water
N 7	15	63°38.2	163°30.3	van Veen Grab, water
N 8	15.5	63°42.0	162°28.5	van Veen Grab
N 9	15	63°41.5	161°31.1	van Veen Grab, HAPS, water
N10	37.5	64°01.0	168°26.0	van Veen Grab
N11	40	64°00.4	167°32.1	van Veen Grab
N12	31	63°59.2	166°29.8	van Veen Grab
N12D	26	64°23.5	165°44.8	van Veen Grab, HAPS, water
N13	20	63°59.7	165°29.7	van Veen Grab, HAPS
N14	20	64°01.2	164°28.7	van Veen Grab, water
N15	20	64°00.3	163°30.5	van Veen Grab, HAPS, water
N16	19	64°00.0	162°30.0	van Veen Grab
N17	18.5	64°00.0	161°30.3	van Veen Grab, HAPS, water
N18	23	64°20.2	165°30.0	van Veen Grab
N19	15.5	64°19.4	164°30.4	van Veen Grab
N20	20	64°20.1	163°31.0	van Veen Grab, HAPS, water
N21	19	64°15.25	162°29.7	van Veen Grab, HAPS, water
N22	13	63°30.3	162°00.5	van Veen Grab, water
N23	15	64°17.5	161°30.7	van Veen Grab, HAPS, water
N24	40	64°29.7	168°28.3	van Veen Grab, water
N25	31	64°29.6	167°29.6	van Veen Grab, water
N26	28	64°30.2	166°31.5	van Veen Grab, HAPS, water
N27	46.5	65°00.5	168°26.7	van Veen Grab, water
N28	30	65°00.1	167°31.5	van Veen Grab
N28A	24	64°44.6	167°01.0	van Veen Grab, HAPS
N29	14.5	65°17.8	167°00.4	van Veen Grab
N30		65°30.5	168°31.0	van Veen Grab, water

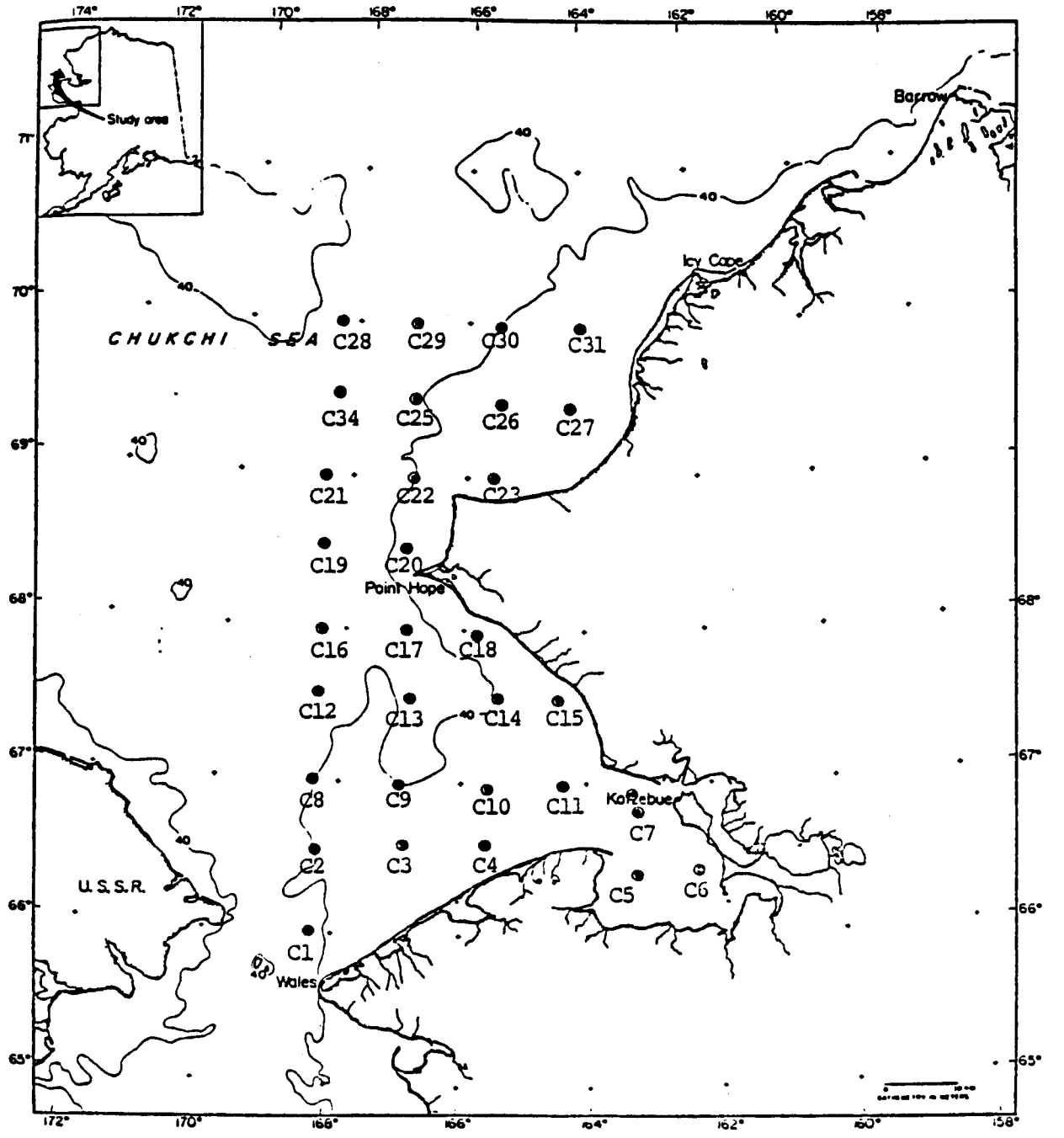


FIGURE B.6 Sampling Stations in the Chukchi Sea
Discoverer, September 1976

FIGURE B.6 (continued)

S. CHUKCHI SEA

Discoverer Leg IV - September 8-24, 1976
Station localities and operations

Station No.	Depth	Latitude	Longitude	Sampling Operations
C 1	53	65°59.8	168°20.5	van Veen Grab, water
C 2	49	66°30.1	168°24.1	van Veen Grab, water
C 3	31	66°30.5	167°01.6	van Veen Grab, HAPS, water
C 4	15.5	66°30.0	165°39.2	van Veen Grab
C 5	14	66°18.1	163°13.5	van Veen Grab, HAPS, water
C 6	15	66°23.3	162°14.4	van Veen Grab, HAPS, water
C 7	14	66°44.5	163°17.0	van Veen Grab, HAPS, water
C 7A	13.5	66°52.5	163°09.4	van Veen Grab, HAPS, water
C 8	35	67°00.3	168°26.2	van Veen Grab, water
C 9	42	67°00.2	167°01.9	van Veen Grab, HAPS, water
C10	24	66°58.0	165°46.9	van Veen Grab, HAPS, water
C11	26.5	67°00.0	164°20.0	van Veen Grab
C12	48	67°31.6	168°20.0	van Veen Grab, HAPS, water
C13	46.5	67°30.3	167°02.5	van Veen Grab, HAPS, water
C14	38.5	67°28.9	165°39.5	van Veen Grab, HAPS, water
C15	17	67°26.2	164°18.2	van Veen Grab, HAPS, water
C16	59	68°01.2	168°28.6	van Veen Grab, HAPS, water
C17	52	67°58.8	167°01.5	van Veen Grab, water
C18	28	67°57.3	165°47.8	van Veen Grab, water
C19	52	68°30.0	168°22.0	van Veen Grab, HAPS, water
C20	31.5	68°28.1	167°03.0	van Veen Grab, HAPS, water
C21	51	69°00.3	168°29.3	van Veen Grab
C22	46	68°59.2	166°59.7	van Veen Grab, HAPS
C23	20	69°00.9	165°37.0	van Veen Grab, HAPS
C24	51	69°30.0	168°21.9	van Veen Grab, HAPS
C25	46	69°30.0	167°04.1	van Veen Grab, HAPS
C26	33	69°30.1	165°32.0	van Veen Grab
C27	22	69°29.5	164°11.2	van Veen Grab
C28	45	70°00.7	168°19.4	van Veen Grab
C29	46.5	70°00.0	167°01.2	van Veen Grab, HAPS
C30	40	69°58.5	165°33.4	van Veen Grab
C31	30	69°58.1	164°00.4	van Veen Grab

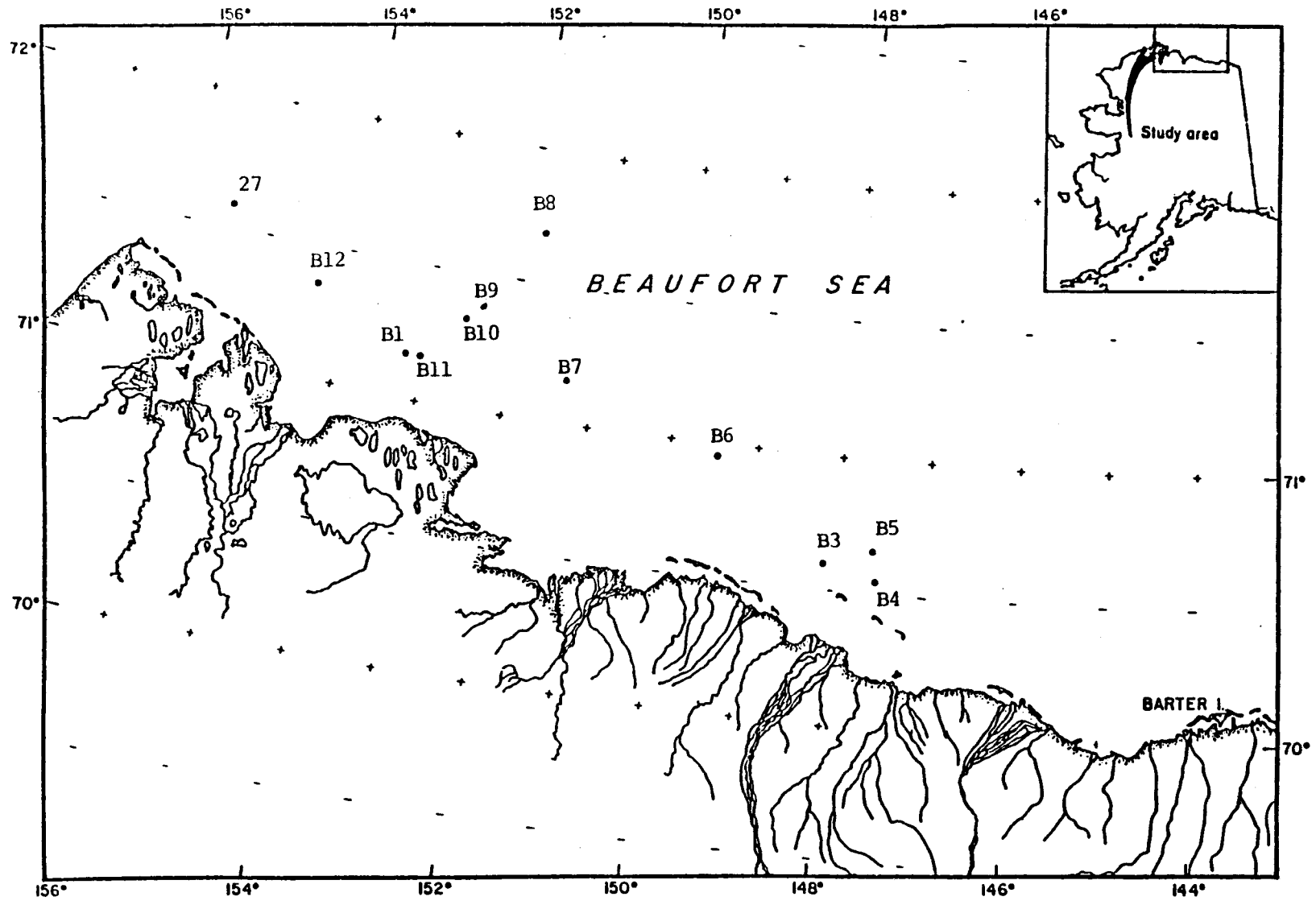


FIGURE B.7 Sampling Stations in the Beaufort Sea
Glacier, August 1976

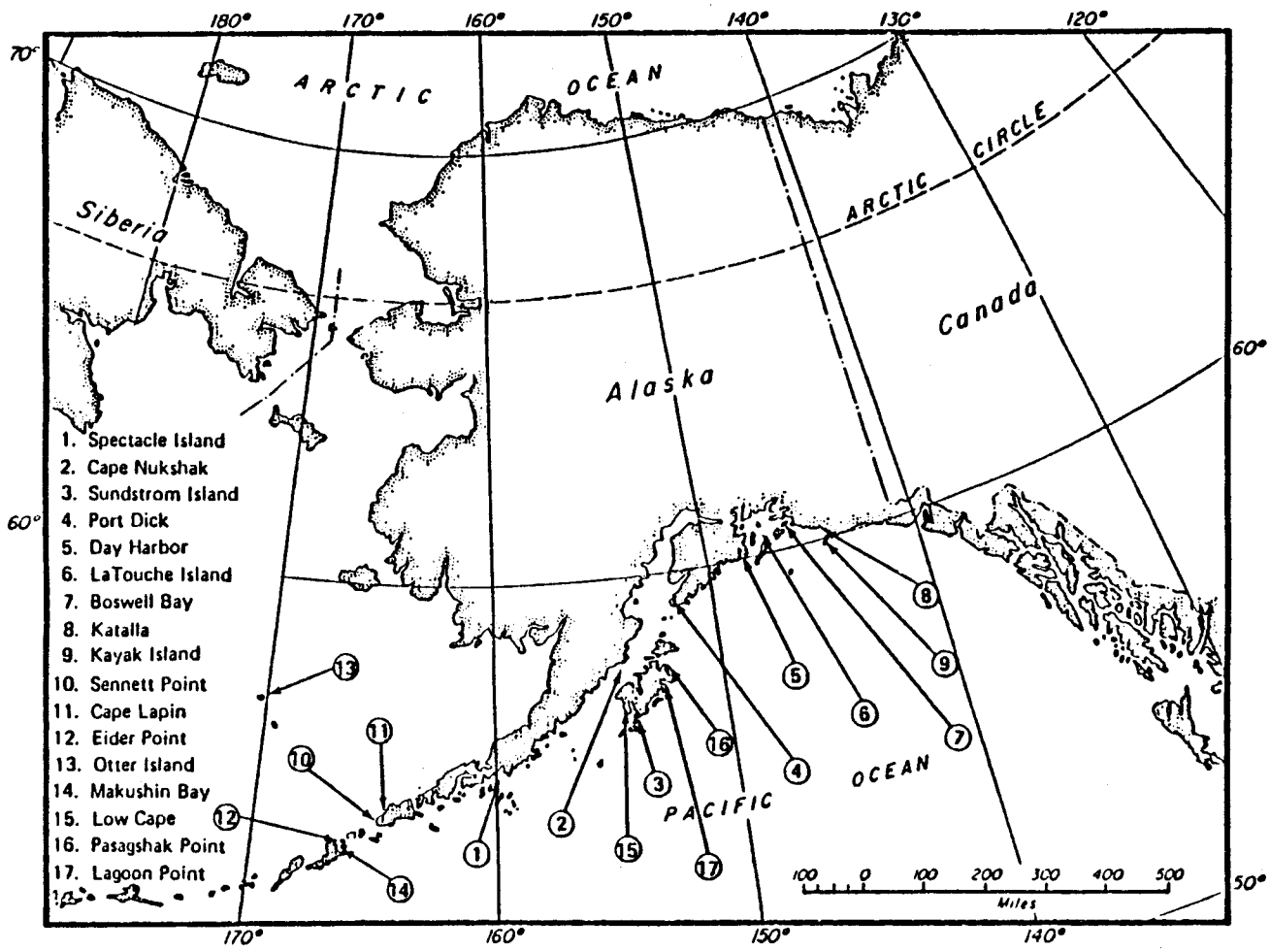


FIGURE B.8 Sampling Locations for Intertidal Biota

APPENDIX C

Elemental Composition of Alaska Shelf Surficial Sediments

TABLE C.1. Al, Ca, Mn, and V Concentrations in Bering Sea, Northwestern Gulf of Alaska, and Northeastern Gulf of Alaska Surficial Sediments.

Station	Depth Interval	Al(%)	Ca(%)	Mn (ppm)	V (ppm)
MB-8	0-2 cm	7.29 ± 0.03	3.69 ± 0.84	720 ± 38	126 ± 26
	4-6 cm	7.18 ± 0.03	3.29 ± 0.65	567 ± 36	87 ± 25
	8-10cm	9.38 ± 0.04	3.22 ± 0.37	715 ± 43	165 ± 29
	12-14cm	7.23 ± 0.03	2.92 ± 0.64	629 ± 37	90 ± 25
MB-12	0-3 cm	6.66 ± 0.03	1.93 ± 0.80	573 ± 49	118 ± 25
MB-19	0-2 cm	7.94 ± 0.03	4.63 ± 0.70	628 ± 43	93 ± 27
MB-28	0-3 cm	6.05 ± 0.03	2.31 ± 1.03	524 ± 50	92 ± 25
MB-29	0-4 cm	5.91 ± 0.02	2.09 ± 0.33	572 ± 45	77 ± 23
MB-30	0-4 cm	6.10 ± 0.03	2.97 ± 1.34	571 ± 43	112 ± 24
	4-8 cm	6.26 ± 0.03	1.86 ± 1.25	574 ± 38	114 ± 25
	8-12cm	6.09 ± 0.04	2.45 ± 1.63	574 ± 43	106 ± 27
MB-37	0-2 cm	5.50 ± 0.03	2.32 ± 1.00	358 ± 42	85 ± 23
	4-6 cm	5.75 ± 0.02	2.37 ± 0.70	360 ± 38	85 ± 21
	8-11cm	6.12 ± 0.06	1.85 ± 0.66	441 ± 17	82 ± 22
MB-41	0-2 cm	5.01 ± 0.05	<0.74	392 ± 15	79 ± 19
MB-43	0-2 cm	5.05 ± 0.07	1.70 ± 0.25	400 ± 13	90 ± 21
	4-6 cm	4.79 ± 0.04	1.91 ± 0.35	379 ± 8	77 ± 12
MB-56	0-2 cm	5.01 ± 0.10	1.73 ± 0.50	341 ± 7	85 ± 17
	4-6 cm	5.23 ± 0.03	2.82 ± 0.53	425 ± 38	83 ± 22
	8-10cm	5.42 ± 0.03	1.61 ± 1.13	427 ± 45	86 ± 23
	12-18cm	5.60 ± 0.03	2.55 ± 1.25	427 ± 49	98 ± 23
MB-59	0-2 cm	5.10 ± 0.02	2.08 ± 0.47	366 ± 42	77 ± 22
	4-6 cm	4.97 ± 0.02	1.87 ± 0.69	393 ± 40	77 ± 20
MB-64	0-2 cm	5.10 ± 0.03	3.73 ± 1.25	397 ± 48	82 ± 24
	4-6 cm	5.44 ± 0.16	2.20 ± 1.66	414 ± 22	87 ± 43
	8-10cm	5.49 ± 0.03	2.82 ± 1.02	403 ± 47	89 ± 23
	12-14cm	5.81 ± 0.03	2.52 ± 0.89	422 ± 45	96 ± 24
	16-20cm	5.64 ± 0.03	2.62 ± 0.89	420 ± 46	89 ± 23
	20-24cm	5.89 ± 0.02	1.96 ± 0.73	422 ± 45	89 ± 23

TABLE C.1 (cont'd.)

Station	Depth Interval	Al(%)	Ca(%)	Mn (ppm)	V (ppm)
GASSE-2	0-2 cm	7.11 ± 0.04	1.89 ± 0.82	738 ± 49	150 ± 29
	6-8 cm	7.91 ± 0.04	2.47 ± 0.80	847 ± 48	190 ± 28
	10-12cm	7.73 ± 0.03	1.86 ± 0.76	845 ± 55	173 ± 29
	14-16cm	7.85 ± 0.03	2.44 ± 1.03	995 ± 48	185 ± 28
	18-20cm	7.86 ± 0.04	2.70 ± 0.73	817 ± 46	170 ± 28
GASSE-5	8-10cm	7.61 ± 0.04	4.33 ± 1.37	777 ± 48	165 ± 29
	14-16cm	7.24 ± 0.04	2.51 ± 0.98	774 ± 49	181 ± 28
GASSE-26	0-2 cm	6.19 ± 0.03	5.29 ± 0.92	924 ± 51	92 ± 16
	4-6 cm	6.68 ± 0.03	6.93 ± 1.03	879 ± 48	147 ± 25
	8-10cm	6.38 ± 0.03	5.52 ± 0.97	836 ± 48	141 ± 24
	12-14cm	6.81 ± 0.04	5.46 ± 1.25	810 ± 53	135 ± 30
GASSE-30	0-2 cm	6.70 ± 0.03	1.56 ± 1.27	600 ± 51	91 ± 26
GASSE-33	0-2 cm	4.06 ± 0.03	9.62 ± 1.11	635 ± 45	108 ± 24
	4-6 cm	4.17 ± 0.02	7.42 ± 1.20	432 ± 40	75 ± 20
	8-10cm	5.16 ± 0.02	12.65 ± 0.60	562 ± 42	108 ± 20
GASSE-44	0-2 cm	7.15 ± 0.03	3.81 ± 0.68	851 ± 43	146 ± 26
	4-6 cm	7.32 ± 0.12	2.45 ± 1.15	786 ± 18	174 ± 30
GASSE-48	0-2 cm	7.63 ± 0.03	3.29 ± 1.06	799 ± 44	161 ± 27
	4-6 cm	7.52 ± 0.03	4.24 ± 1.22	812 ± 46	143 ± 27
	8-10cm	7.72 ± 0.03	4.39 ± 0.74	756 ± 56	174 ± 28
GASSE-49	0-2 cm	7.07 ± 0.03	3.42 ± 1.32	776 ± 51	157 ± 28
	4-6 cm	7.78 ± 0.03	3.07 ± 0.77	746 ± 40	168 ± 27
	8-10cm	8.29 ± 0.04	4.22 ± 0.69	731 ± 41	165 ± 27
	12-14cm	7.77 ± 0.03	3.98 ± 0.92	731 ± 38	145 ± 25
	16-18cm	7.76 ± 0.03	2.43 ± 0.99	713 ± 40	166 ± 27
GASSE-50	0-2 cm	7.52 ± 0.04	3.34 ± 1.41	776 ± 40	163 ± 27
	4-6 cm	8.45 ± 0.04	3.14 ± 0.97	812 ± 43	183 ± 28
	8-10cm	8.08 ± 0.04	2.61 ± 1.41	782 ± 45	169 ± 29
	12-14cm	7.77 ± 0.03	2.51 ± 1.21	740 ± 39	169 ± 26
	18-20cm	7.89 ± 0.03	2.16 ± 1.04	763 ± 40	166 ± 27
GASSE-51	0-2 cm	8.20 ± 0.04	2.32 ± 1.15	969 ± 50	179 ± 30
	4-6 cm	7.10 ± 0.04	2.46 ± 1.06	912 ± 46	177 ± 28

TABLE C.1 (cont'd.)

Station	Depth Interval	Al(%)	Ca(%)	Mn (ppm)	V (ppm)
GASSE-52	0-2 cm	8.07 ± 0.04	3.79 ± 1.24	936 ± 41	165 ± 27
	4-6 cm	8.76 ± 0.04	3.13 ± 0.69	889 ± 46	183 ± 31
	8-10cm	8.69 ± 0.04	3.38 ± 0.64	825 ± 45	180 ± 30
	12-14cm	8.14 ± 0.04	3.46 ± 1.23	816 ± 40	166 ± 27
	14-16cm	8.39 ± 0.04	3.18 ± 1.15	852 ± 44	152 ± 29
GASSE-56	0-2 cm	6.73 ± 0.03	7.52 ± 1.08	734 ± 41	138 ± 25
	4-6 cm	8.25 ± 0.04	7.93 ± 1.20	621 ± 46	158 ± 27
	8-10cm	7.78 ± 0.03	3.33 ± 0.72	933 ± 43	151 ± 27
	12-14cm	8.10 ± 0.03	3.46 ± 1.16	886 ± 45	197 ± 26
GASSE-57	0-2 cm	7.06 ± 0.03	6.00 ± 1.07	878 ± 51	152 ± 26
	4-6 cm	7.41 ± 0.04	5.31 ± 0.84	747 ± 44	144 ± 27
GASSE-58	0-2 cm	8.52 ± 0.04	2.81 ± 1.32	951 ± 47	176 ± 29
	4-6 cm	7.81 ± 0.03	3.31 ± 0.89	789 ± 44	149 ± 27
	8-10cm	7.96 ± 0.04	2.72 ± 1.19	779 ± 49	167 ± 29
GASSE-59A	V.V.	7.92 ± 0.03	2.51 ± 0.83	858 ± 57	155 ± 30
GASSW-105	0-2 cm	5.57 ± 0.02	4.56 ± 0.51	386 ± 45	40 ± 23
	4-6 cm	6.09 ± 0.03	10.52 ± 0.35	651 ± 49	123 ± 24
GASSW-104	0-2 cm	2.40 ± 0.01	15.74 ± 0.79	846 ± 39	72 ± 19
	4-6 cm	6.21 ± 0.02	10.66 ± 1.10	546 ± 48	108 ± 24
	8-10cm	5.13 ± 0.02	11.40 ± 1.05	570 ± 42	94 ± 22
GASSW-119	0-2 cm	7.36 ± 0.04	2.54 ± 1.07	991 ± 48	130 ± 29
	4-6 cm	7.58 ± 0.03	2.53 ± 1.17	802 ± 45	137 ± 27
	8-10cm	7.66 ± 0.04	2.59 ± 0.75	724 ± 47	119 ± 28
GASSW-120	0-2 cm	7.57 ± 0.04	1.16 ± 1.69	1066 ± 51	164 ± 31
	4-6 cm	7.06 ± 0.04	2.06 ± 1.22	958 ± 47	123 ± 28
	8-10cm	7.48 ± 0.04	1.94 ± 1.37	997 ± 57	167 ± 32
	12-14cm	7.64 ± 0.04	1.71 ± 0.95	1074 ± 52	150 ± 30
	16-18cm	7.24 ± 0.04	1.42 ± 1.53	931 ± 49	144 ± 28
GASSW-121	0-2 cm	6.95 ± 0.03	1.9 ± 1.2	782 ± 53	118 ± 26
	4-6 cm	6.61 ± 0.04	<1.6%	690 ± 50	121 ± 29
	8-10cm	6.89 ± 0.04	1.97 ± 1.02	744 ± 44	114 ± 26
GASSW-122	0-2 cm	2.06 ± 0.02	26.9 ± 1.3	312 ± 31	27 ± 15
GASSW-124	0-2 cm	6.07 ± 0.03	1.8 ± 1.3	489 ± 47	83 ± 25
	4-6 cm	5.63 ± 0.03	2.2 ± 0.9	541 ± 45	88 ± 23
	8-10cm	5.55 ± 0.02	2.6 ± 0.7	464 ± 45	70 ± 22

TABLE C.1 (cont'd.)

Station	Depth Interval	Al(%)	Ca(%)	Mn (ppm)	V (ppm)
GASSW-133	V. V.	8.13 ± 0.04	7.7 ± 1.0	1170 ± 50	173 ± 28
GASSW-134	0-2 cm	6.69 ± 0.03	3.2 ± 1.4	711 ± 54	126 ± 27
	4-6 cm	5.98 ± 0.03	3.4 ± 1.2	651 ± 52	124 ± 25
	8-10cm	7.36 ± 0.03	2.8 ± 1.2	844 ± 56	148 ± 28
	12-14cm	7.05 ± 0.04	3.2 ± 1.2	804 ± 46	147 ± 27
	16-18cm	6.75 ± 0.04	2.7 ± 1.4	742 ± 51	118 ± 30
GASSW-135	0-2 cm	7.46 ± 0.03	3.6 ± 1.4	806 ± 56	129 ± 28
	4-6 cm	7.46 ± 0.03	3.9 ± 0.9	900 ± 45	140 ± 27
	8-10cm	7.73 ± 0.03	3.9 ± 1.1	906 ± 45	132 ± 27
GASSE-48	4-6 cm	7.83 ± 0.03	4.63 ± 0.96	726 ± 39	150 ± 26
	4-6 cm	7.94 ± 0.04	3.10 ± 1.21	732 ± 44	165 ± 28
	4-6 cm	7.75 ± 0.03	4.36 ± 1.08	720 ± 40	159 ± 26
	4-6 cm	7.52 ± 0.03	4.24 ± 1.22	812 ± 46	143 ± 27

TABLE C.2. As, Ba, Co, Cr, Fe, Sb, and Sc in Bering Sea, Northwestern Gulf of Alaska, and Northeastern Gulf of Alaska Surficial Sediments

		As	Ba	Co	Cr	Fe(%)	Sb	Sc
MB-8	0-2	4.1 ± 0.4	370 ± 230	13	47 ± 5	3.87	0.46 ± 0.13	13
	4-6	5.1 ± 0.3	230 ± 210	10	32 ± 4	2.87	0.56 ± 0.22	11
	8-10	4.1 ± 0.4	310 ± 220	14	46 ± 4	4.21	0.68 ± 0.14	14
	12-14	3.9 ± 0.4	<210	7.2	25 ± 4	2.11	0.36 ± 0.08	8
MB-19	0-2	3.7 ± 0.4	440 ± 140	10	48 ± 4	2.49	0.63 ± 0.12	12
MB-30	0-4	3.4 ± 0.6	200 ± 190	10	38 ± 5	3.55	0.55 ± 0.13	15
	4-8	2.1 ± 0.5	<260	11	36 ± 5	3.53	0.50 ± 0.13	15
	8-12	1.5 ± 0.5	<370	10	46 ± 5	3.42	0.34 ± 0.13	14
MB-37	0-2	4.1 ± 0.6	430 ± 190	9.1	53 ± 4	2.53	0.61 ± 0.11	10
	4-6	3.1 ± 0.5	500 ± 150	8.9	59 ± 4	2.44	0.44 ± 0.11	11
	8-11	5.8 ± 0.4	750 ± 150	11	60 ± 5	2.73	0.79 ± 0.14	10
MB-41	0-2	3.0 ± 0.4	480 ± 140	8.9	64 ± 5	2.39	0.52 ± 0.12	10
MB-43	0-2	3.2 ± 0.5	<420	7.0	61 ± 5	2.06	0.57 ± 0.10	8
MB-56	0-2	0.7 ± 0.6	<260	9	86	2.59	0.63 ± 0.08	10
	4-6	4.3 ± 0.6	460 ± 280	8	73	2.24	0.69 ± 0.08	9
	8-10	2.8 ± 0.6	570 ± 440	10	95	2.87	0.74 ± 0.09	11
	12-18	4.0 ± 0.7	<500	9	79	2.47	0.82 ± 0.14	10
MB-59	0-2	4.0 ± 0.4	1070 ± 340	9	107	2.52	0.73 ± 0.08	10
	4-6	3.8 ± 0.4	<350	8	115	2.20	0.72 ± 0.09	9
MB-64	0-2	2.7 ± 0.8	1030 ± 340	9	93	2.68	0.48 ± 0.09	10
	4-6	3.6 ± 0.6	500 ± 270	9	85	2.81	0.60 ± 0.11	11
	8-10	2.9 ± 0.6	<280	10	102	3.07	0.71 ± 0.07	11
	12-14	3.6 ± 0.6	810 ± 300	8	76	2.47	0.68 ± 0.09	10
	16-20	4.6 ± 0.5	400 ± 260	11	101 ± 5	3.36	0.75 ± 0.19	13
	20-24	6.5 ± 0.4	600 ± 240	11	92 ± 5	3.27	1.02 ± 0.17	13

TABLE C.2 (cont'd.)

		As	Ba	Co	Cr	Fe(%)	Sb	Sc
MB-12	0-3	4.3 ± 0.5	650 ± 170	11	48 ± 5	3.42	0.86 ± 0.17	13
MB-28	0-3	2.9 ± 0.5	490 ± 170	9	63 ± 4	2.67	0.56 ± 0.14	12
MB-29	0-4	7.2 ± 0.5	530 ± 220	14	58 ± 5	3.29	0.96 ± 0.18	12
GASW-BNW 104								
	0-2	1.9 ± 0.5	260 ± 170	14	56 ± 4	2.94	0.53 ± 0.15	10
	4-6	1.8 ± 0.4	<220	18	83 ± 5	4.08	1.03 ± 0.19	13
	8-10	1.8 ± 0.5	340 ± 250	15	82 ± 4	3.26	0.72 ± 0.15	12
GASW-BNW 119								
	0-2	7.9 ± 0.6	360 ± 200	21	82 ± 6	5.36	1.56 ± 0.24	18
	4-6	7.7 ± 0.6	520 ± 190	18	92 ± 6	4.67	1.15 ± 0.19	17
	8-10	5.3 ± 0.6	470 ± 180	18	69 ± 5	4.64	1.50 ± 0.19	15
GASW-BNW 120								
	0-2	5.2 ± 0.8	1080 ± 230	18	100 ± 4	4.45	1.46 ± 0.17	16

TABLE C.2 (cont'd.)

Alaska Outer Continental Shelf Sediment Composition - Concentrations in ppm except where noted (dry weight).

Station	Interval	As	Ba	Co	Cr	Fe(%)	Sb	Sc
120	4-6	2.9	670 ± 60	16	97	3.85	0.49 ± 0.10	14
	8-10	2.6	1100 ± 60	17	102	4.18	0.97 ± 0.12	15
	12-14	5.2	790 ± 80	16	100	3.96	0.96 ± 0.11	14
	16-18	2.6	610 ± 60	15	89	3.63	0.81 ± 0.09	13
121	0-2	5.4	760 ± 80	15	117	4.10	0.82 ± 0.12	15
	4-6	3.8	710 ± 80	15	106	3.93	0.73 ± 0.12	14
	8-10	5.6	670 ± 70	13	96	3.39	0.82 ± 0.09	13
122	0-2	2.9	260 ± 30	3	15	0.83	0.17 ± 0.06	3
124	0-2	2.8	630 ± 60	8	67	2.75	0.52 ± 0.10	10
	4-6	3.3	570 ± 70	9	61	2.73	0.43 ± 0.09	10
	8-10	3.7	460 ± 60	9	59	2.96	0.33 ± 0.09	9
133	Grab	3.8	400 ± 80	16	31	4.10	0.35 ± 0.10	14
134	0-2	6.6	670 ± 90	16	77	4.17	0.51 ± 0.12	16
	4-6	5.7	620 ± 100	15	75	4.08	0.64 ± 0.14	16
	8-10	7.3	820 ± 120	21	75	4.61	0.69 ± 0.14	18
	12-14	8.8	830 ± 110	18	75	4.73	0.73 ± 0.14	18
	16-18	5.1	490 ± 110	14	66	3.87	0.48 ± 0.10	15
135	0-2	4.3	710 ± 130	16	74	4.90	0.56 ± 0.15	18
	4-6	4.5	680 ± 110	15	54	4.49	0.50 ± 0.12	16
	8-10	5.1	250 ± 110	16	77	4.73	0.56 ± 0.13	17
2	0-2	5.3	700 ± 190	16	115	4.20	0.61 ± 0.19	14
	6-8	7.8	930 ± 140	22	166	5.91	0.90 ± 0.16	20
	10-12	7.7	710 ± 130	19	134	5.02	0.71 ± 0.13	17
	14-16	8.0	890 ± 140	22	156	5.64	0.74 ± 0.16	19
	18-20	6.3	770 ± 110	19	112	4.96	0.81 ± 0.13	17
5	8-10	2.2	500 ± 100	20	130	5.14	0.59 ± 0.10	18
	14-16	9.5	720 ± 140	23	119	5.14	0.90 ± 0.15	18
26	0-2	1.8	540 ± 120	20	124	4.95	0.43 ± 0.11	18
	4-6	<2.0	460 ± 130	16	88	4.14	0.49 ± 0.12	16
	8-10	3.5	490 ± 120	20	126	4.98	0.57 ± 0.10	19
	12-14	3.1	340 ± 140	17	98	4.27	0.58 ± 0.14	16
30	Top 2 cm	7.2	460 ± 110	12	112	3.10	0.16 ± 0.09	14
51	0-2	8.7	540 ± 100	27	162	6.84	0.44 ± 0.28	24
	4-6	7.9	530 ± 130	20	138	4.94	0.37 ± 0.10	17
105	0-2	4.7	460 ± 80	5	192	1.32	0.26 ± 0.06	
	4-6	1.8	560 ± 120	16	82	3.72	0.70 ± 0.08	

TABLE C.2 (cont'd.)

Station	Interval	As	Ba	Co	Cr	Fe(%)	Sb	Sc
EGA-BNW								
59A	v.v.	1.6 ± 0.6	570 ± 160	17	156	4.52	0.66 ± 25	19
58	0-2	2.7 ± 0.7	430 ± 160	18	145	4.80	0.35 ± 0.08	20
58	4-6	2.3 ± 0.6	250 ± 160	17	131	4.37	0.40 ± 0.07	15
58	8-10	2.3 ± 0.7	480 ± 170	18	153	5.19	0.45 ± 0.09	21
57	0-2	2.1 ± 0.6	350 ± 180	18	134	4.37	0.46 ± 0.16	16
57	4-6	1.9 ± 0.7	490 ± 170	15	79	3.79	0.43 ± 0.09	12
56	0-2	2.2 ± 0.5	620 ± 140	19	116	4.23	0.24 ± 0.07	20
56	4-6	1.9 ± 0.8	770 ± 180	12	88	2.99	0.30 ± 0.05	9
56	8-10	3.2 ± 0.6	740 ± 160	22	171	5.73	0.56 ± 0.09	24
56	12-14	2.7 ± 0.7	530 ± 170	18	142	4.68	0.47 ± 0.08	17
33	0-2	2.6 ± 0.6	450 ± 160	16	114	5.23	0.81 ± 0.07	16
33	4-6	1.5 ± 0.7	450 ± 140	11	79	3.33	0.63 ± 0.06	12
33	8-10	1.4 ± 0.6	350 ± 100	12	32	2.27	0.40 ± 0.05	10
48	0-2	2.5 ± 0.4	550 ± 130					
48	4-6	2.3 ± 0.7	500 ± 120	16	104	4.41	0.51 ± 0.09	17
48	8-10	2.1 ± 0.4	440 ± 140					
44	0-2	2.7 ± 0.7	450 ± 120	15	112	4.36	0.42 ± 0.08	18
44	4-6	0.8 ± 0.4	400 ± 130	16	55	2.97	0.33 ± 0.05	16
49	0-2	4.4 ± 0.9	350 ± 150	18	129	4.86	0.41 ± 0.10	23
49	4-6	3.4 ± 0.4	540 ± 120	18	144	5.25	0.36 ± 0.08	22
49	8-10	3.4 ± 0.7	530 ± 140	19	66	3.46	0.35 ± 0.06	21
49	12-14	2.2 ± 0.3	670 ± 110	20	78	3.67	0.29 ± 0.04	25
49	16-18	2.6 ± 0.4	380 ± 60	17	58	3.04	0.39 ± 0.06	18
50	0-2	3.0 ± 0.2	500 ± 70	19	74	3.44	0.26 ± 0.05	21
50	8-10	2.4 ± 0.4	370 ± 130	12	98	2.84	<0.16	9
50	12-14	3.2 ± 0.4	410 ± 140	20	136	5.08	0.35 ± 0.08	20
50	18-20	2.3 ± 0.4	510 ± 110	16	110	3.76	0.28 ± 0.06	10
52	0-2	4.3 ± 0.5	770 ± 140	19	137	4.90	0.59 ± 0.09	14
52	4-6	2.9 ± 0.4	720 ± 120	21	142	5.44	0.57 ± 0.25	17
52	8-10	2.5 ± 0.5	580 ± 140	20	94	4.26	0.58 ± 0.05	14
52	12-14	2.9 ± 0.4	520 ± 120	17	122	4.12	0.51 ± 0.08	12
52	14-16	3.5 ± 0.5	690 ± 80	22	136	5.41	0.56 ± 0.09	18
48	4-6	1.8 ± 0.4	440 ± 110	20	146	5.15	0.55 ± 0.08	19
48	4-6	1.8 ± 0.3	600 ± 80	18	131	4.81	0.54 ± 0.09	18
48	4-6	1.4 ± 0.4	490 ± 30	19	137	4.77	0.50 ± 0.08	17

TABLE C.3. Al, Ti, Mn and V Concentrations in Cook Inlet, Shelikof Strait, Chukchi Sea, Norton Sound and Beaufort Sea Surficial Sediments.

	Al (%)	Ti (%)	Mn	V
BEAUFORT SEA				
Station B-1	8.00±0.28	0.56±0.14	506±37	176±32
B-3	5.34±0.18	0.31±0.07	369±22	122±12
B-7	6.59±0.22	0.51±0.10	444±25	150±14
B-8	7.26±0.24	0.46±0.11	1008±49	163±15
B-12	6.08±0.21	0.42±0.09	491±26	117±12
NORTON SOUND				
Station N-1	5.35±0.18	0.45±0.09	344±21	82±10
N-5	6.18±0.21	0.46±0.10	586±30	113±12
N-9	7.32±0.24	0.36±0.09	544±29	149±14
N-15	5.88±0.20	0.45±0.09	458±25	102±11
N-20	5.57±0.19	0.46±0.09	396±23	73±10
N-26	4.43±1.5	0.36±0.08	417±54	56±9
CHUKCHI SEA				
Station C-3	4.76±0.16	0.47±0.09	428±24	87±11
C-7	4.31±0.15	0.32±0.08	405±23	91±10
C-10	6.11±0.21	0.46±0.09	432±24	109±12
C-20	3.36±0.12	0.22±0.06	243±16	66±8
C-23	1.70±0.06	0.16±0.04	143±10	37±8
C-25	5.15±0.17	0.42±0.09	359±21	106±11
SHELIKOF STRAIT				
Station SS-2	7.66±0.26	0.46±0.10	820±40	148±14
SS-2, surface <0.2 cm	7.50±0.26	0.51±0.15	1810±90	142±19
SS-4	7.68±0.26	0.54±0.11	966±46	106±13
SS-5	8.01±0.27	0.34±0.10	867±43	142±15
SS-8	8.21±0.27	0.48±0.11	800±40	149±15
SS-10	7.59±0.25	0.53±0.11	761±38	112±13

TABLE C.3 (cont'd.)

COOK INLET		Al(%)	Ti(%)	Mn	V
Station	CB-1	7.70±0.26	0.38±0.10	698±35	96±13
	CB-3	7.58±0.26	0.56±0.11	726±36	110±14
	CB-6	6.05±0.21	0.26±0.08	415±23	61±11
	CB-7	7.20±0.25	0.42±0.10	652±33	114±14
	CB-8	8.41±0.29	0.51±0.11	784±39	148±16
WESTERN GULF					
Station	WG 105	5.48±0.19	0.29±0.08	672±34	89±11
	WG 120	7.31±0.25	0.45±0.10	989±43	140±14
	WG 133	8.46±0.29	0.74±0.16	1380±70	216±21
BRISTOL BAY					
Station	MB-8	7.02±0.24	0.50±0.10	692±35	132±13
	MB-12	6.63±0.23	0.31±0.09	574±29	95±13
	MB-41	5.36±0.19	0.39±0.09	448±24	89±11
EASTERN GULF					
	EG-33	5.76±0.20	0.31±0.09	567±28	120±13
	EG-44	7.45±0.26	0.58±0.11	777±38	132±15
	EG-58	8.36±0.29	0.46±0.11	837±40	174±17

TABLE C.4. Na, K, As, La and Sm Concentrations in Cook Inlet, Shelikof Strait, Chukchi Sea, Norton Sound and Beaufort Sea Surficial Sediments.

NORTON SOUND

Station	Na(%)	K(%)	As	La	Sm
N-1	2.03±0.01	1.38±0.24	7.8±1.1	24.6±1.1	3.5±0.1
N-5	2.02±0.01	1.65±0.22	11.8±1.2	30.2±0.9	4.4±0.1
N-9	2.31±0.01	2.14±0.24	19.8±1.1	36.8±0.8	5.5±0.1
N-15	2.01±0.01	1.14±0.18	10.7±1.0	29.0±0.7	4.2±0.1
N-20	1.65±0.01	1.60±0.19	6.9±0.8	31.2±0.8	4.7±0.1
N-26	1.72±0.01	1.29±0.17	8.3±0.8	19.7±0.6	3.3±0.1

CHUKCHI SEA

Station	Na(%)	K(%)	As	La	Sm
C-3	1.38±0.01	1.05±0.14	9.3±0.9	28.0±0.9	4.3±0.1
C-7	1.12±0.01	0.97±0.12	8.4±0.9	33.3±0.9	4.7±0.1
C-10	1.23±0.01	0.62±0.11	6.9±0.7	22.5±0.7	3.6±0.1
C-14	2.42±0.01	1.45±0.16	11.7±1.0	30.6±0.9	4.7±0.1
C-20	1.20±0.01	0.59±0.10	13.5±0.7	17.6±0.6	2.8±0.1
C-23	0.53±0.01	0.32±0.07	23.3±0.6	13.8±0.5	2.1±0.1
C-25	1.66±0.01	1.61±0.15	13.9±0.9	27.1±0.5	4.4±0.1

BEAUFORT SEA

Station	Na(%)	K(%)	As	La	Sm
B-1	1.10±0.01	2.16±0.14	17.6±0.9	35.3±0.6	5.1±0.1
B-3	0.89±0.01	1.65±0.12	15.7±0.8	37.3±0.6	5.1±0.1
B-7	0.95±0.01	1.99±0.13	17.9±0.9	34.8±0.6	5.2±0.1
B-8	3.19±0.01	2.72±0.23	54.6±1.4	35.0±0.7	5.3±0.1
B-12	2.07±0.01	1.68±0.18	22.9±1.0	32.0±0.6	5.0±0.1

TABLE C.4 (cont'd.)

COOK INLET

Station	Na(%)	K(%)	As	La	Sm
CB-1	2.60±0.01	1.28±0.19	8.07±0.9	22.4±0.6	3.8±0.1
CB-3	2.55±0.01	1.50±0.18	6.1±0.9	22.2±0.6	3.9±0.1
CB-6	2.13±0.01	1.49±0.15	7.8±0.8	11.7±0.5	2.0±0.1
CB-7	2.61±0.01	1.34±0.19	7.7±0.9	16.2±0.6	3.0±0.1
CB-8	2.46±0.01	1.24±0.20	12.4±1.0	23.6±0.6	4.3±0.1

SHELIKOF STRAIT

Station	Na(%)	K(%)	As	La	Sm
SS-2 Surface	3.82±0.01	1.71±0.27	11.4±1.1	18.7±0.7	3.8±0.1
SS-2	3.10±0.01	1.39±0.25	9.6±1.2	20.0±0.6	4.1±0.1
SS-4	3.00±0.01	1.56±0.21	10.7±1.1	15.1±0.6	3.3±0.1
SS-5	3.55±0.01	1.56±0.24	10.8±1.1	23.1±0.6	4.4±0.1
SS-8	3.25±0.01	1.85±0.22	14.1±1.1	22.2±0.7	4.4±0.1
SS-10	3.30±0.01	1.45±0.24	8.5±1.4	20.7±0.7	4.2±0.1

TABLE C.5 Sc, Cr, Fe, Co, Sb, Ba, Cs, Eu, Tb, Ta and Th Concentrations in Cook Inlet, Shelikof Strait, Chukchi Sea, Norton Sound and Beaufort Sea Surficial Sediments.

(ppm EXCEPT WHERE NOTED)

		Sc	Cr	Fe(%)	Co	Sb	Ba	Cs	Eu	Tb	Ta	Th
NORTON SOUND												
STATION	N-1	9.40 ± 0.08	96 ± 2	2.34 ± 0.07	8.49 ± 0.05	0.68 ± 0.06	790 ± 30	1.85 ± 0.09	0.92 ± 0.03	0.58 ± 0.05	0.68 ± 0.05	5.48 ± 0.07
	N-5	11.52 ± 0.08	83 ± 1	3.16 ± 0.08	12.53 ± 0.17	0.97 ± 0.05	730 ± 20	0.66 ± 0.05	1.08 ± 0.02	0.78 ± 0.06	0.75 ± 0.08	7.36 ± 0.06
	N-9	16.98 ± 0.08	114 ± 2	4.92 ± 0.09	19.05 ± 0.10	1.79 ± 0.08	970 ± 30	5.61 ± 0.17	1.36 ± 0.02	0.84 ± 0.06	0.93 ± 0.09	11.6 ± 0.1
	N-15	10.49 ± 0.08	71 ± 1	2.76 ± 0.05	11.27 ± 0.23	1.03 ± 0.07	620 ± 30	2.42 ± 0.10	1.03 ± 0.03	0.69 ± 0.06	0.65 ± 0.07	6.62 ± 0.07
	N-20	8.00 ± 0.06	67 ± 1	2.10 ± 0.04	9.31 ± 0.06	0.76 ± 0.04	670 ± 20	2.44 ± 0.08	1.02 ± 0.02	0.64 ± 0.05	0.72 ± 0.07	6.92 ± 0.06
	N-26	8.80 ± 0.09	47 ± 1	2.49 ± 0.05	7.29 ± 0.08	0.84 ± 0.06	520 ± 30	2.18 ± 0.09	0.87 ± 0.02	0.62 ± 0.05	1.32 ± 0.13	4.75 ± 0.06
CHUKCHI SEA												
STATION	C-3	8.62 ± 0.04	229 ± 3	2.26 ± 0.01	8.48 ± 0.05	0.73 ± 0.04	540 ± 20	1.97 ± 0.05	0.92 ± 0.01	0.42 ± 0.01	0.65 ± 0.04	6.46 ± 0.07
	C-7	8.29 ± 0.03	333 ± 4	2.47 ± 0.02	11.46 ± 0.08	0.69 ± 0.05	480 ± 20	2.08 ± 0.08	0.90 ± 0.02	0.41 ± 0.02	0.62 ± 0.05	6.79 ± 0.08
	C-10	6.81 ± 0.04	247 ± 3	1.91 ± 0.01	7.24 ± 0.07	0.49 ± 0.03	430 ± 20	1.27 ± 0.04	0.78 ± 0.01	0.35 ± 0.01	0.58 ± 0.05	4.20 ± 0.05
	C-14	12.46 ± 0.04	93 ± 1	3.37 ± 0.01	11.68 ± 0.24	0.98 ± 0.07	730 ± 40	3.61 ± 0.10	1.11 ± 0.02	0.54 ± 0.02	0.81 ± 0.06	8.15 ± 0.10
	C-20	4.67 ± 0.03	80 ± 1	1.80 ± 0.01	7.31 ± 0.12	0.58 ± 0.03	650 ± 20	1.46 ± 0.03	0.65 ± 0.01	0.34 ± 0.01	0.34 ± 0.02	3.87 ± 0.44
	C-23	3.31 ± 0.01	150 ± 2	1.89 ± 0.01	5.57 ± 0.03	0.50 ± 0.02	660 ± 20	0.87 ± 0.03	0.49 ± 0.01	0.25 ± 0.01	0.17 ± 0.02	2.36 ± 0.03
	C-25	4.74 ± 0.02	41 ± 2	1.42 ± 0.01	4.98 ± 0.02	0.40 ± 0.03	---	1.47 ± 0.04	0.48 ± 0.01	0.24 ± 0.02	0.33 ± 0.03	3.43 ± 0.06
BEAUFORT SEA												
STATION	B-1	12.79 ± 0.02	82 ± 3	3.53 ± 0.02	13.93 ± 0.07	0.88 ± 0.04		7.28 ± 0.11	1.01 ± 0.02	0.49 ± 0.04	0.81 ± 0.07	10.1 ± 0.2
	B-3	10.16 ± 0.04	85 ± 3	2.97 ± 0.03	11.76 ± 0.07	0.70 ± 0.04		5.48 ± 0.09	1.01 ± 0.02	0.47 ± 0.04	0.70 ± 0.07	9.13 ± 0.15
	B-7	12.96 ± 0.02	95 ± 4	3.81 ± 0.03	15.03 ± 0.10	0.72 ± 0.06		6.46 ± 0.12	1.13 ± 0.03	0.52 ± 0.04	0.83 ± 0.08	9.94 ± 0.18
	B-8	15.77 ± 0.02	97 ± 4	5.48 ± 0.06	17.05 ± 0.09	1.20 ± 0.06		7.92 ± 0.13	1.19 ± 0.03	0.53 ± 0.04	0.84 ± 0.08	10.7 ± 0.2
	B-12	12.21 ± 0.06	89 ± 4	3.72 ± 0.04	12.93 ± 0.07	0.74 ± 0.05		5.93 ± 0.10	1.06 ± 0.02	0.51 ± 0.04	0.81 ± 0.07	9.29 ± 0.16
COOK INLET												
STATION	CB-1	13.23 ± 0.02	65 ± 2	3.52 ± 0.01	12.82 ± 0.06	0.72 ± 0.04		2.38 ± 0.05	0.72 ± 0.01	0.33 ± 0.02	0.45 ± 0.03	5.22 ± 0.07
	CB-3	7.39 ± 0.05	35 ± 1	2.04 ± 0.01	8.23 ± 0.04	0.48 ± 0.03		1.33 ± 0.04	0.65 ± 0.01	0.28 ± 0.02	0.38 ± 0.03	2.47 ± 0.05
	CB-7	12.77 ± 0.03	69 ± 2	3.33 ± 0.02	14.68 ± 0.12	0.63 ± 0.07		2.33 ± 0.07	0.84 ± 0.02	0.35 ± 0.02	0.51 ± 0.06	4.31 ± 0.10
	CB-8	18.97 ± 0.16	108 ± 3	5.15 ± 0.02	20.80 ± 0.11	2.15 ± 0.10		4.85 ± 0.11	1.11 ± 0.02	0.45 ± 0.03	0.70 ± 0.07	5.84 ± 0.12
SHELIKOF STRAIT												
STATION	SS-2 (SURFACE)	16.80 ± 0.03	82 ± 2	4.94 ± 0.02	20.04 ± 0.11	1.23 ± 0.09		4.19 ± 0.09	0.94 ± 0.02	0.41 ± 0.04	0.62 ± 0.07	5.50 ± 0.11
	SS-2	17.26 ± 0.03	85 ± 2	4.82 ± 0.02	19.63 ± 0.11	1.27 ± 0.08		4.45 ± 0.10	1.00 ± 0.02	0.51 ± 0.04	0.84 ± 0.08	5.80 ± 0.13
	SS-4	16.74 ± 0.04	47 ± 2	4.62 ± 0.03	17.84 ± 0.19	0.77 ± 0.11		2.17 ± 0.15	0.91 ± 0.03	0.35 ± 0.04	0.30 ± 0.06	3.50 ± 0.18
	SS-5	17.55 ± 0.03	98 ± 3	4.95 ± 0.02	19.61 ± 0.27	1.22 ± 0.09		4.76 ± 0.11	1.02 ± 0.02	0.46 ± 0.04	0.75 ± 0.08	6.60 ± 0.15
	SS-8	18.45 ± 0.03	101 ± 3	5.22 ± 0.02	21.00 ± 0.28	1.17 ± 0.08		5.02 ± 0.10	1.05 ± 0.02	0.53 ± 0.04	0.72 ± 0.08	6.64 ± 0.14
	SS-10	16.2 ± 0.03	73 ± 2	4.29 ± 0.02	15.98 ± 0.33	0.93 ± 0.08		3.34 ± 0.10	0.97 ± 0.02	0.42 ± 0.04	0.54 ± 0.07	5.66 ± 0.14

TABLE C.6 Regional Average Concentrations of Major and Trace Metals

	Eastern Bering Sea (12 samples)	Northwest Gulf of Alaska (10 samples)	Northeast Gulf of Alaska (15 samples)
Al(%)	6.09±0.96	6.02±2.13	7.24±0.85
Ca(%)	2.86±0.90	6.91±8.24	4.10±2.20
Fe(%)	2.84±0.55	3.25±1.47	4.64±0.88
Ba(ppm)	531±269	558±188	503±118
Mn(ppm)	494±119	756±287	813±111
V(ppm)	93±17	106±49	147±28
Cr(ppm)	64±21	84±55	126±22
Co(ppm)	9.9±1.9	12±5.6	18±3.4
Sc(ppm)	11±1.9	13±4.7	18±3.2
As(ppm)	3.6±1.5	4.8±1.7	3.6±2.1
Sb(ppm)	0.63±0.15	0.47±0.21	0.46±0.18

TABLE C.6 (cont'd.)

	Norton Sound (6 samples)	Chukchi Sea (7 samples)	Beaufort Sea (5 samples)
Al (%)	5.79 ± 0.96	4.23 ± 1.53	6.65 ± 1.03
Fe (%)	2.96 ± 1.03	2.16 ± 0.63	3.90 ± 0.94
Ba (ppm)	720 ± 150	580 ± 120	---
Mn (ppm)	458 ± 92	335 ± 117	564 ± 254
V (ppm)	96 ± 33	83 ± 27	146 ± 26
Cr (ppm)	80 ± 23	168 ± 106	90 ± 6
Co (ppm)	11.3 ± 4.2	8.10 ± 2.64	14.1 ± 2.0
Sc (ppm)	10.9 ± 3.2	6.99 ± 3.12	12.78± 2.01
As (ppm)	10.9 ± 4.7	12.4 ± 5.5	25.7 ± 16.4
Sb (ppm)	1.01 ± 0.40	0.62 ± 0.19	0.85 ± 0.21
Eu (ppm)	1.05 ± 0.17	0.76 ± 0.24	1.08 ± 0.08
Th (ppm)	7.12 ± 2.40	5.04 ± 2.11	9.83 ± 0.64

TABLE C.7 Western Gulf of Alaska Surficial Sediment Elemental Correlation Matrix

	As	Ba	Co	Cr	Fe	Sb	Sc	Al	Ca	Mn	V
As	1	.285	.707^{x}	.534	.713^{x}	.661	.716^{x}	.466	-.338	.642	.582
Ba		1	.334	.734^{x}	.444	.436	.521	.493	-.550	.487	.582
Co			1	.596	.950^{xx}	.706^{x}	.921^{xx}	.863^{xx}	-.738^{x}	.629	.745^{x}
Cr				1	.648	.679^{x}	.688^{x}	.570	-.774^{x}	.337	.435
Fe					1	.658	.991^{xx}	.915^{xx}	-.782^{x}	.715^{x}	.811^{x}
Sb						1	.613	.500	-.544	.495	.474
Sc							1	.906^{xx}	-.793^{x}	.704^{x}	.814^{xx}
Al								1	-.847^{xx}	.733^{x}	.880^{xx}
Ca									1	-.361	-.569
Mn										1	.948^{xx}
V											1

^{x} Significant at 0.5

^{xx} Significant at 0.1

TABLE C.8 Eastern Gulf of Alaska Surficial Sediment Elemental Correlation Matrix

	As	Ba	Co	Cr	Fe	Sb	Sc	Al	Ca	Mn	V
As	1	.131	.252	.184	.280	-.209	.077	.236	-.534	-.091	.111
Ba		1	.166	.063	.068	.231	-.348	.212	-.141	.134	.109
Co			1	.433	.801^{xx}	.019	.652^{x}	.350	-.002	.663^{x}	.501
Cr				1	.704^{xx}	.312	.202	.403	-.192	.590^{x}	.343
Fe					1	.400	.475	.136	.087	.604^{x}	.371
Sb						1	-.278	-.343	.325	.060	.039
Sc							1	.317	-.089	.351	.472
Al								1	-.744^{xx}	.650^{x}	.762^{xx}
Ca									1	-.242	-.356
Mn										1	.581^{x}
V											1

^{x} Significant at .05

^{xx} Significant at .01

TABLE C.9 Bering Sea - Bristol Bay Surficial Sediment Elemental Correlation Matrix

	As	Ba	Co	Cr	Fe	Sb	Sc	Al	Ca	Mn	V
As	1	-.127	.794^{x}	-.174	.306	.797^{x}	.059	.018	-.385	.212	-.199
Ba		1	-.335	.934^{xx}	-.470	.142	-.721^{x}	-.227	-.157	-.622	-.535
Co			1	-.412	.724^{x}	.433	.406	-.253	-.041	.678^{x}	.305
Cr				1	-.549	-.002	-.752^{x}	-.182	-.157	-.691^{x}	-.653
Fe					1	.045	.765^{x}	-.319	-.503	.704^{x}	.774^{x}
Sb						1	-.009	-.091	-.600	-.019	-.274
Sc							1	-.393	.088	.762^{x}	.755^{x}
Al								1	-.183	-.453	-.187
Ca									1	.391	.188
Mn										1	.713^{x}
V											1

^{x} Significant at .05

^{xx} Significant at .01

TABLE C.10 Silver Concentrations in Selected Alaskan Shelf Surficial Sediments

Bristol Bay

MB-12	0-3cm	0.072	±	0.015
MB-28	0-3cm	0.075	±	0.014
MB-29	0-4cm	0.054	±	0.014
MB-37	0-2cm	0.088	±	0.010
MB-41	0-2cm	0.042	±	0.010
MB-43	0-2cm	0.089	±	0.012
MB-56	0-2cm	0.091	±	0.014
MB-59	0-2cm	0.074	±	0.013
MB-64	0-2cm	0.102	±	0.013
	Mean	0.076	±	0.019

Western Gulf of Alaska

GASSW-105	0-2cm	0.072	±	0.015
119	0-2cm	0.065	±	0.015
120	0-2cm	0.091	±	0.016
121	0-2cm	0.131	±	0.021
122	0-2cm	0.088	±	0.022
124	0-2cm	0.168	±	0.021
133	Grab	0.299	±	0.020
134	0-2cm	0.058	±	0.018
135	0-2cm	0.036	±	0.019
	Mean	0.112	±	0.081

Eastern Gulf of Alaska

GASSE - 2	0-2cm	0.047 ± 0.018
26	0-2cm	0.057 ± 0.020
33	0-2cm	0.071 ± 0.019
44	0-2cm	0.083 ± 0.018
48	0-2cm	0.077 ± 0.017
49	0-2cm	0.126 ± 0.023
50	0-2cm	0.066 ± 0.016
51	0-2cm	0.102 ± 0.020
52	0-2cm	0.131 ± 0.024
56	0-2cm	0.135 ± 0.019
57	0-2cm	0.078 ± 0.020
58	0-2cm	0.071 ± 0.014
59A	Van Veen	0.104 ± 0.022
	Mean	0.088 ± 0.029

Concentrations in ppm dry weight

TABLE C.11 Silver Concentrations in Two Sediment Cores from the Alaskan Shelf.

Bristol Bay

MB-64	0-2cm	0.102 ± 0.013
	4-6cm	0.070 ± 0.011
	8-10cm	0.045 ± 0.011
	12-14cm	0.090 ± 0.009
	16-20cm	0.064 ± 0.013
	20-24cm	0.143 ± 0.014

Eastern Gulf of Alaska

GASSE - 49	0-2cm	0.126 ± 0.023
	4-6cm	0.080 ± 0.018
	8-10cm	0.071 ± 0.019
	12-14cm	0.051 ± 0.014
	16-18cm	0.175 ± 0.020

APPENDIX D

Display of Surficial Sediment Composition

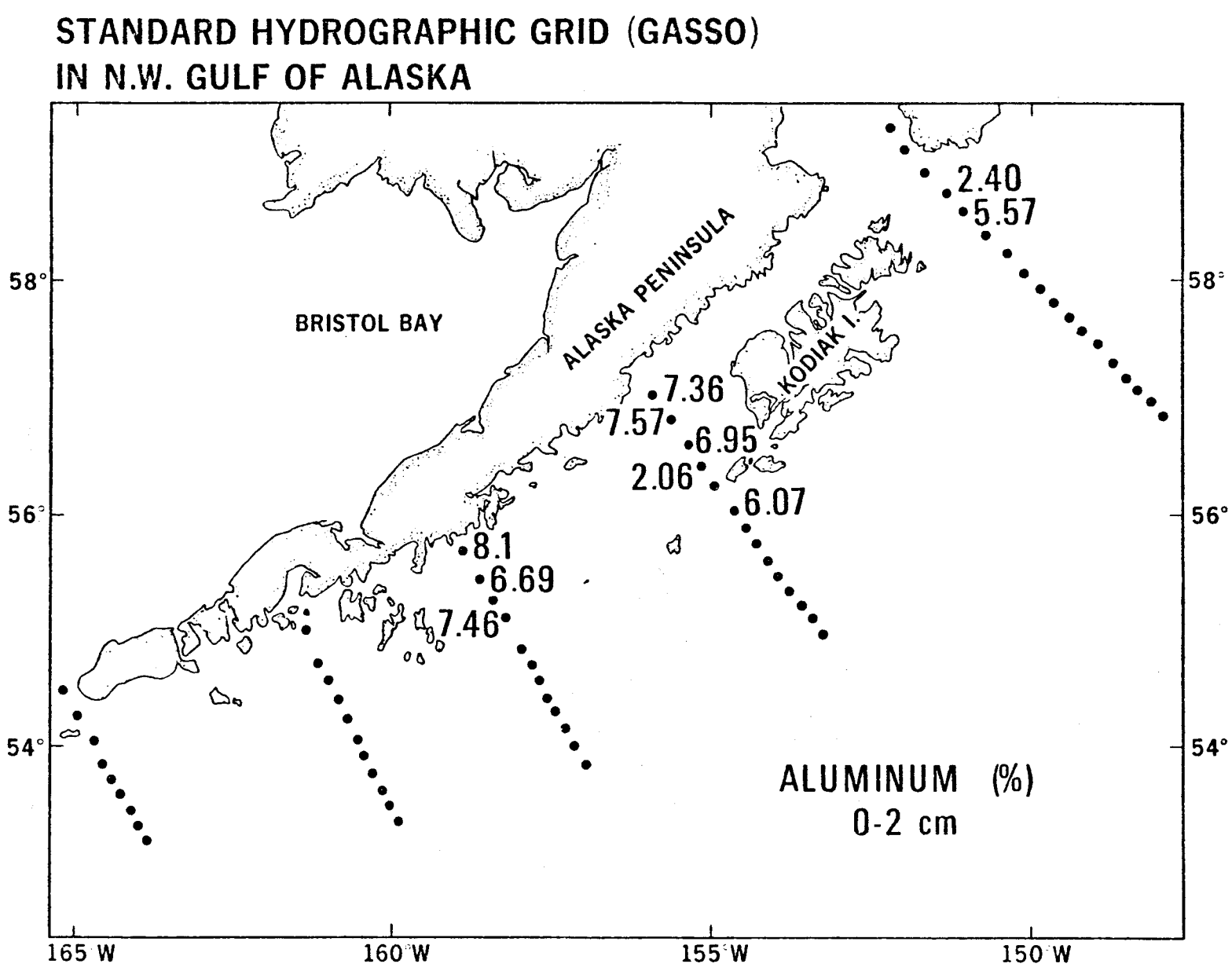


FIGURE D.1 Al Concentrations in N. W. Gulf of Alaska Sediments

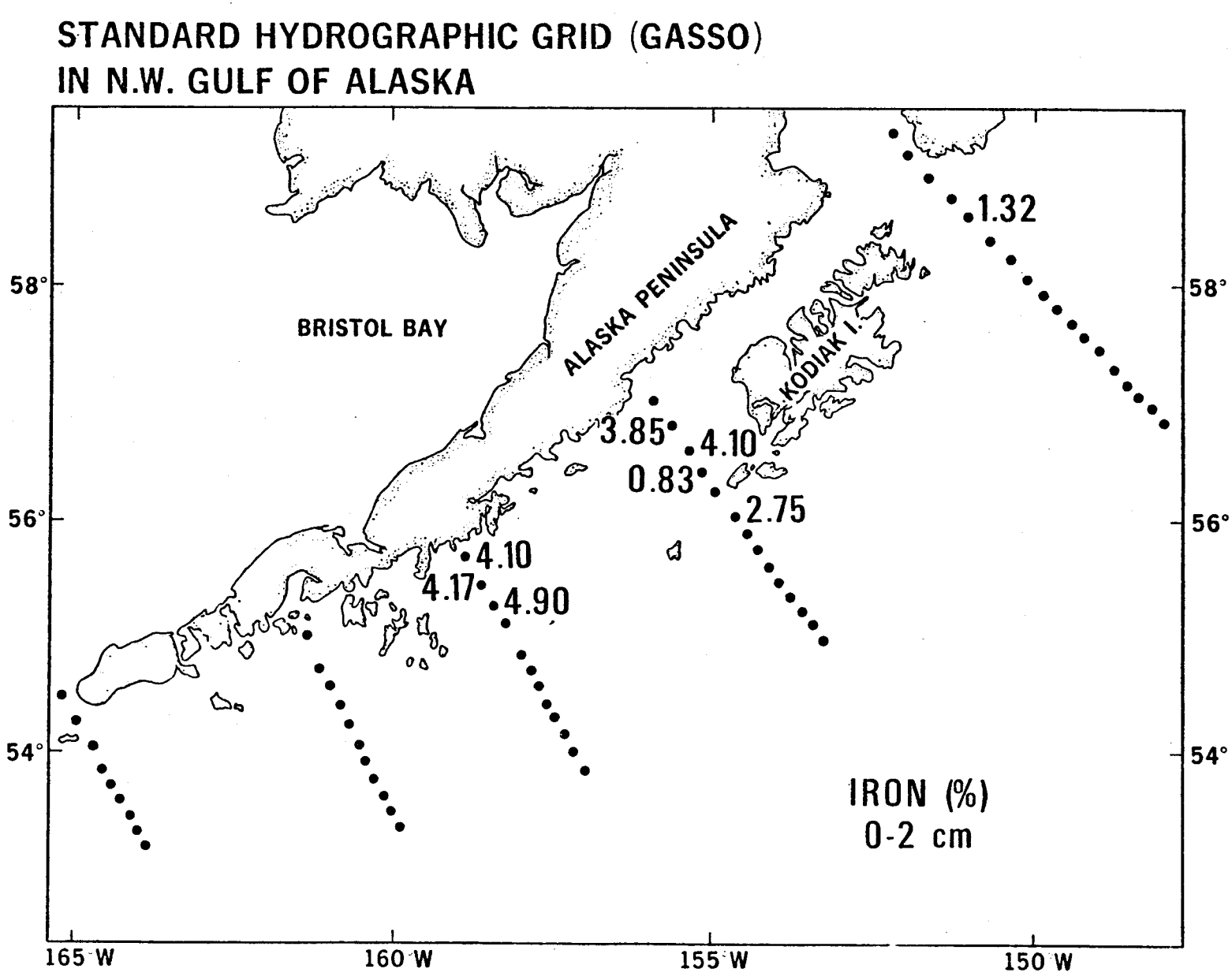


FIGURE D.2 Fe Concentrations in N. W. Gulf of Alaska Sediments

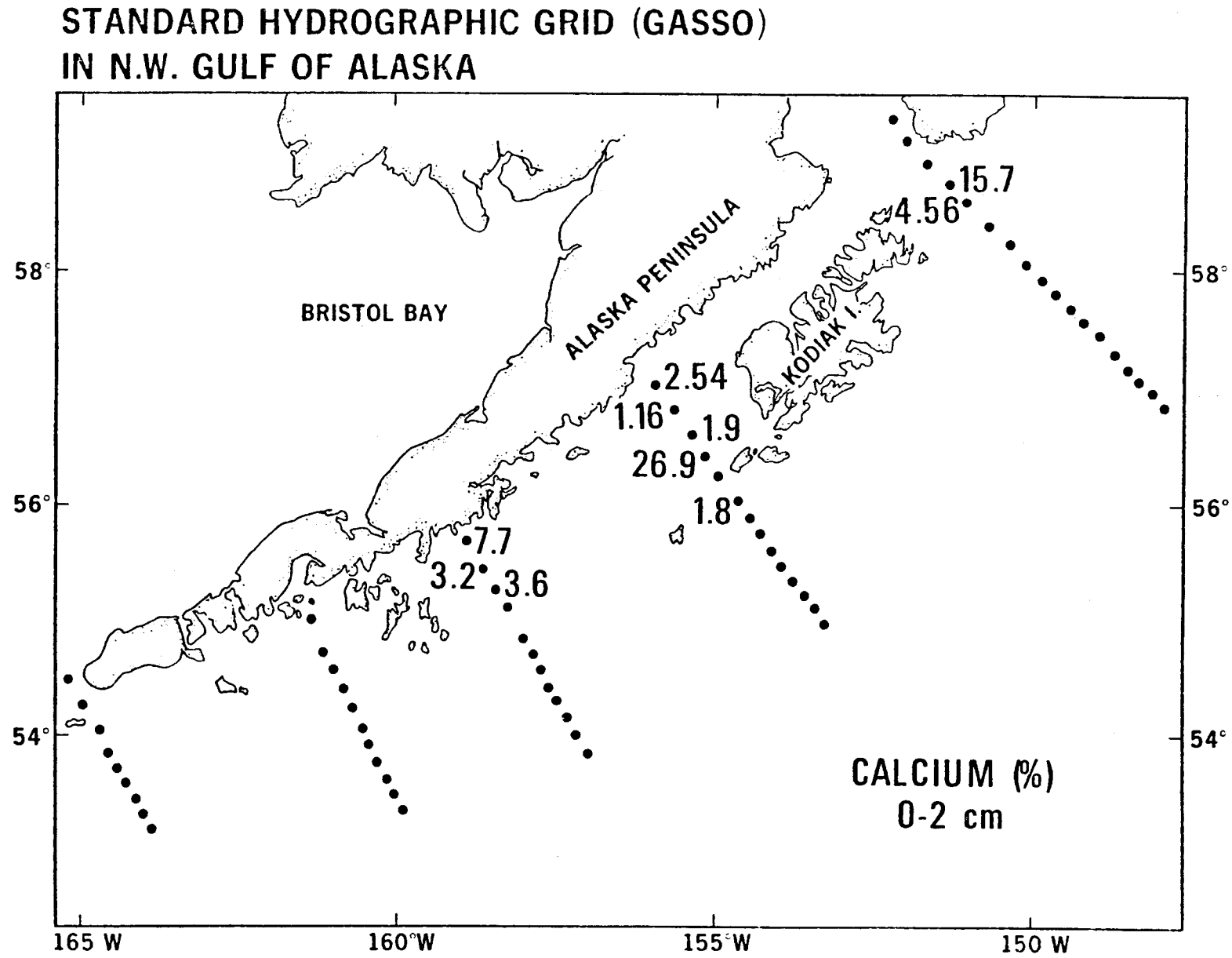


FIGURE D.3 Ca Concentrations in N. W. Gulf of Alaska Sediments

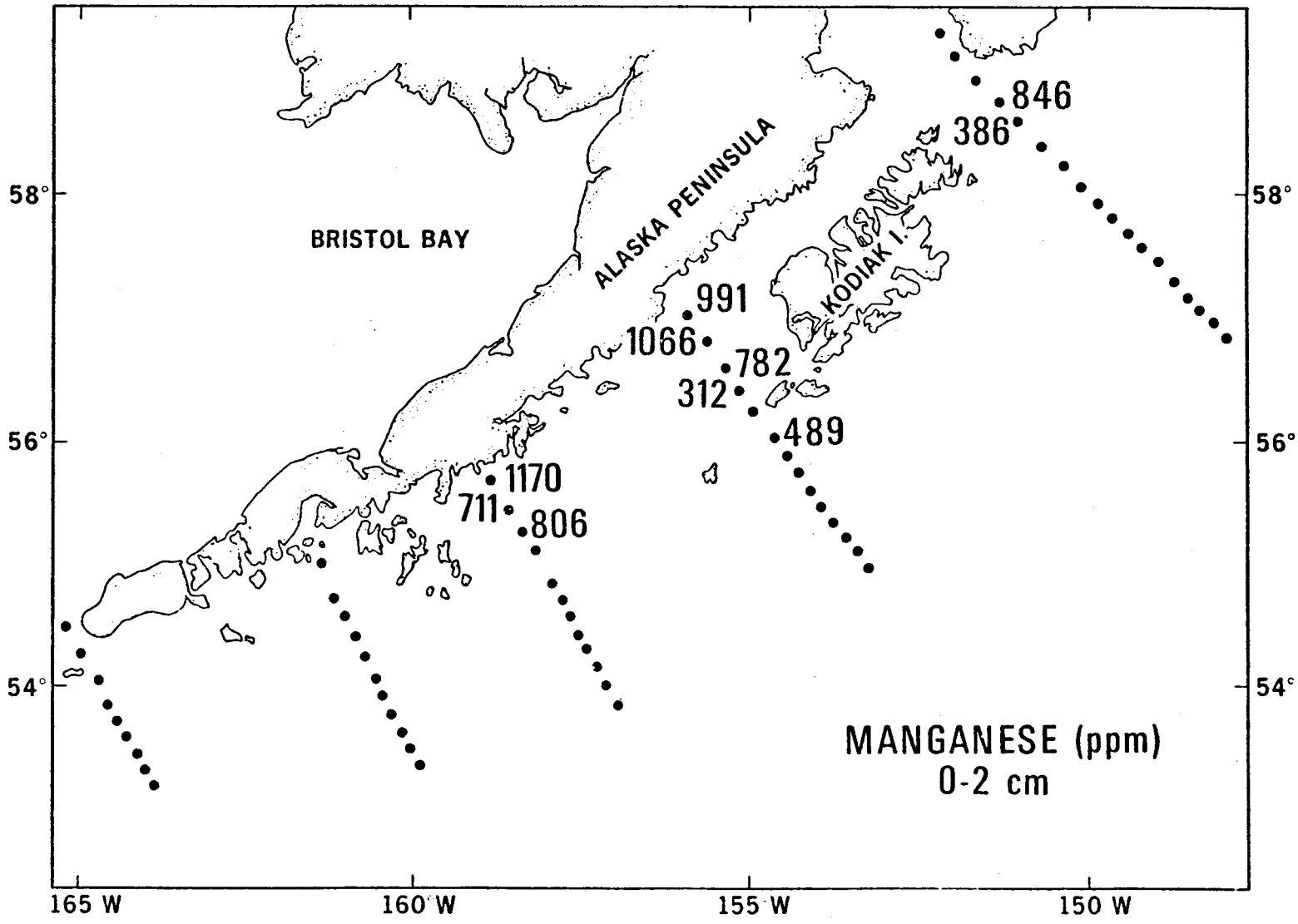

STANDARD HYDROGRAPHIC GRID (GASSO)
IN N.W. GULF OF ALASKA
BRISTOL BAY
ALASKA PENINSULA
KODIAK I.
846
386
991
1066
782
312
489
1170
711
806
58°
56°
54°
165 W
160 W
155 W
150 W
MANGANESE (ppm)
0-2 cm

FIGURE 4

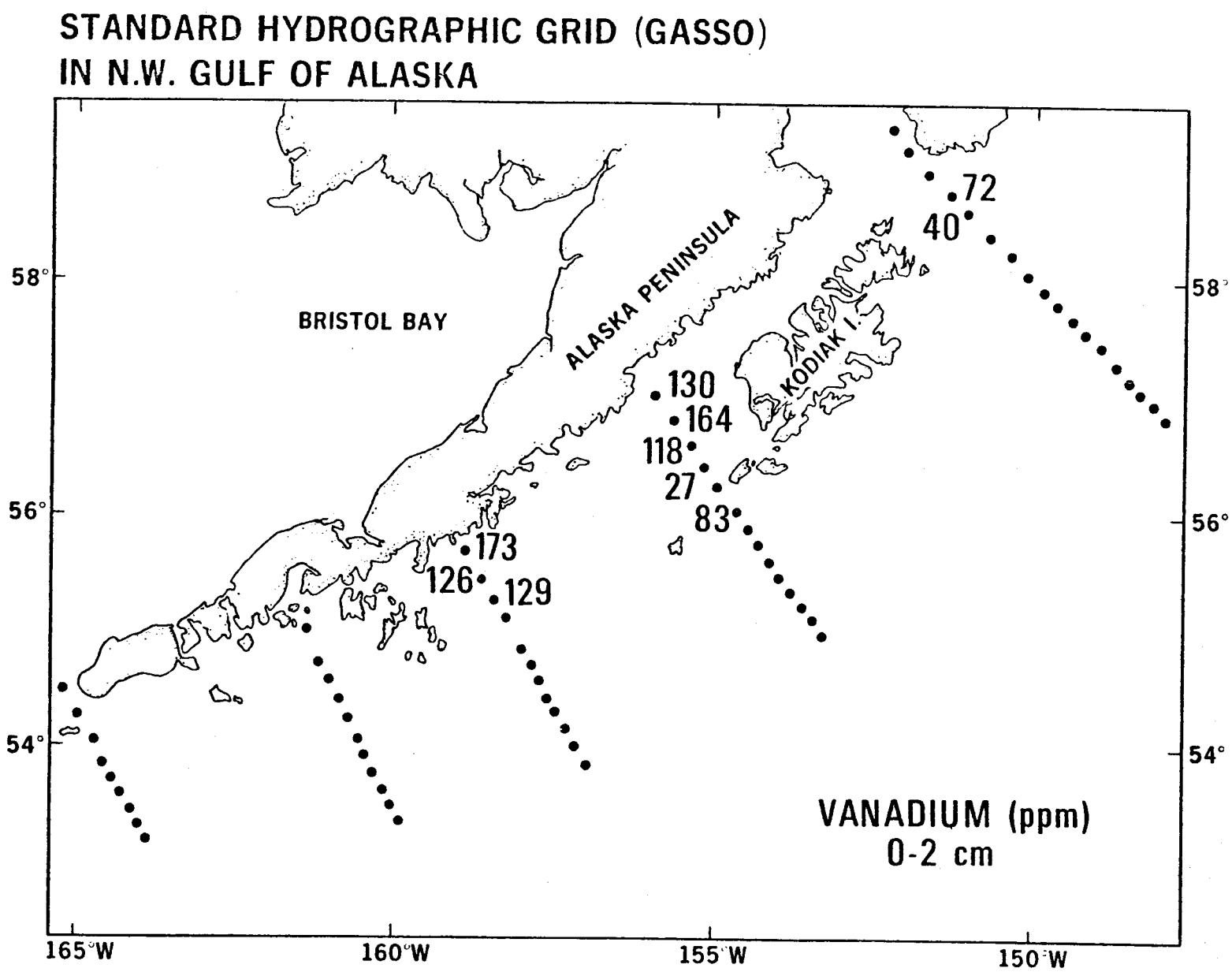


FIGURE D.5 V Concentrations in N. W. Gulf of Alaska Sediments

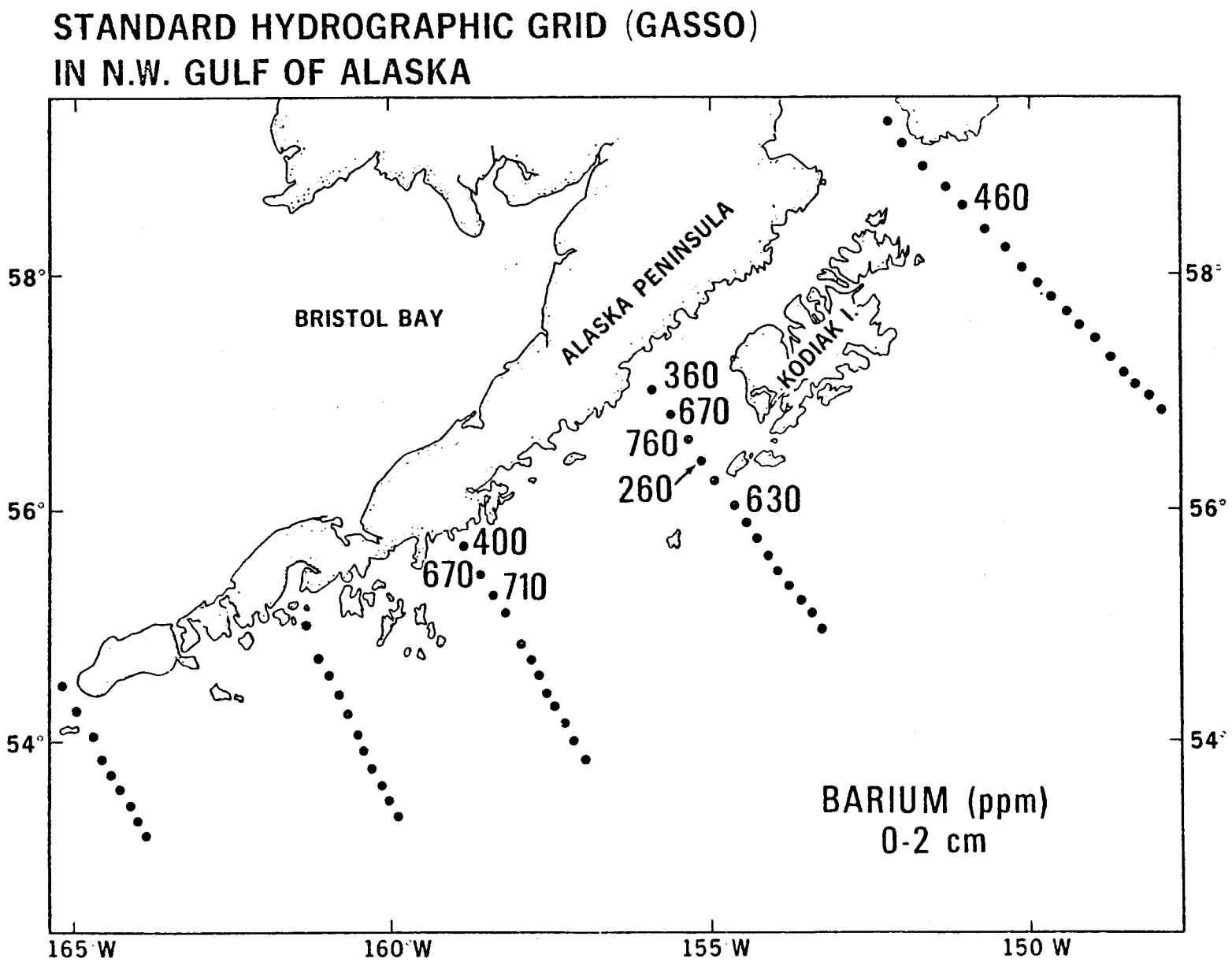


FIGURE D.6 Ba Concentrations in N. W. Gulf of Alaska Sediments

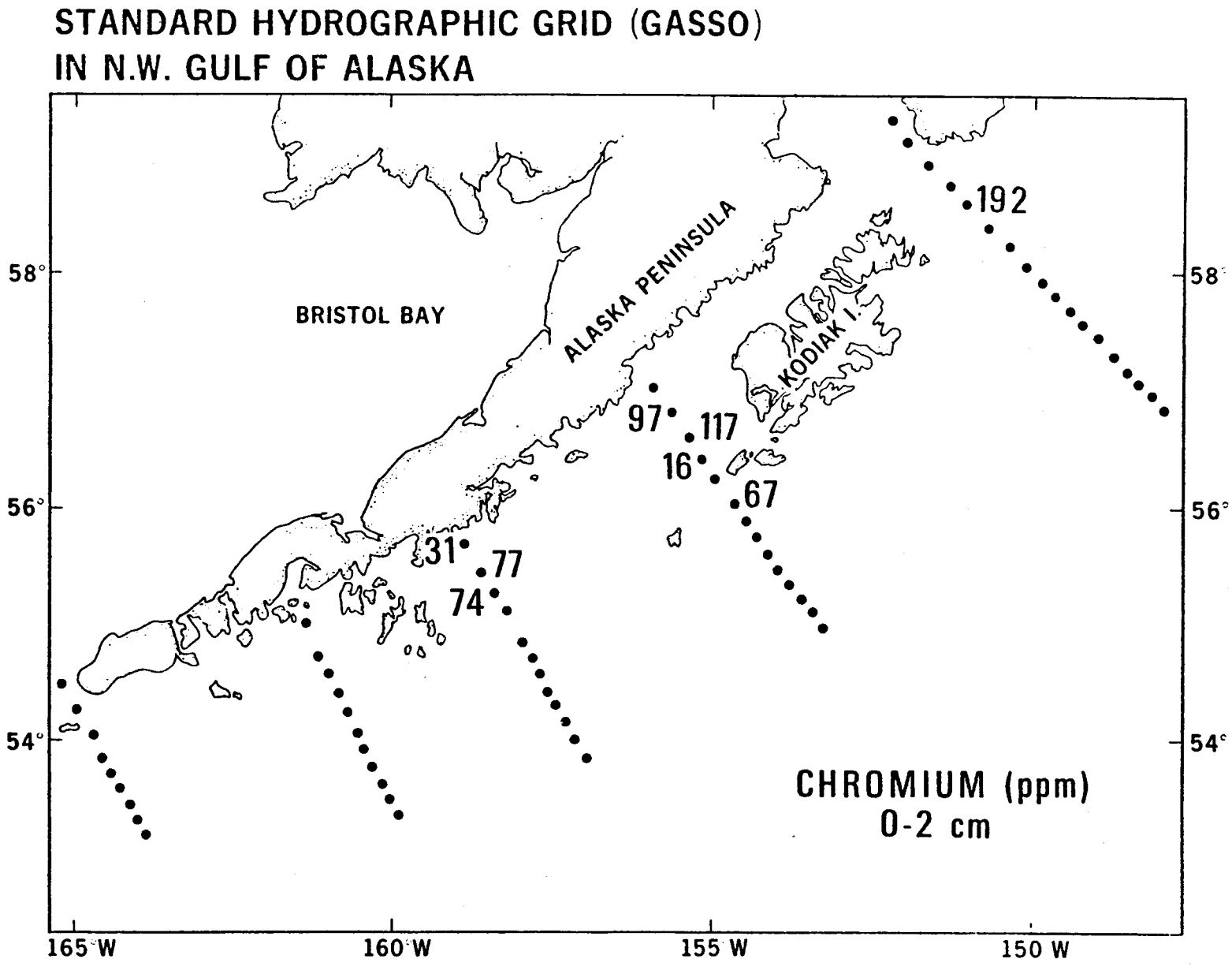


FIGURE D.7 Cr Concentrations in N. W. Gulf of Alaska Sediments

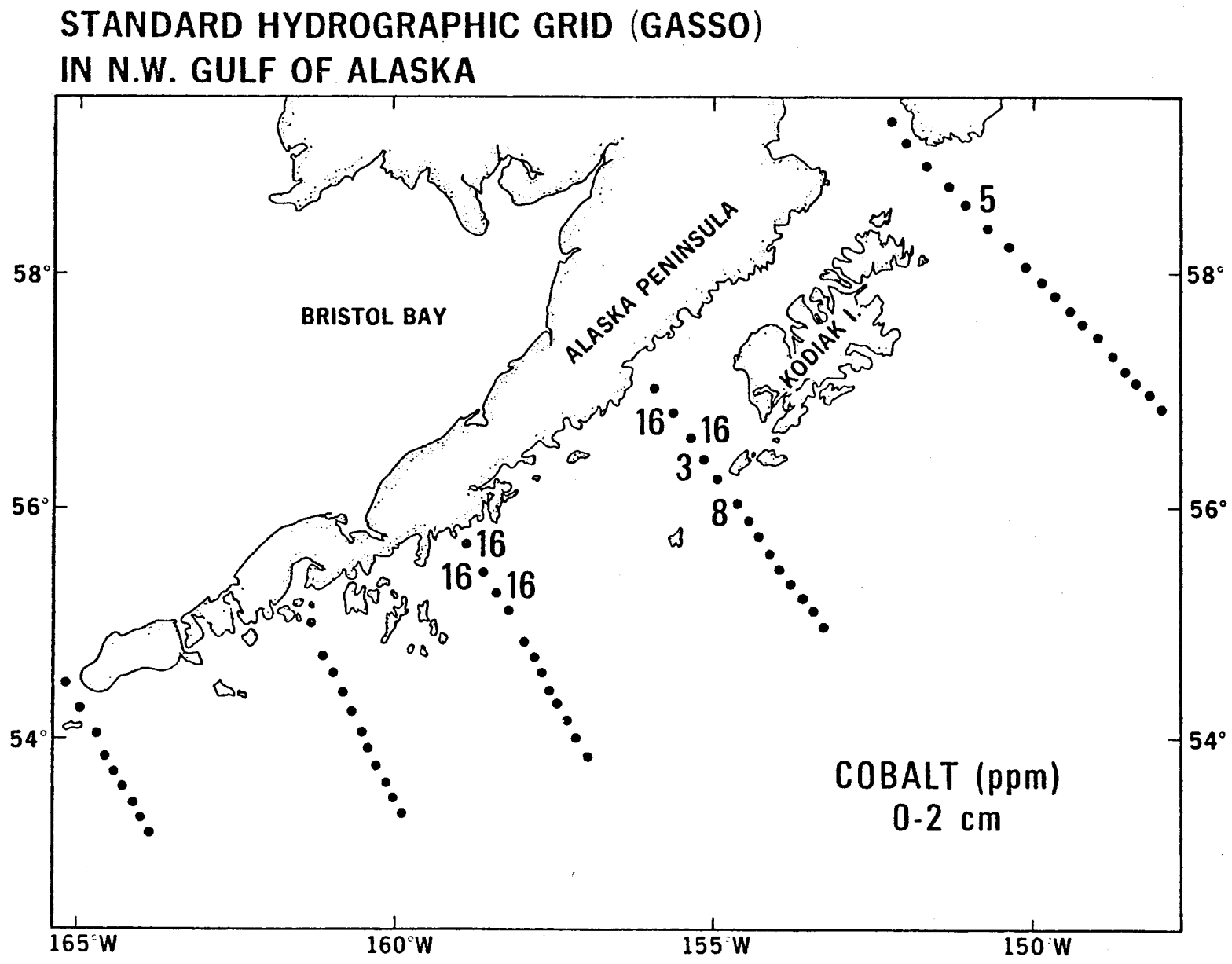


FIGURE D.8 Co Concentrations in N. W. Gulf of Alaska Sediments

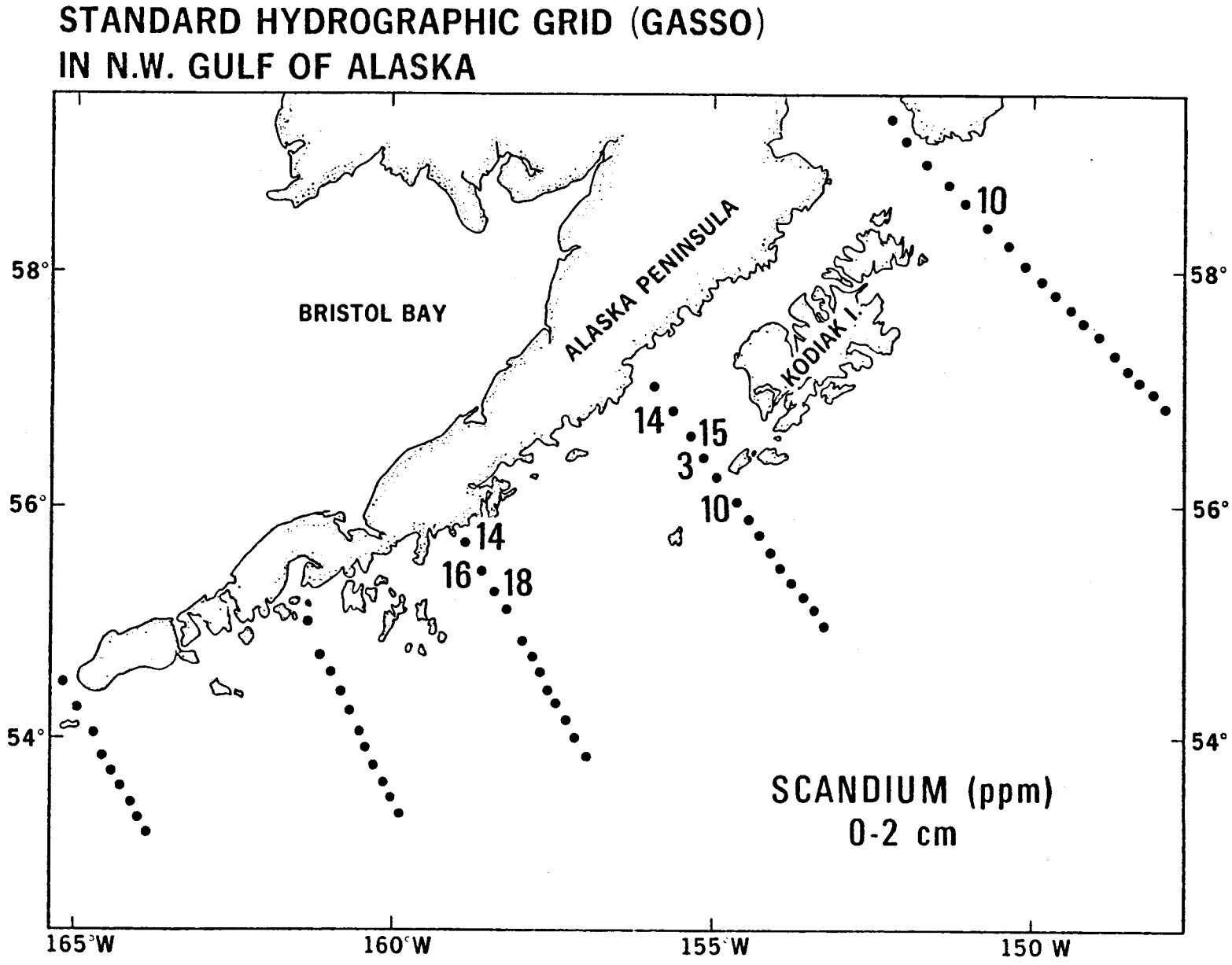


FIGURE D.9 Sc Concentrations in N. W. Gulf of Alaska Sediments

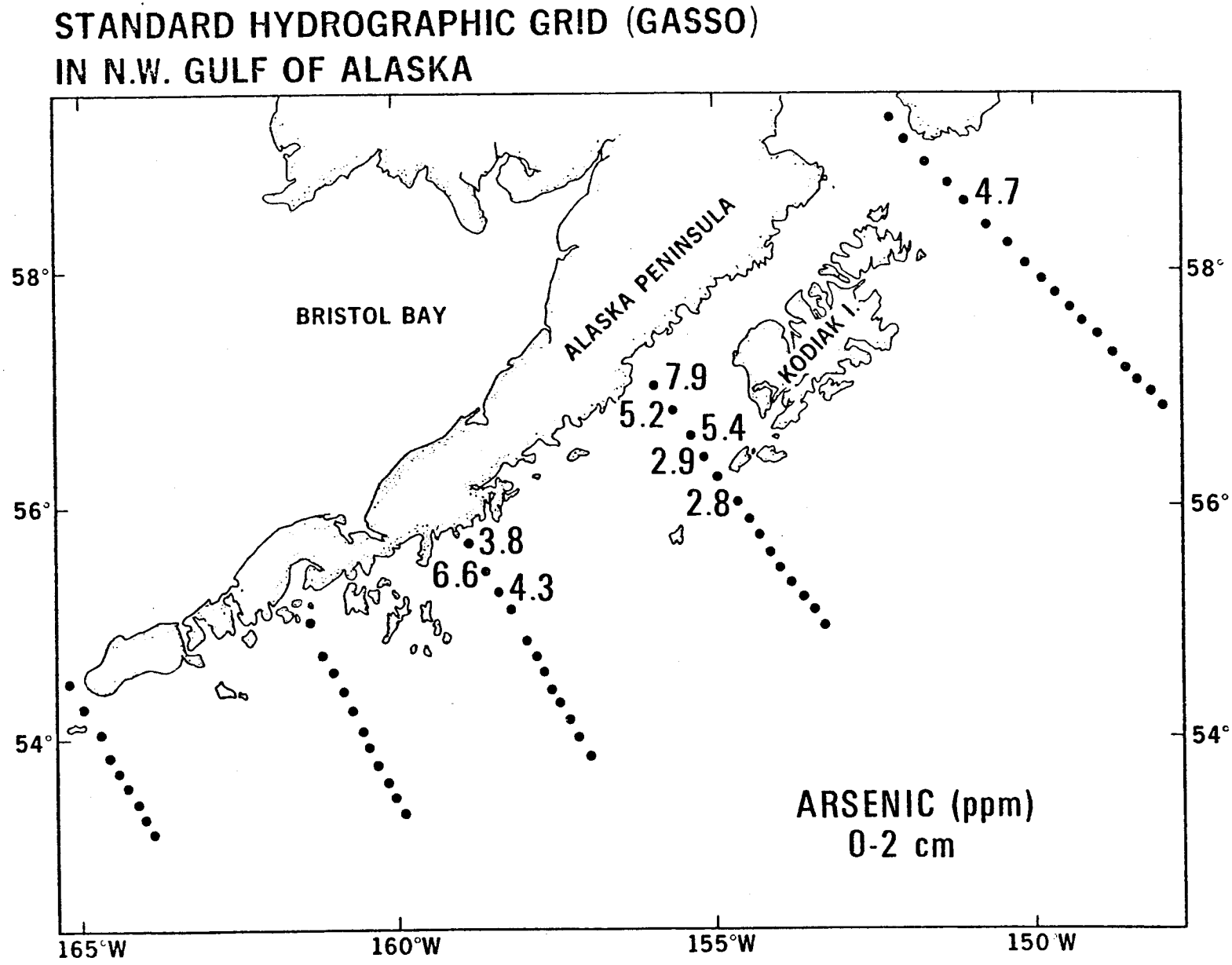


FIGURE D.10 As Concentrations in N. W. Gulf of Alaska Sediments

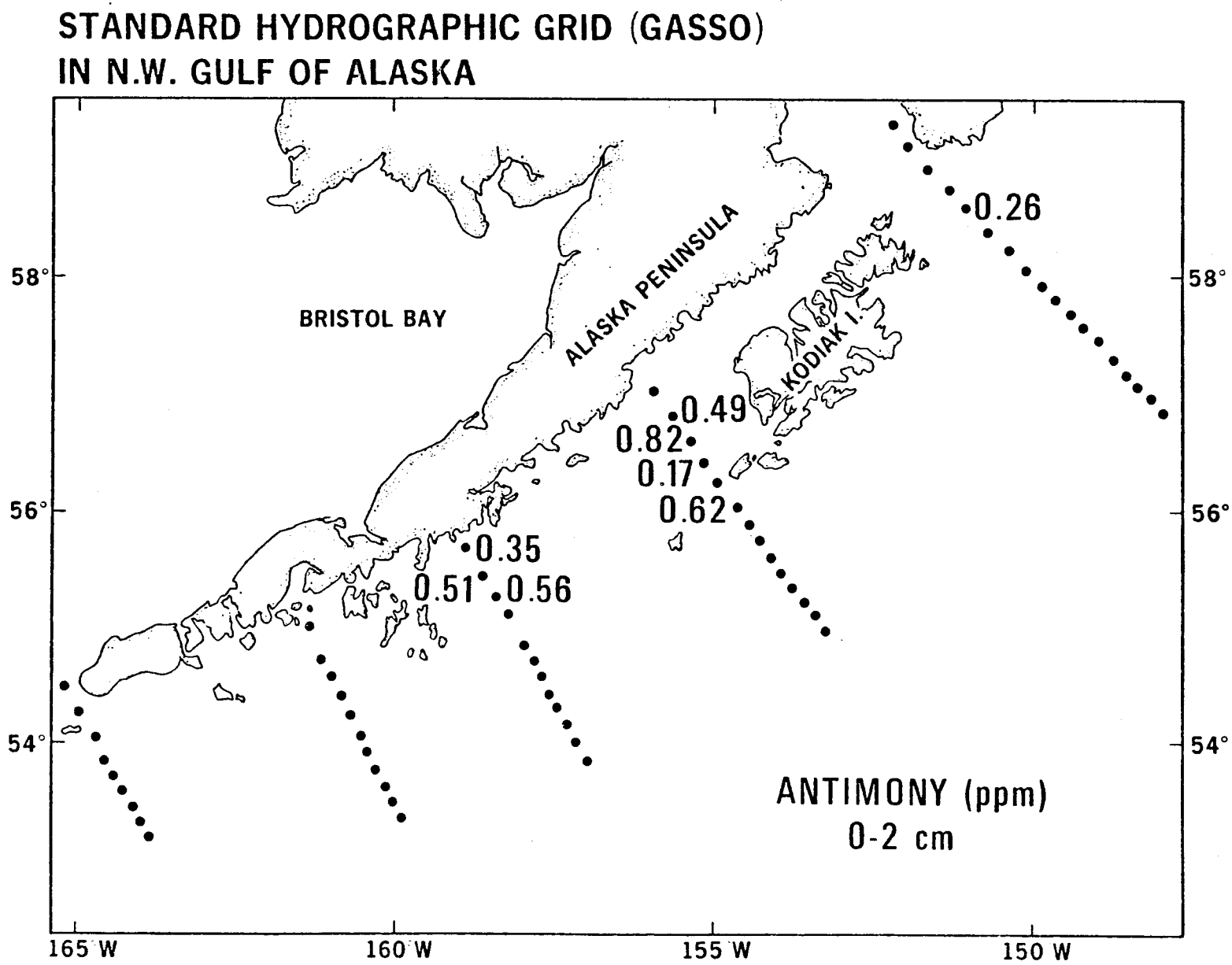


FIGURE D.11 Sb Concentrations in N. W. Gulf of Alaska Sediments

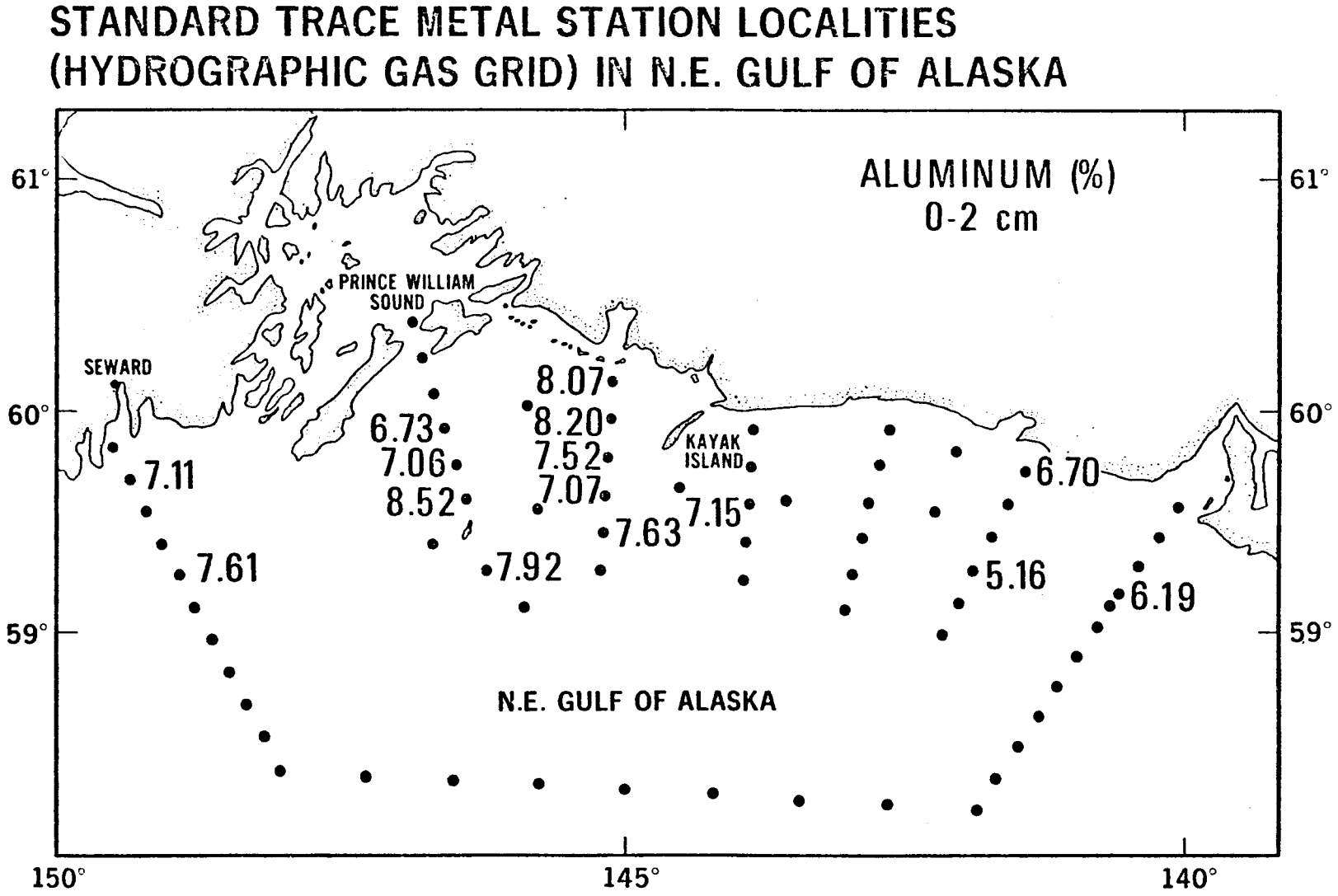


FIGURE D.12 Al Concentrations in N.E. Gulf of Alaska Sediments

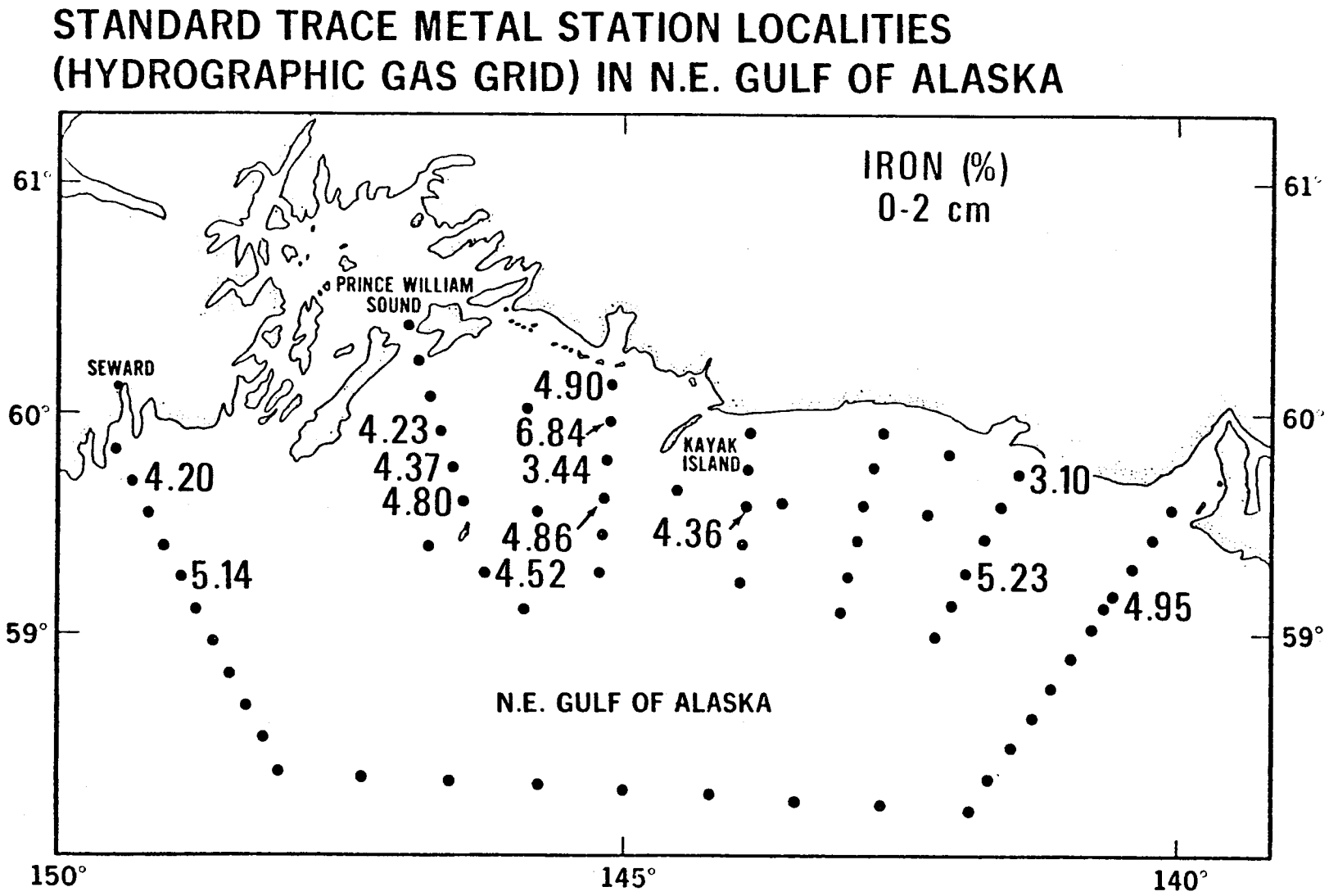


FIGURE D.13 Fe Concentrations in N. E. Gulf of Alaska Sediments

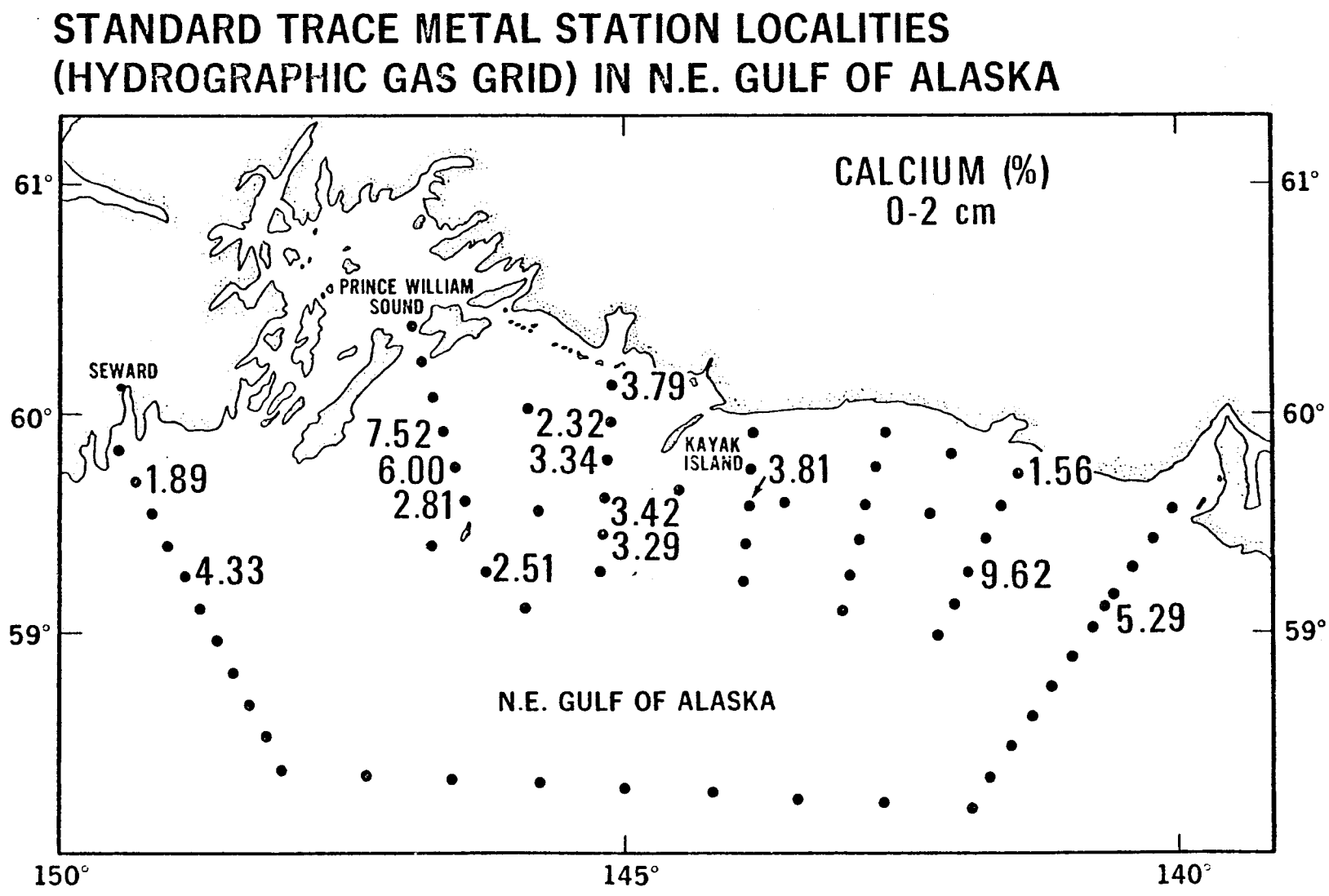
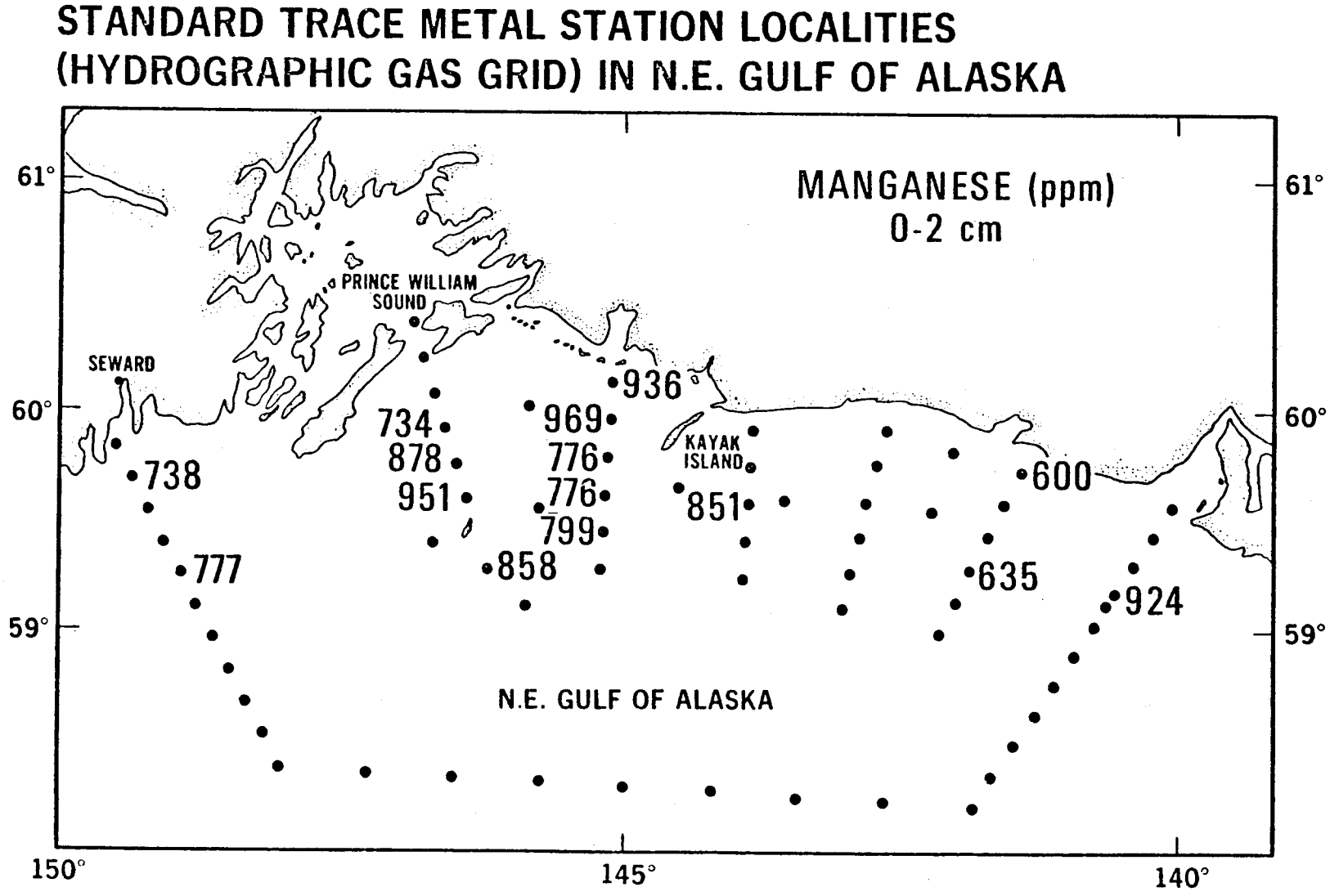


FIGURE D.14 Ca Concentrations in N. E. Gulf of Alaska Sediments



FIGRUE D.15 Mn Concentrations in N. E. Gulf of Alaska Sediments

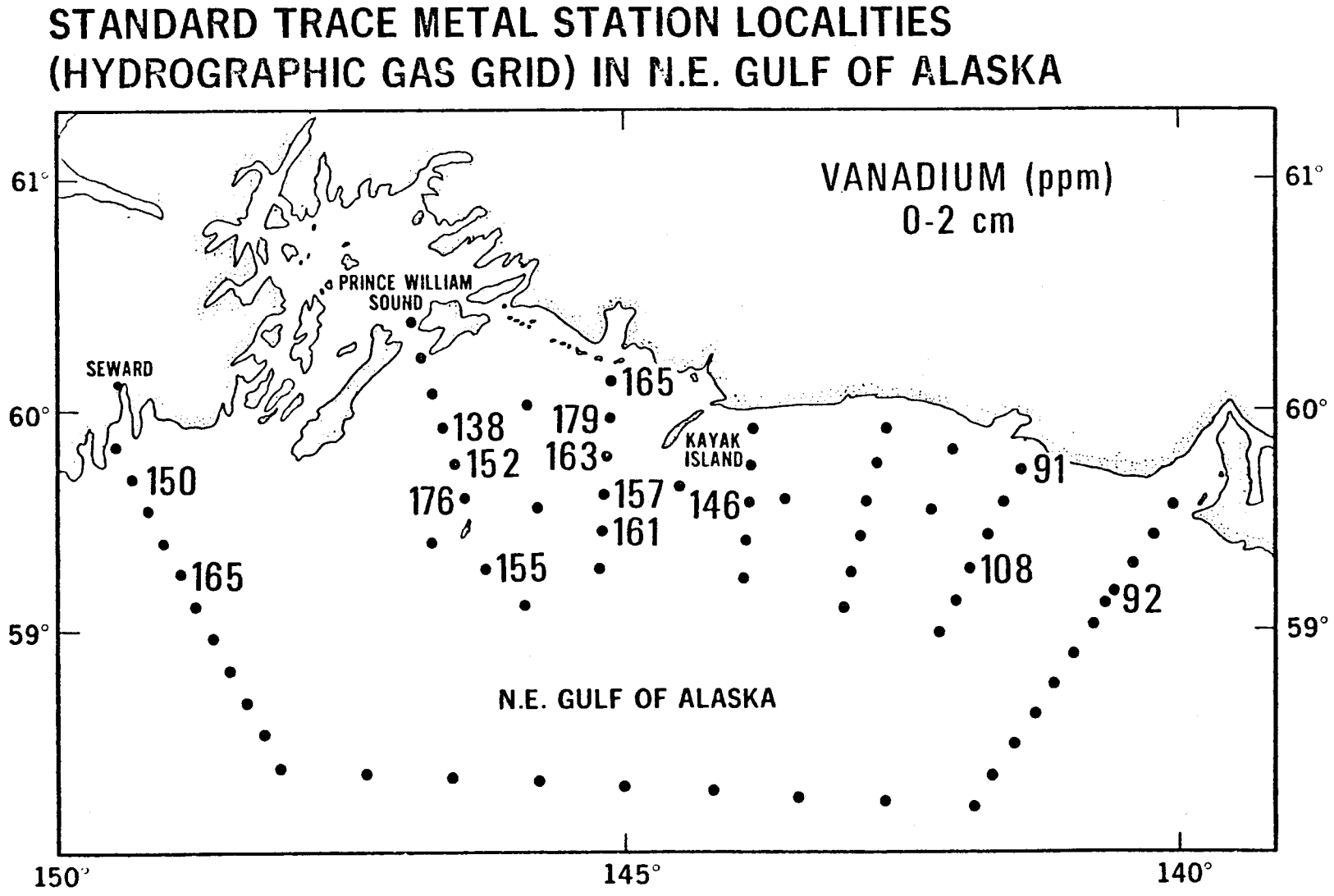


FIGURE D.16 V Concentrations in N. E. Gulf of Alaska Sediments

STANDARD TRACE METAL STATION LOCALITIES (HYDROGRAPHIC GAS GRID) IN N.E. GULF OF ALASKA

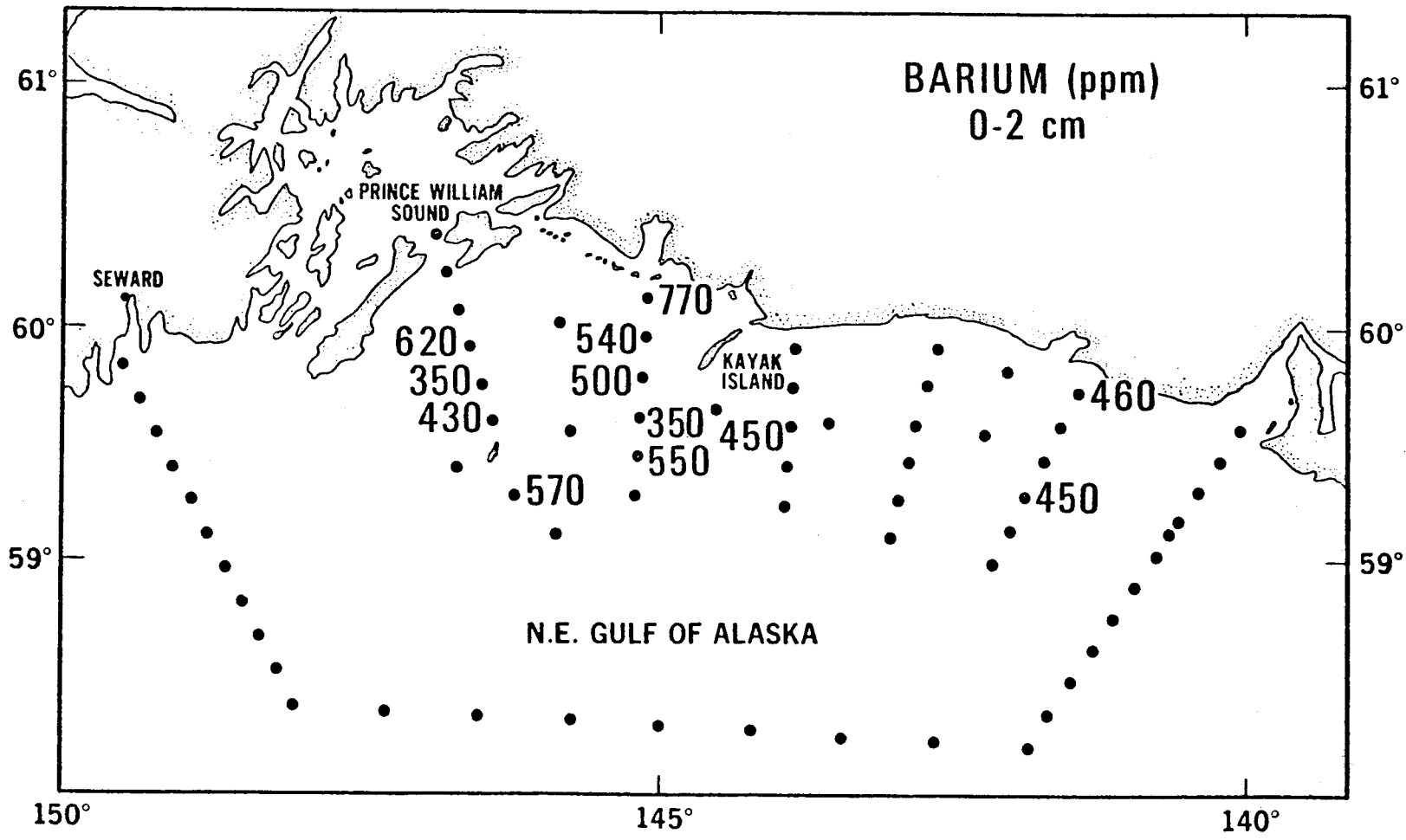


FIGURE D.17 Ba Concentrations in N. E. Gulf of Alaska Sediments

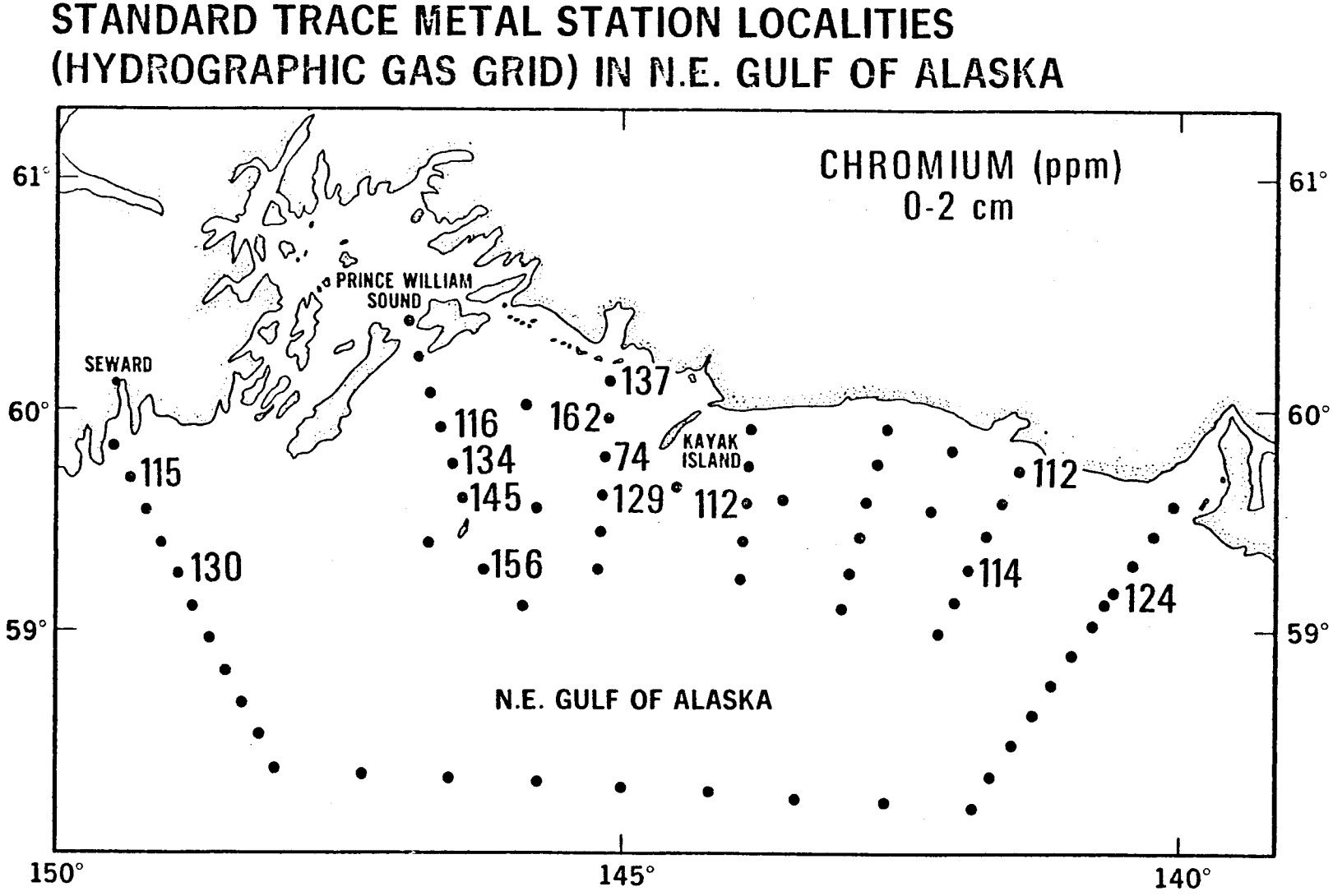


FIGURE D.18 Cr Concentrations in N. E. Gulf of Alaska Sediments

STANDARD TRACE METAL STATION LOCALITIES (HYDROGRAPHIC GAS GRID) IN N.E. GULF OF ALASKA

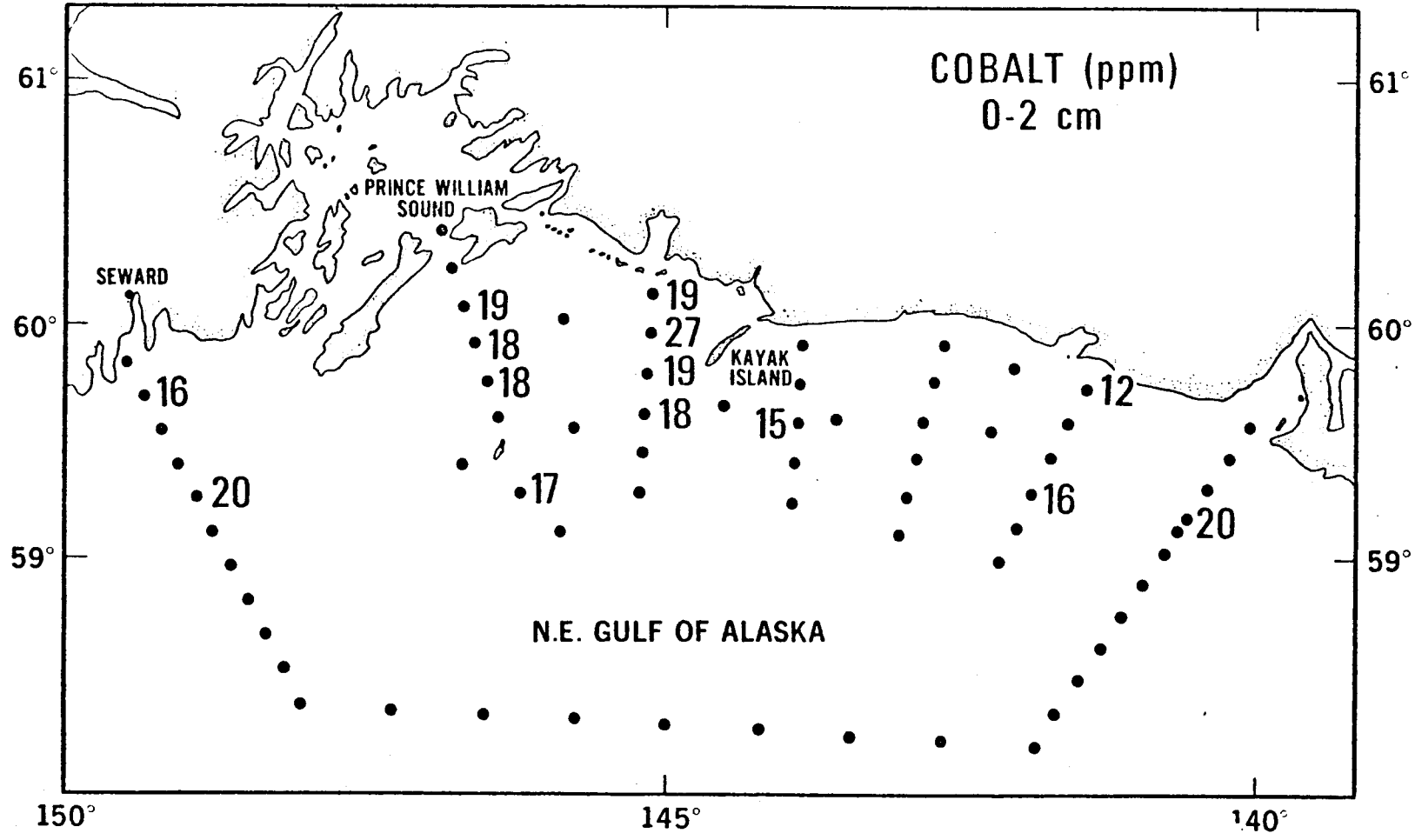


FIGURE D.19 Co Concentrations in N. E. Gulf of Alaska Sediments

STANDARD TRACE METAL STATION LOCALITIES (HYDROGRAPHIC GAS GRID) IN N.E. GULF OF ALASKA

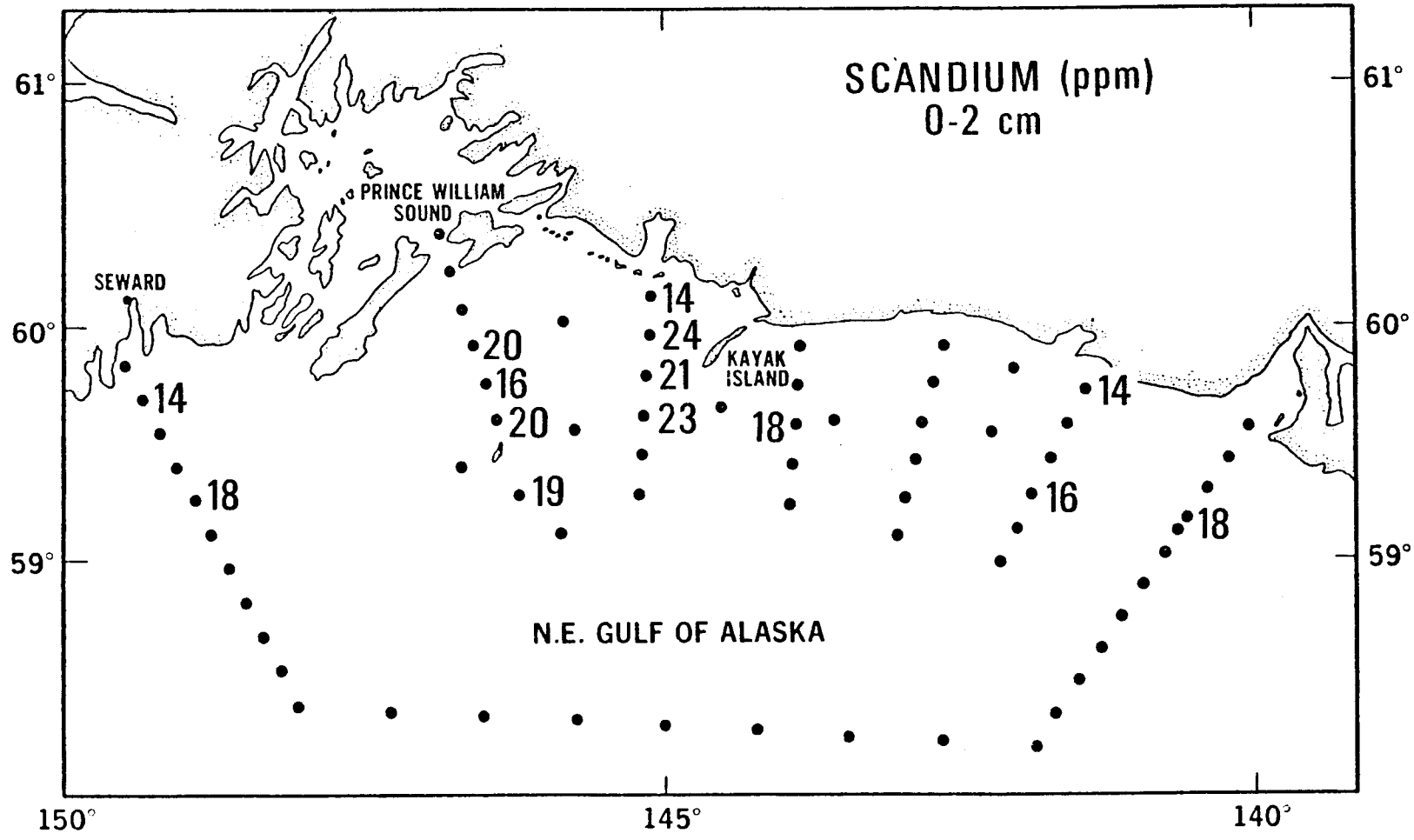


FIGURE D.20 Sc Concentrations in N. E. Gulf of Alaska Sediments

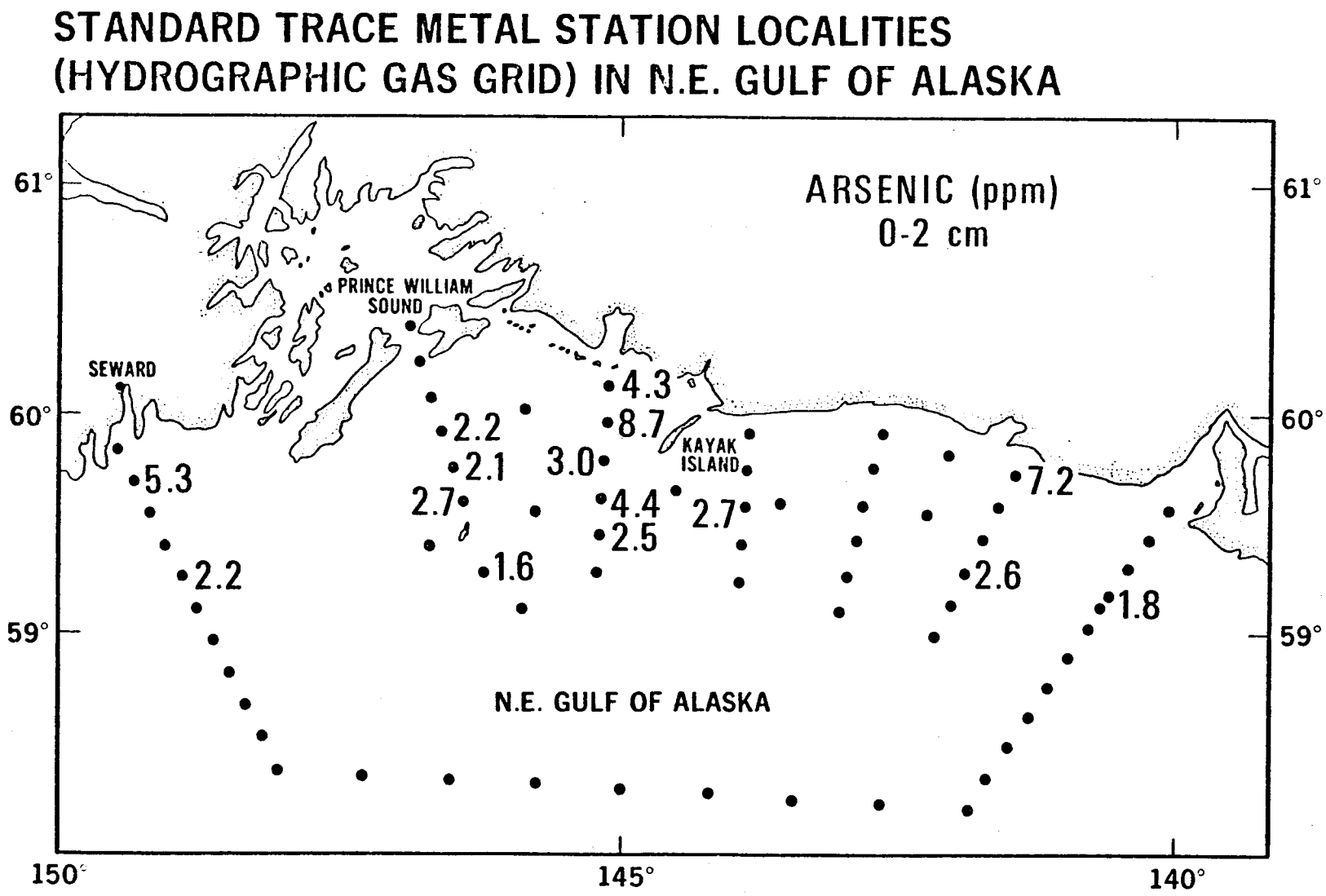


FIGURE D.21 As Concentrations in N. E. Gulf of Alaska Sediments

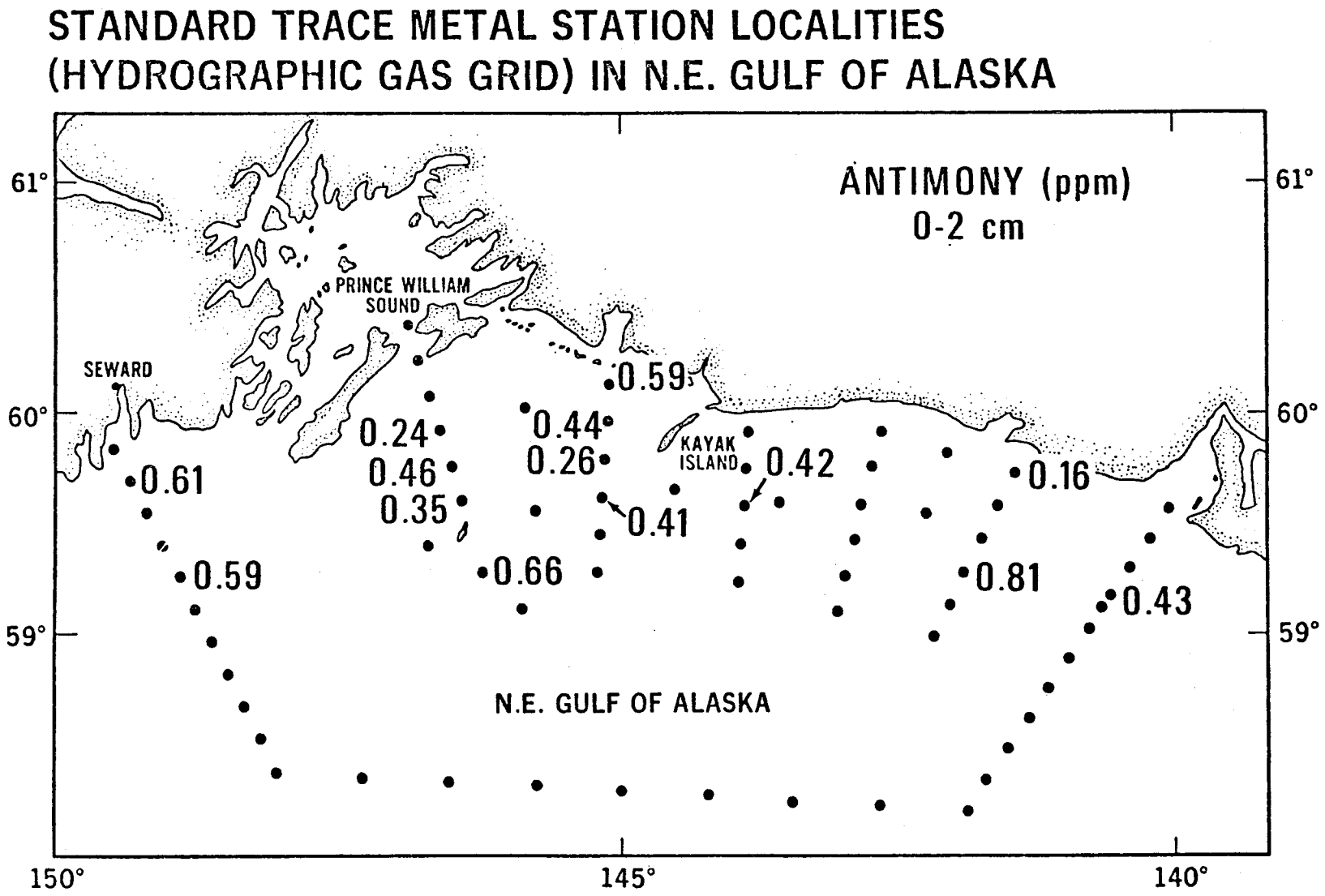


FIGURE D.22 Sb Concentrations in N. E. Gulf of Alaska Sediments

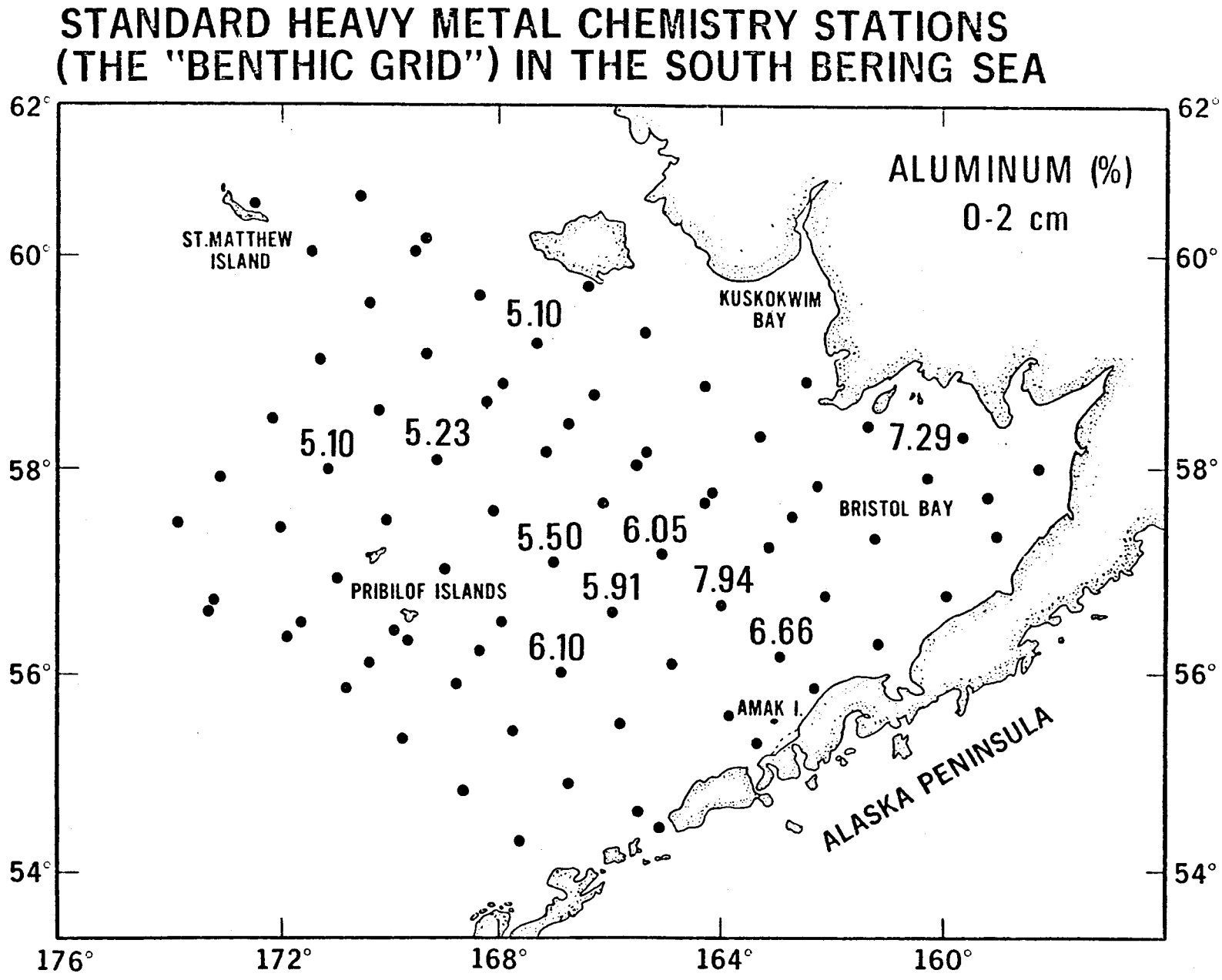


FIGURE D.23 Al Concentrations in Bering Sea Sediments

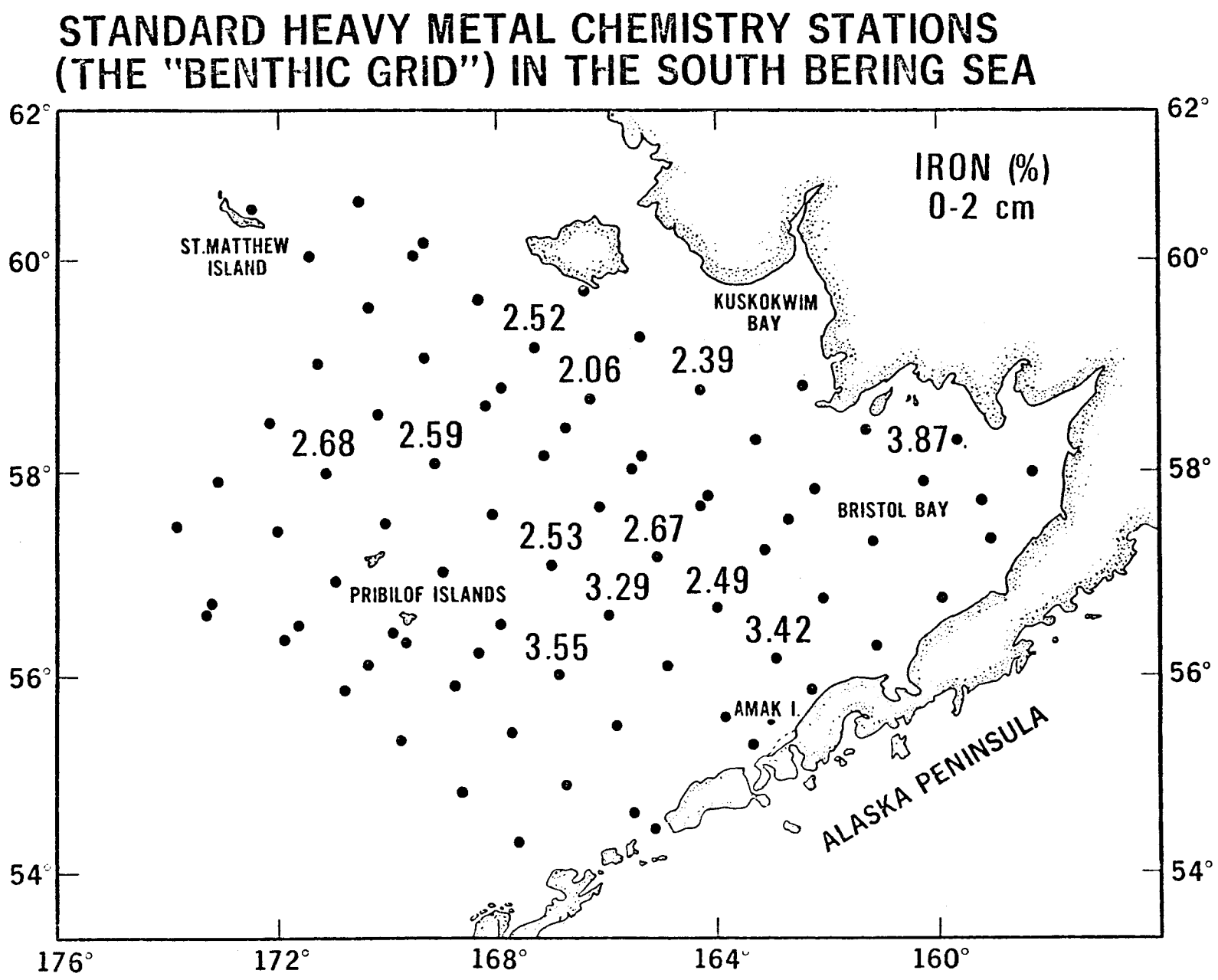


FIGURE D.24 Fe Concentrations in Bering Sea Sediments

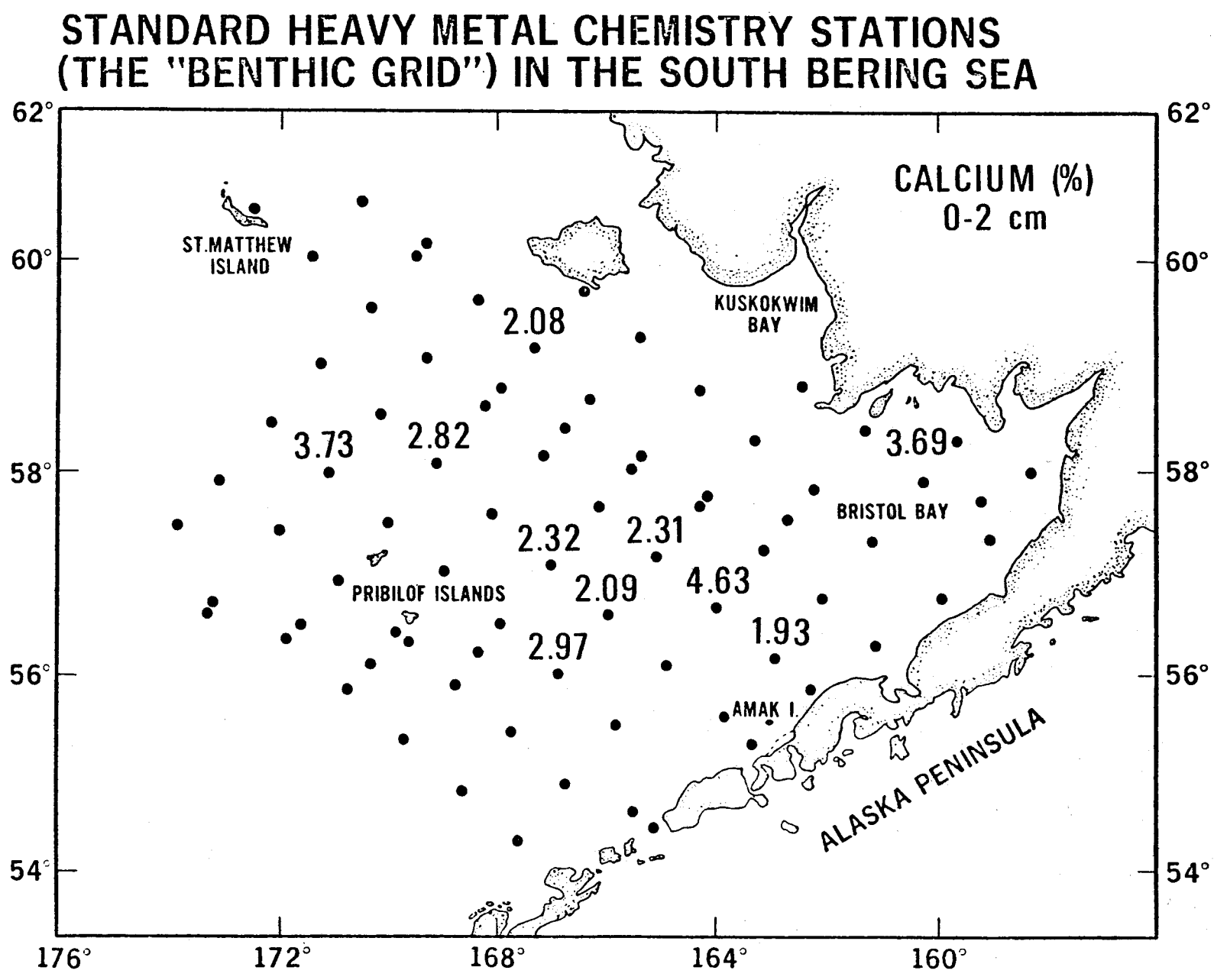


FIGURE D.25 Ca Concentrations in Bering Sea Sediments

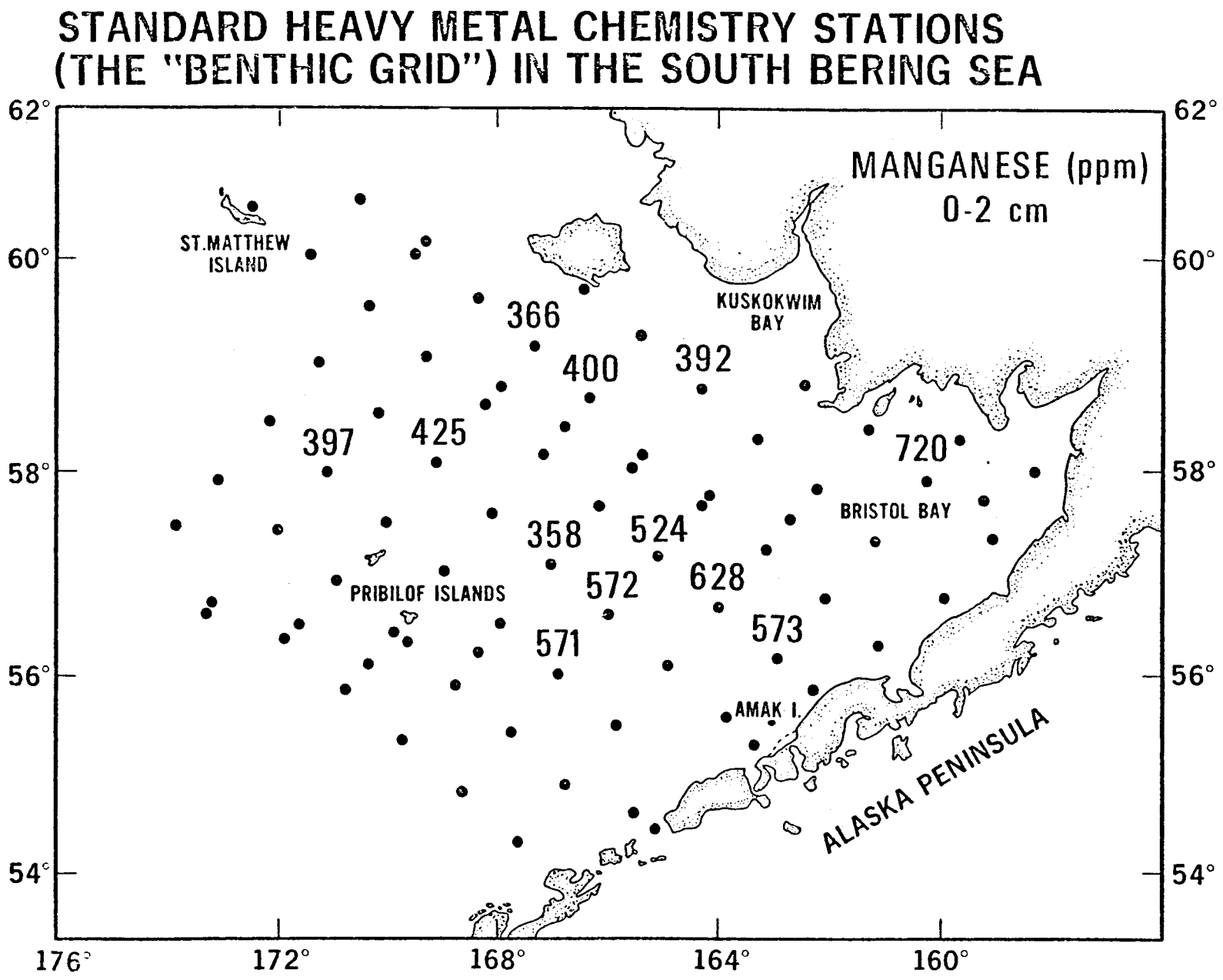


FIGURE D.26 Mn Concentrations in Bering Sea Sediments

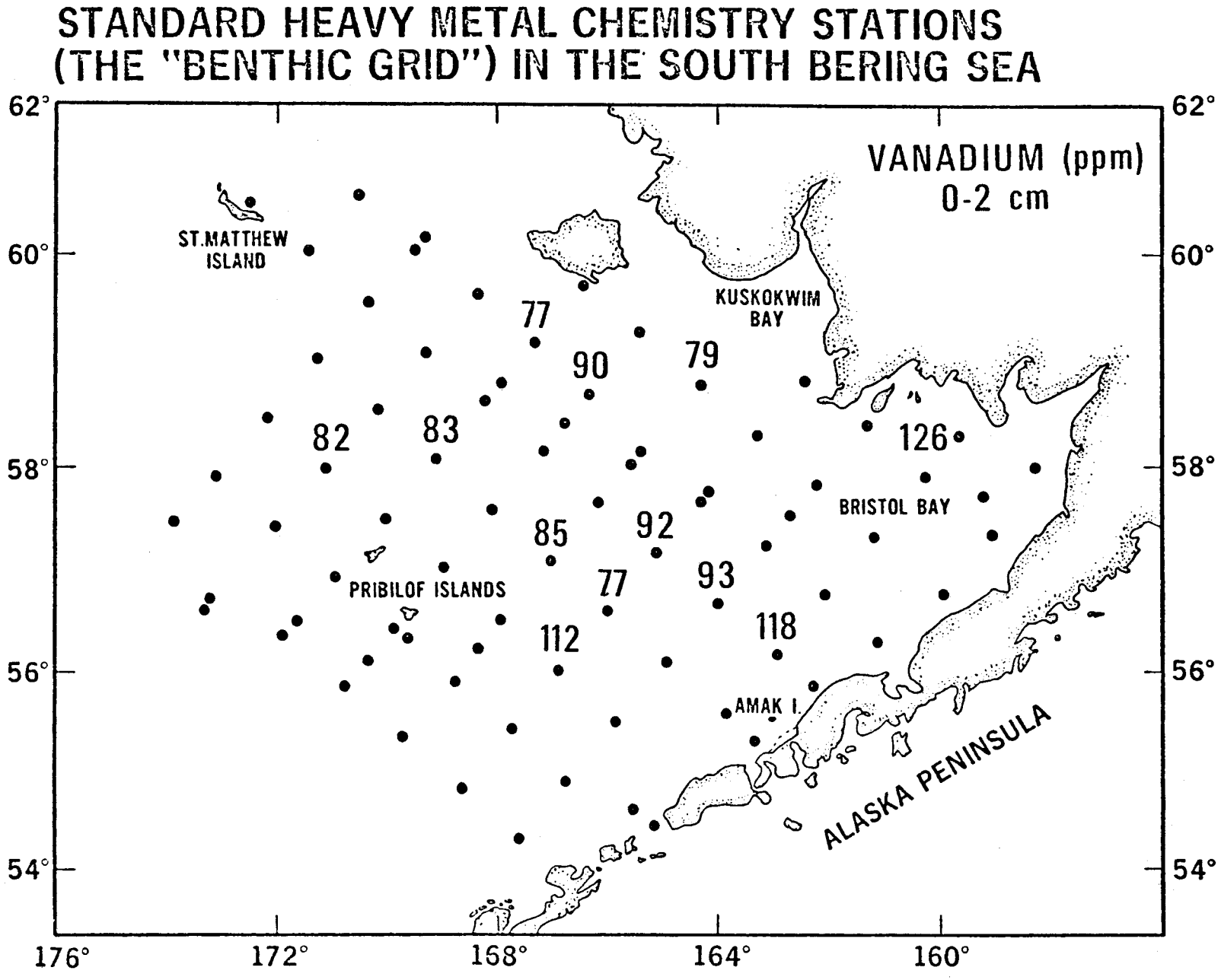


FIGURE D.27 V Concentrations in Bering Sea Sediments

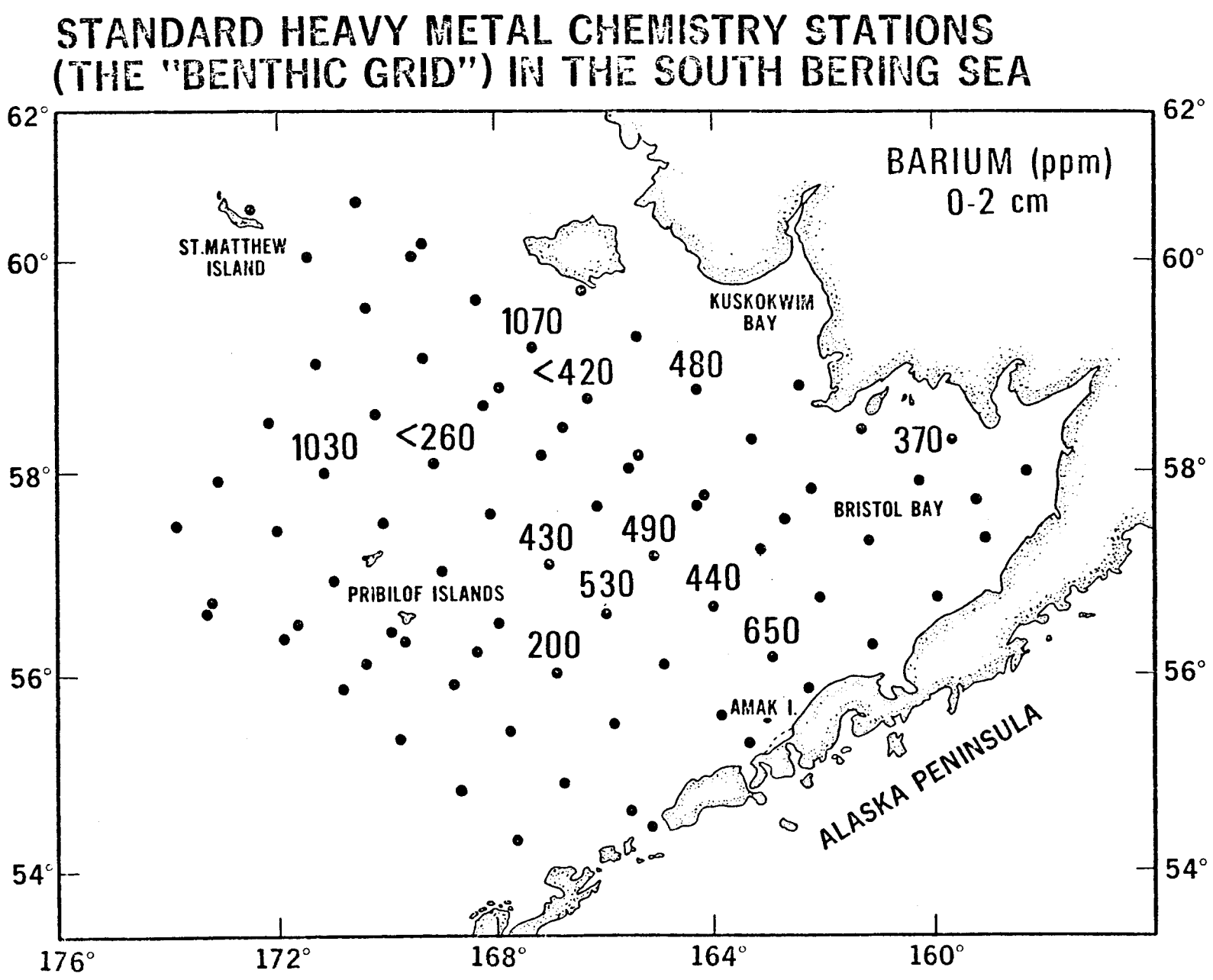


FIGURE D.28 Ba Concentrations in Bering Sea Sediments

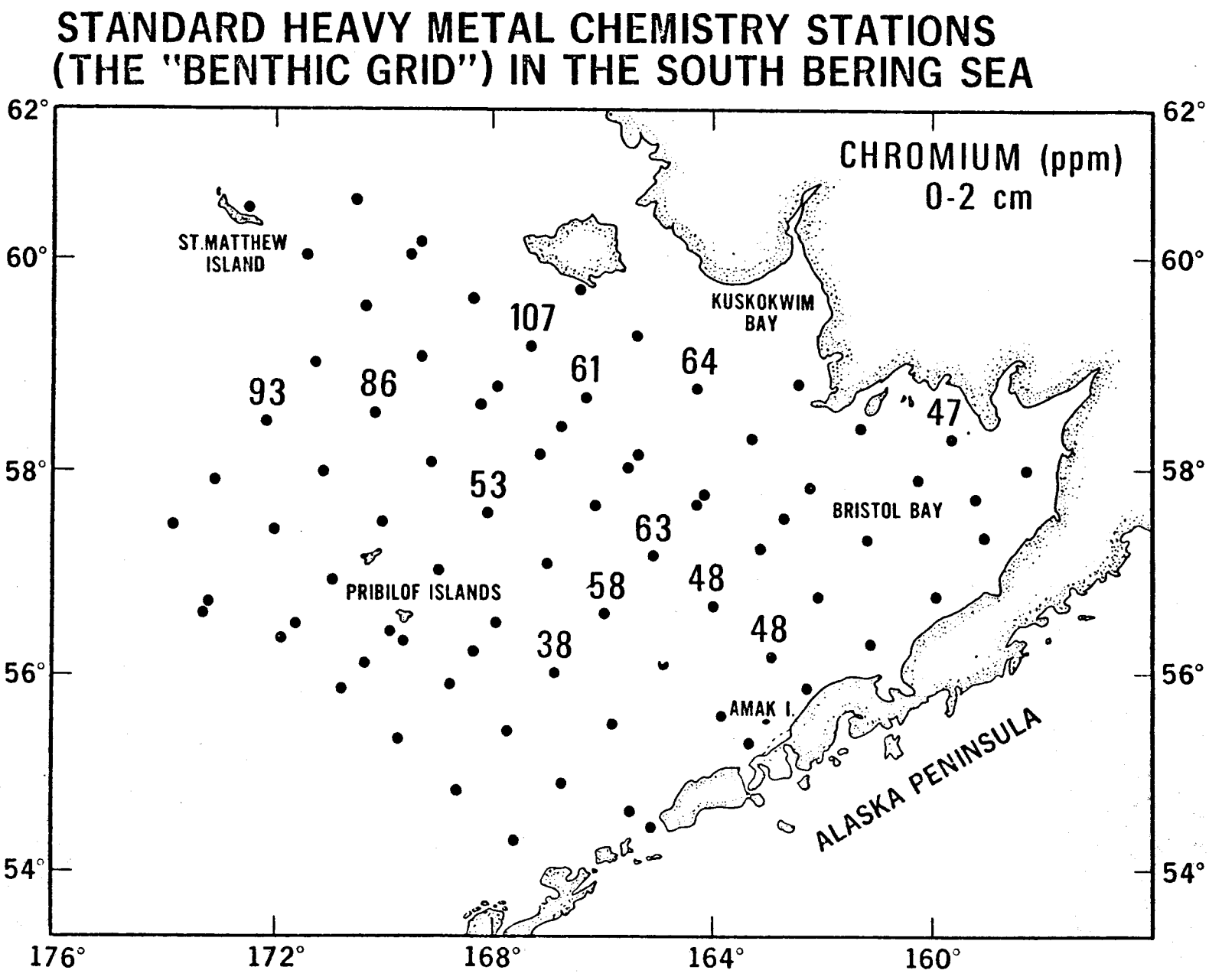


FIGURE D.29 Cr Concentrations in Bering Sea Sediments

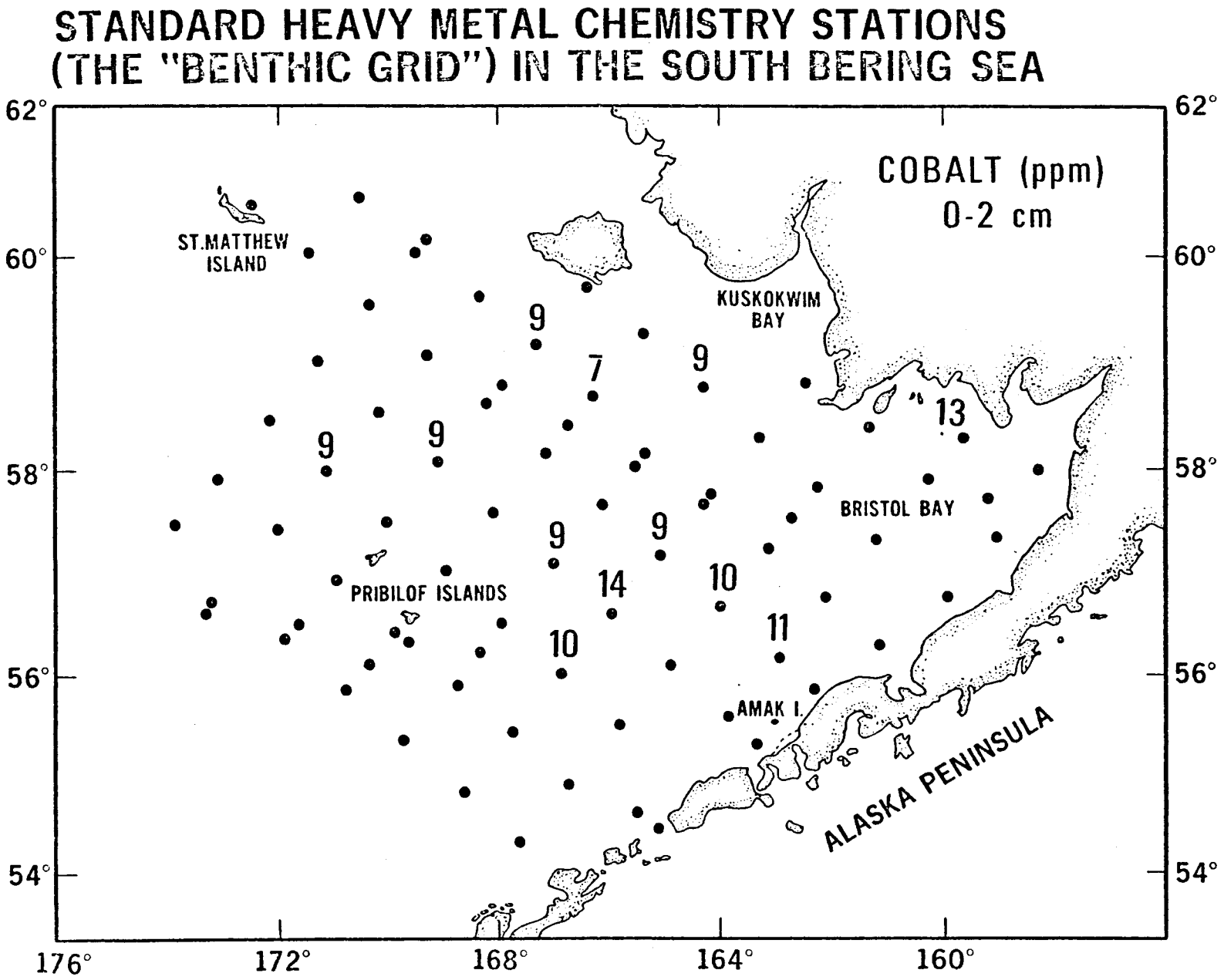


FIGURE D.30 Co Concentrations in Bering Sea Sediments

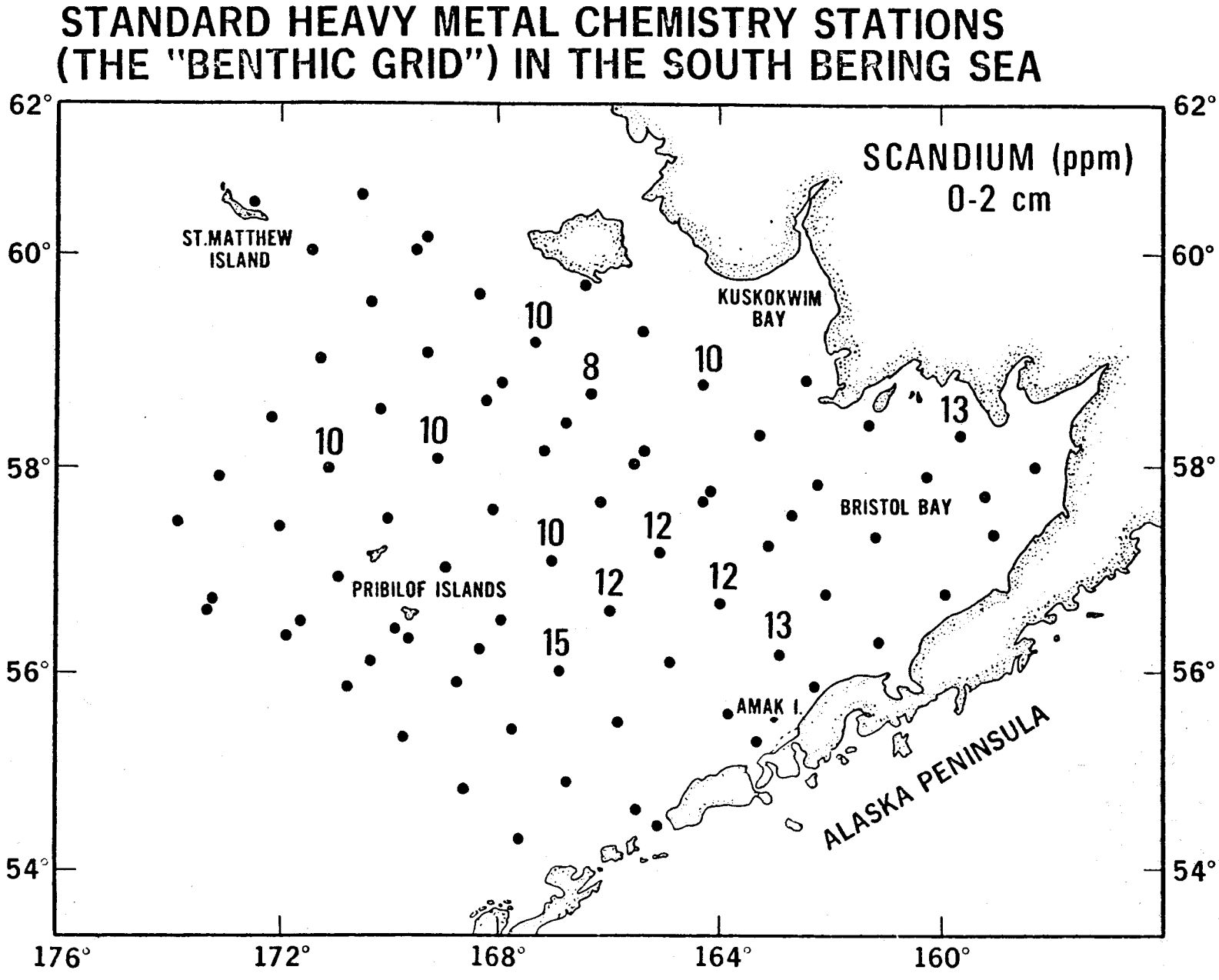


FIGURE D.31 Sc Concentrations in Bering Sea Sediments

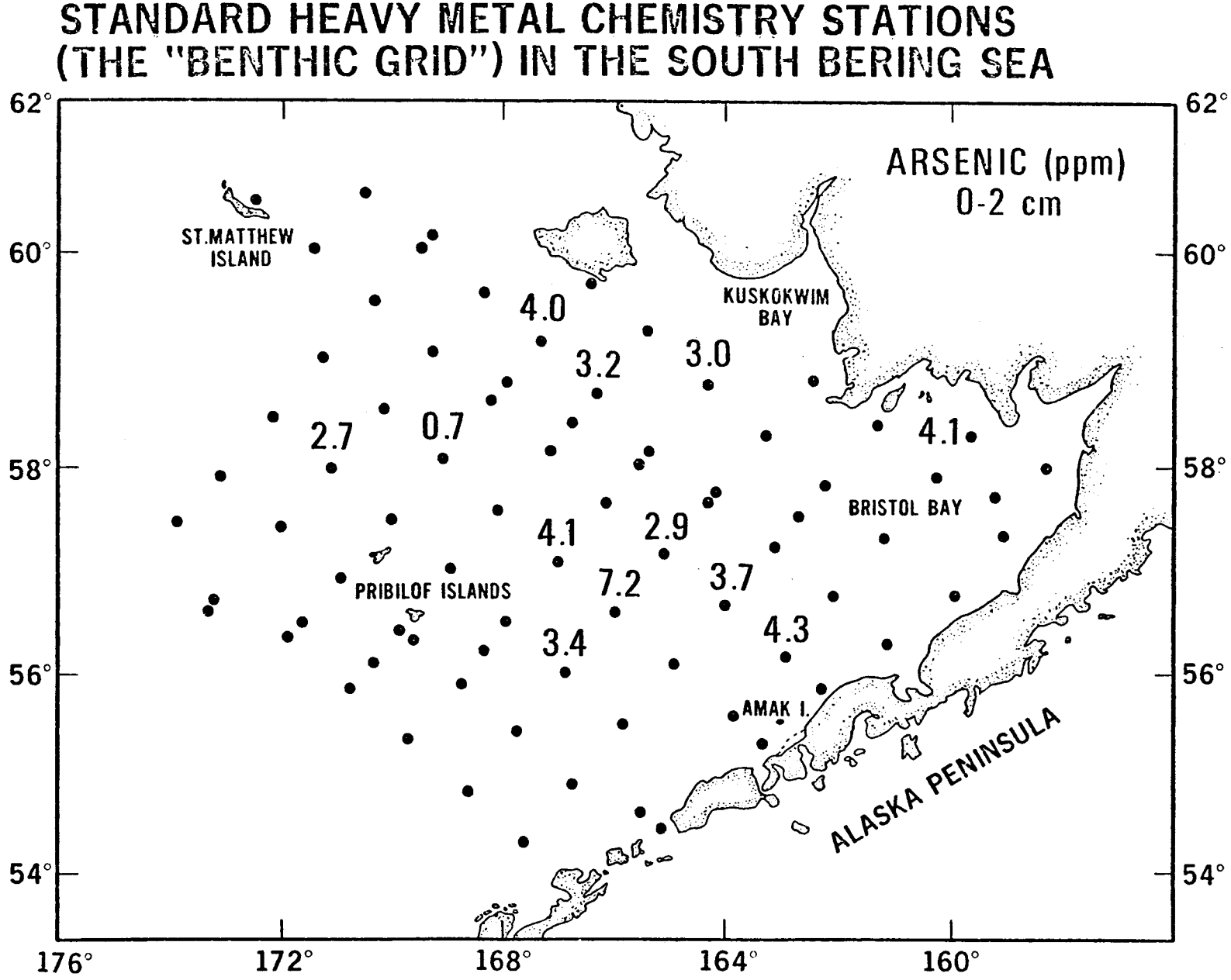


FIGURE D.32 As Concentrations in Bering Sea Sediments

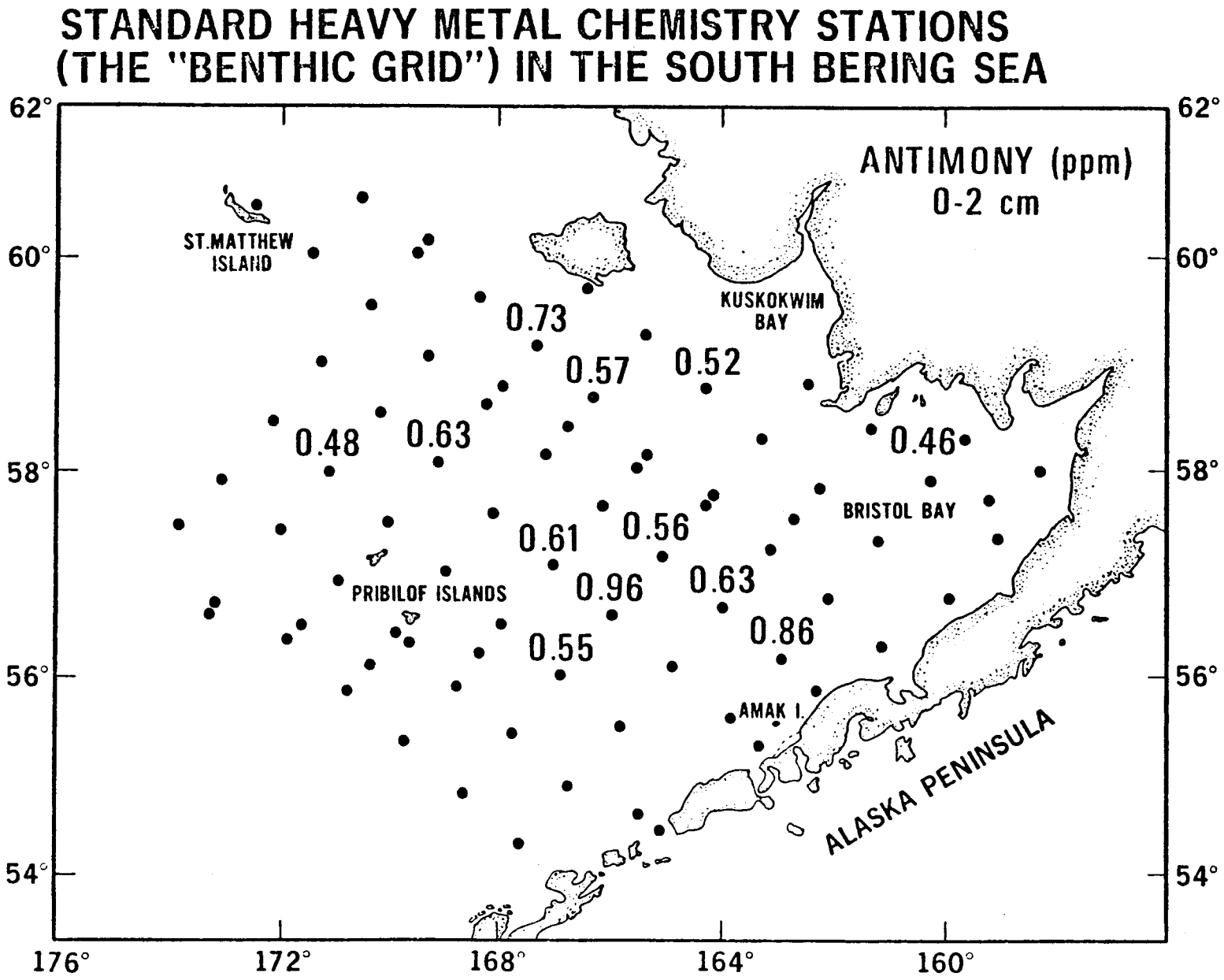


FIGURE D.33 Sb Concentrations in Bering Sea Sediments

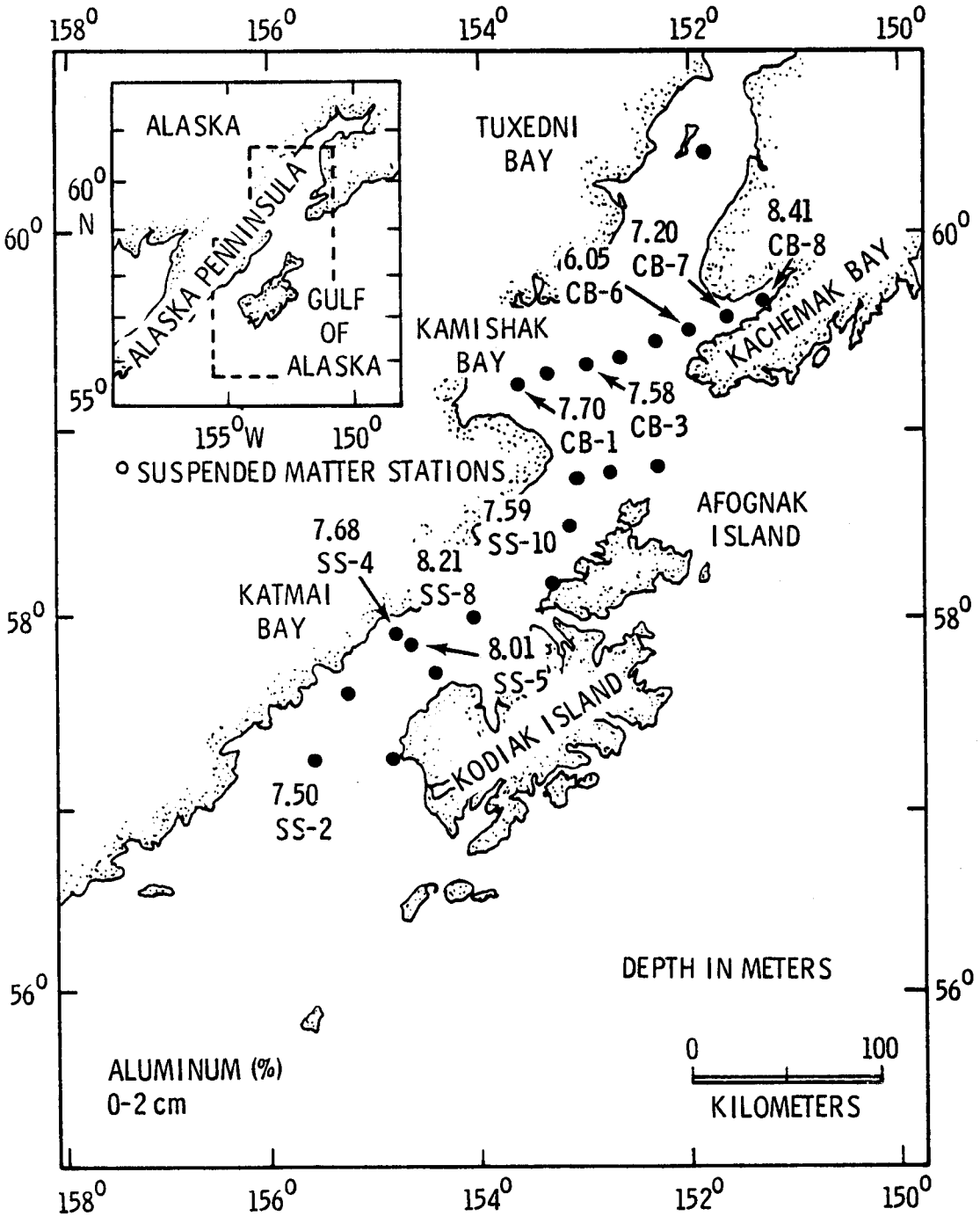


FIGURE D.34 Al Concentrations in Shelik Strait and Cook Inlet Sediments

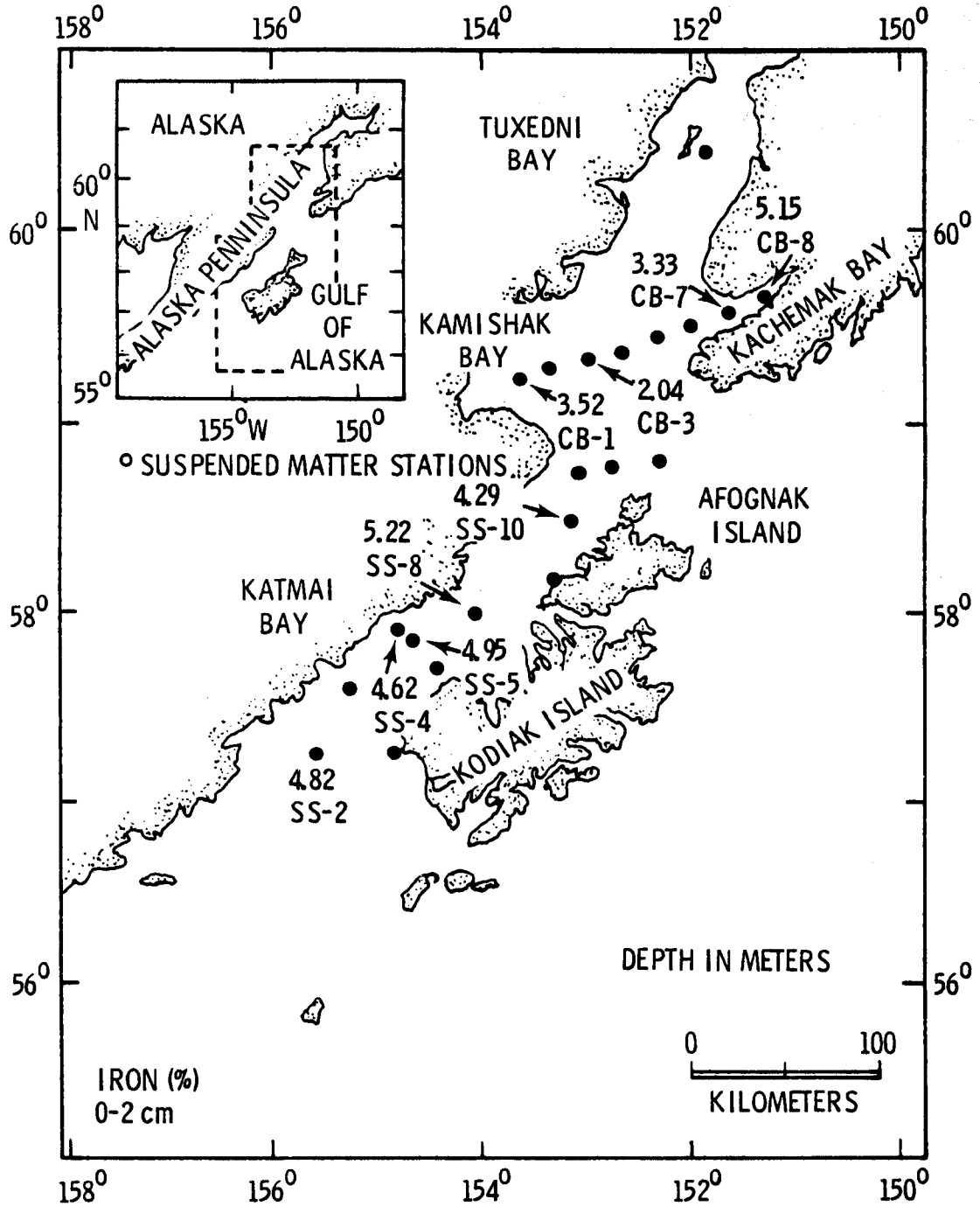


FIGURE D.35 Fe Concentrations in Shelik Strait and Cook Inlet Sediments

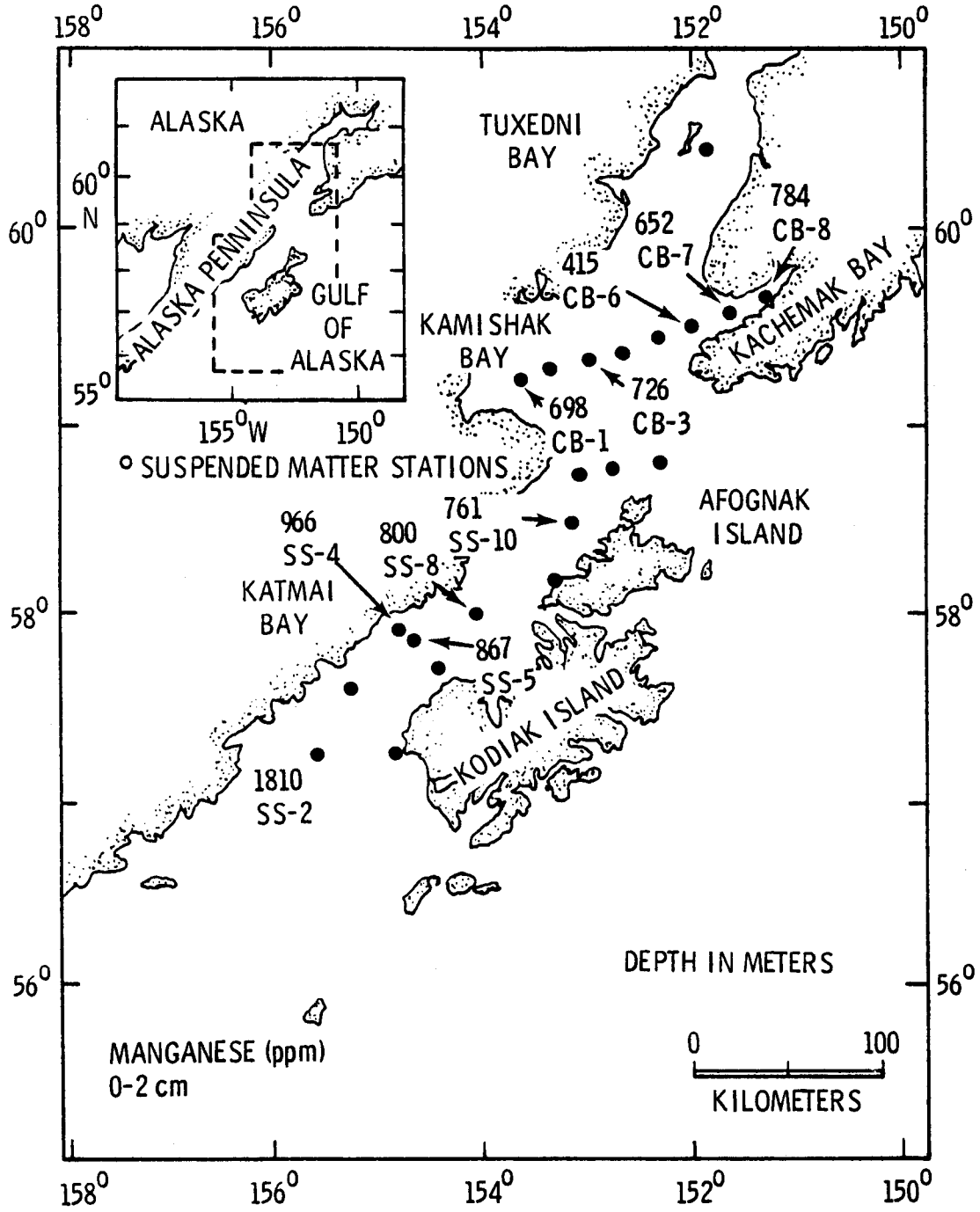


FIGURE D.36 Mn Concentrations in Shelik Strait and Cook Inlet Sediments

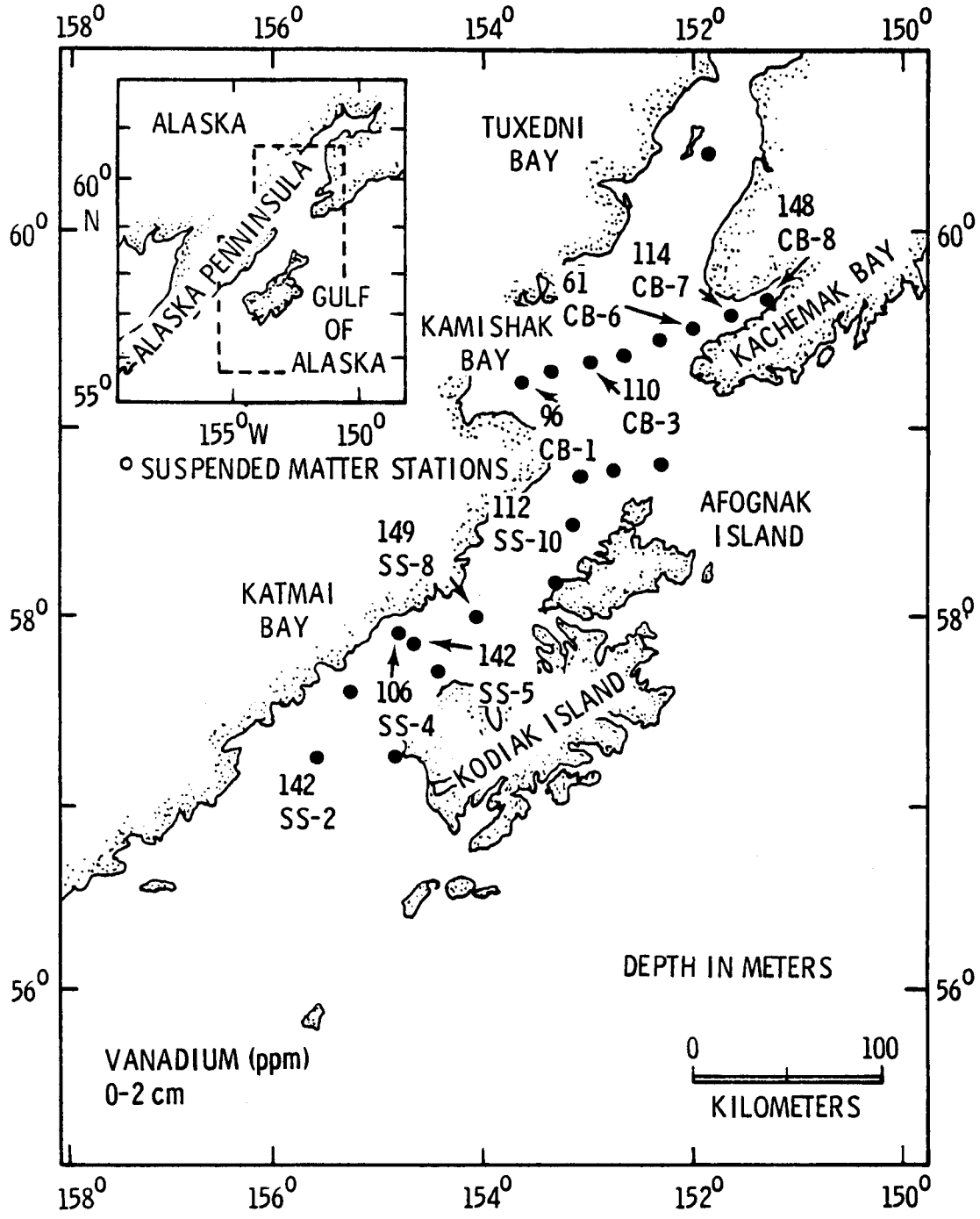


FIGURE D.37 V Concentrations in Shelik Strait and Cook Inlet Sediments

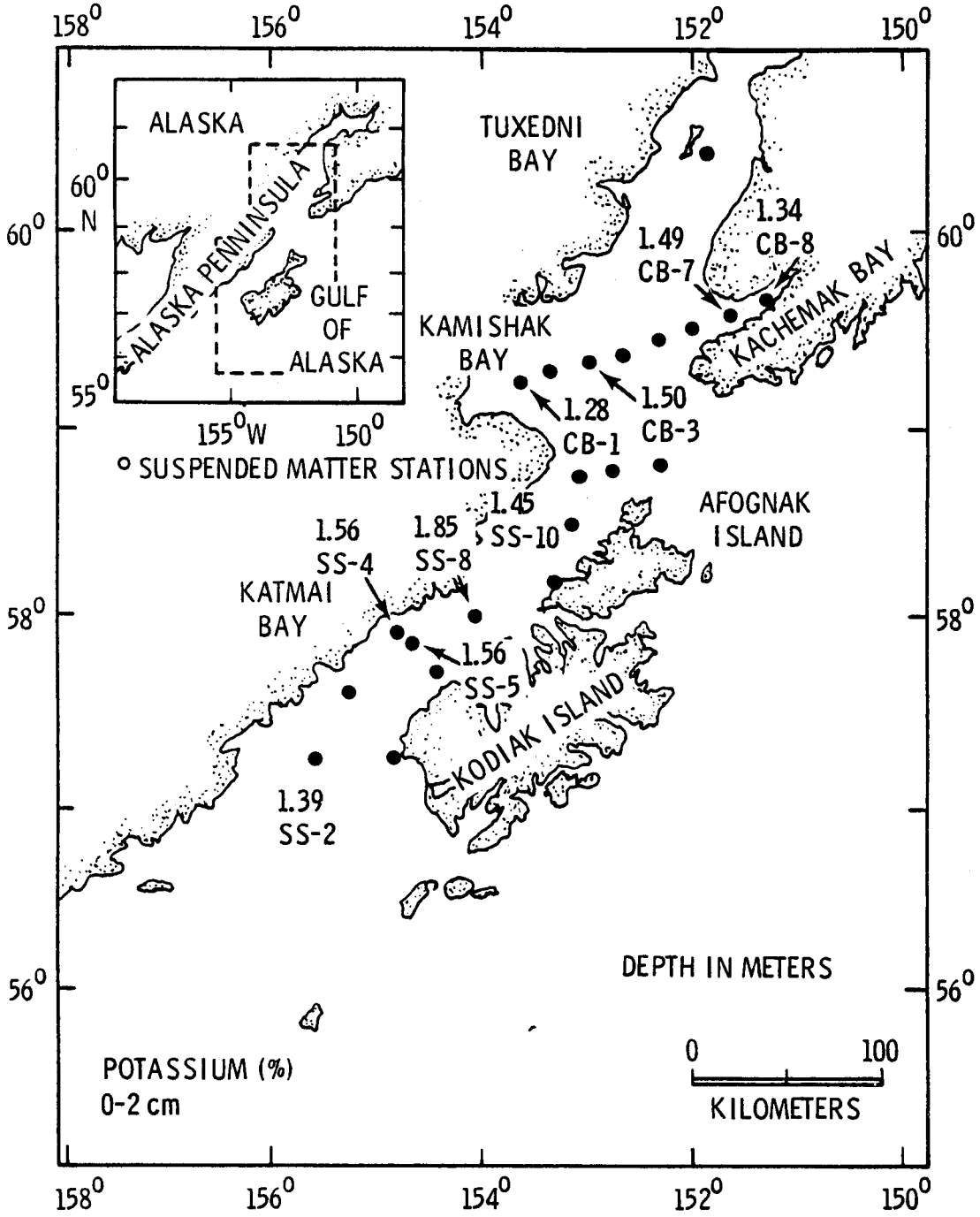


FIGURE D.38 K Concentrations in Shelik Strait and Cook Inlet Sediments

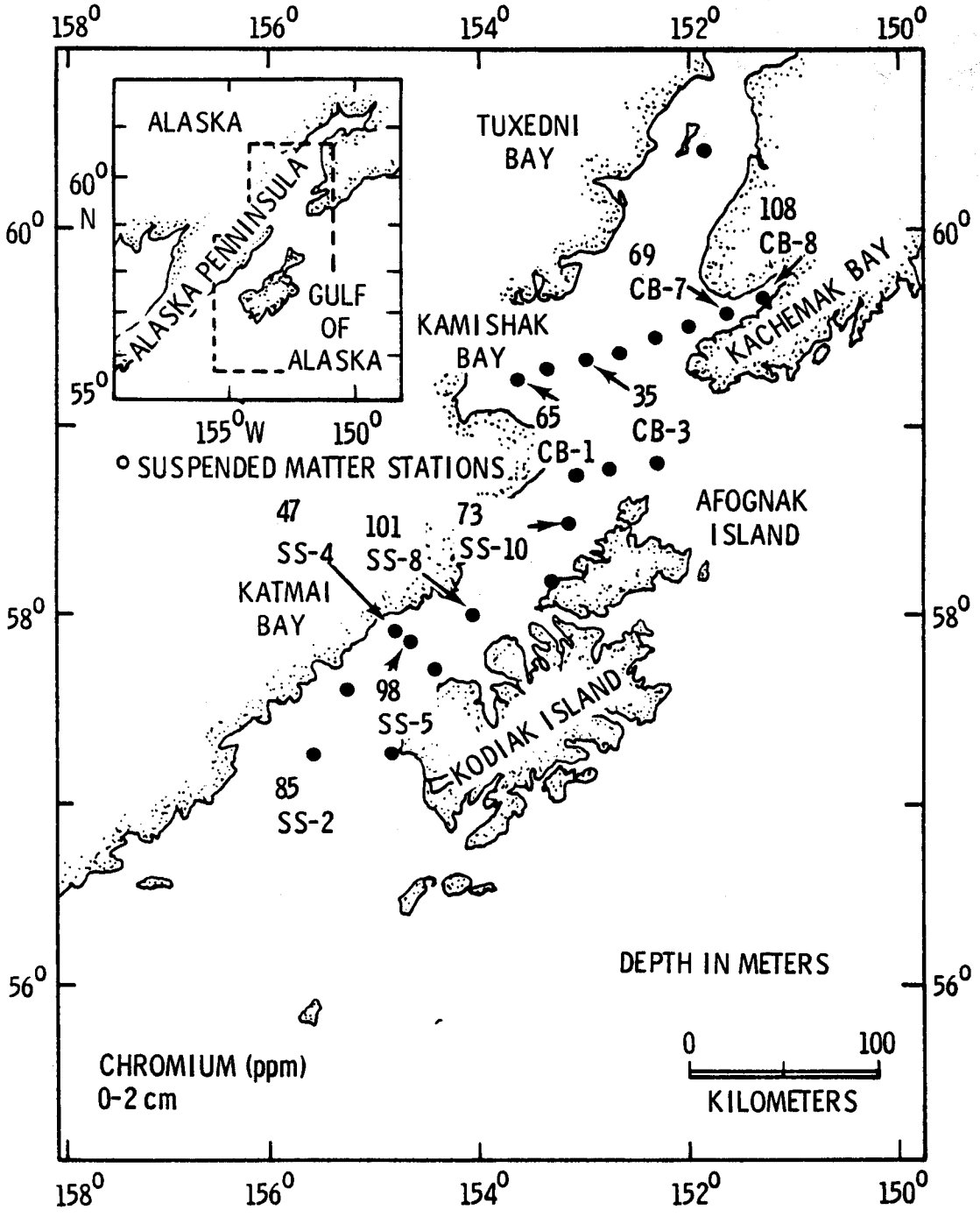


FIGURE D.39 Cr Concentrations in Shelik Strait and Cook Inlet Sediments

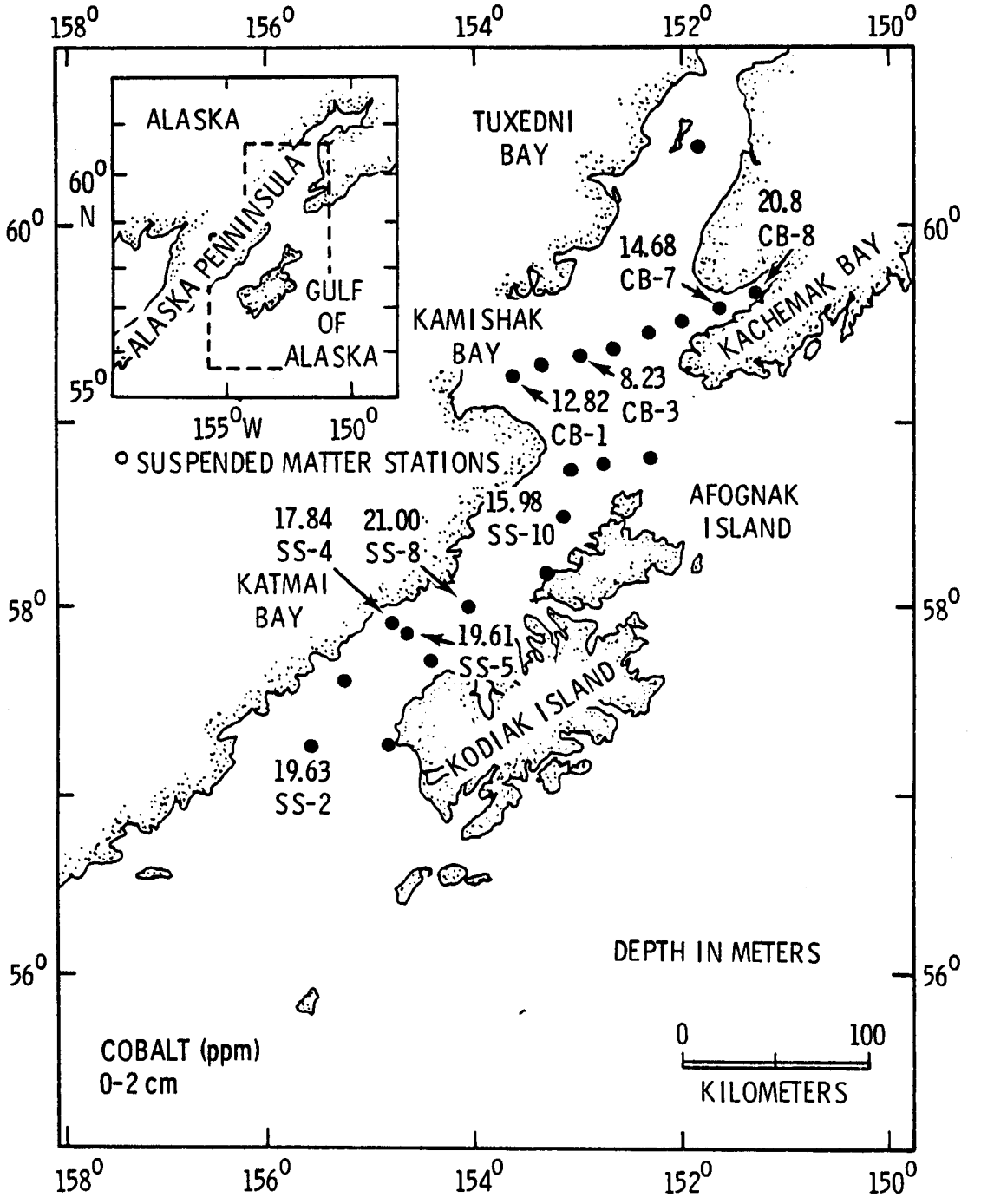


FIGURE D.40 Co Concentrations in Shelik Strait and Cook Inlet Sediments

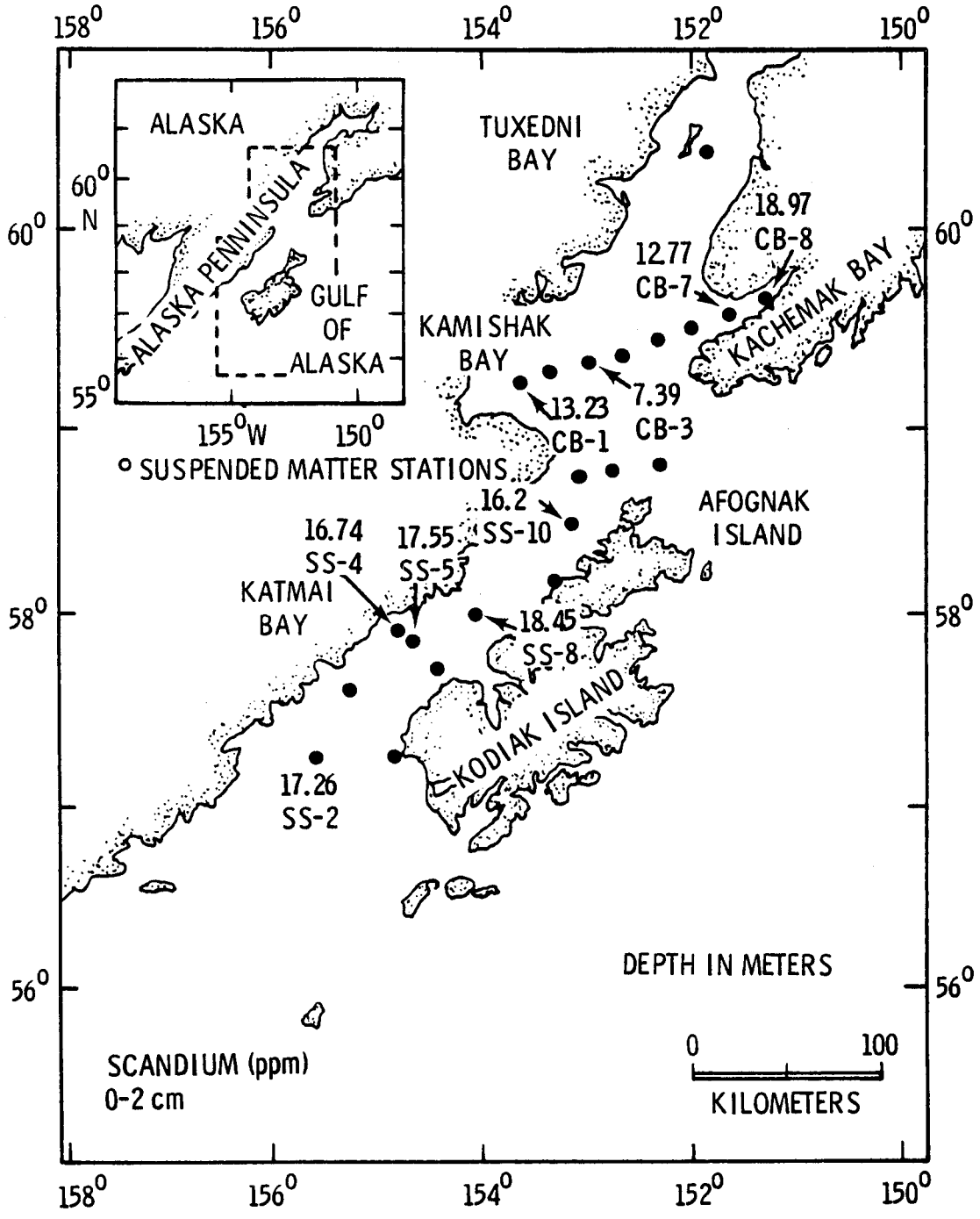


FIGURE D.41 Sc Concentrations in Shelik Strait and Cook Inlet Sediments

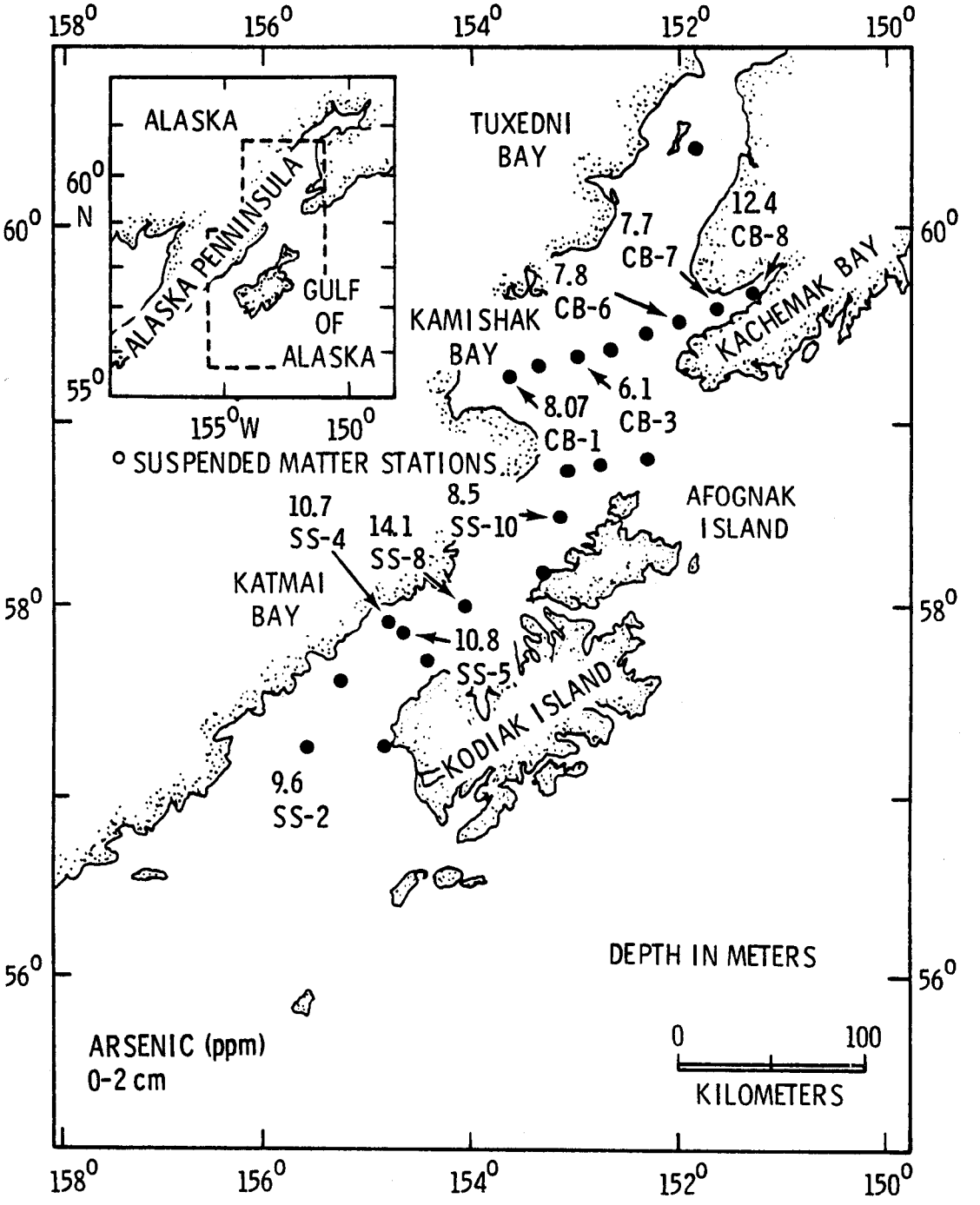


FIGURE D.42 As Concentrations in Shelik Strait and Cook Inlet Sediments

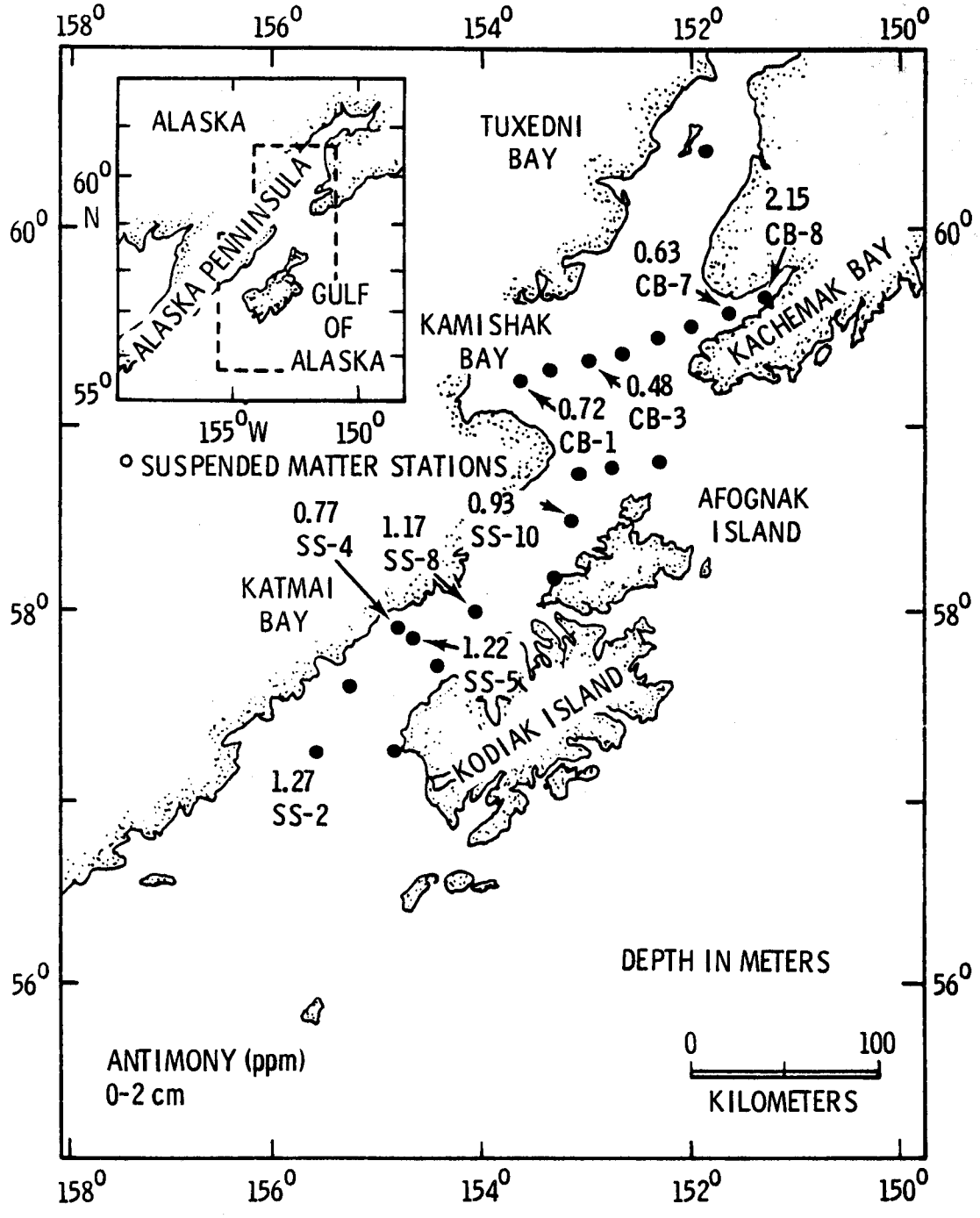


FIGURE D.43 Sb Concentrations in Shelik Strait and Cook Inlet Sediments

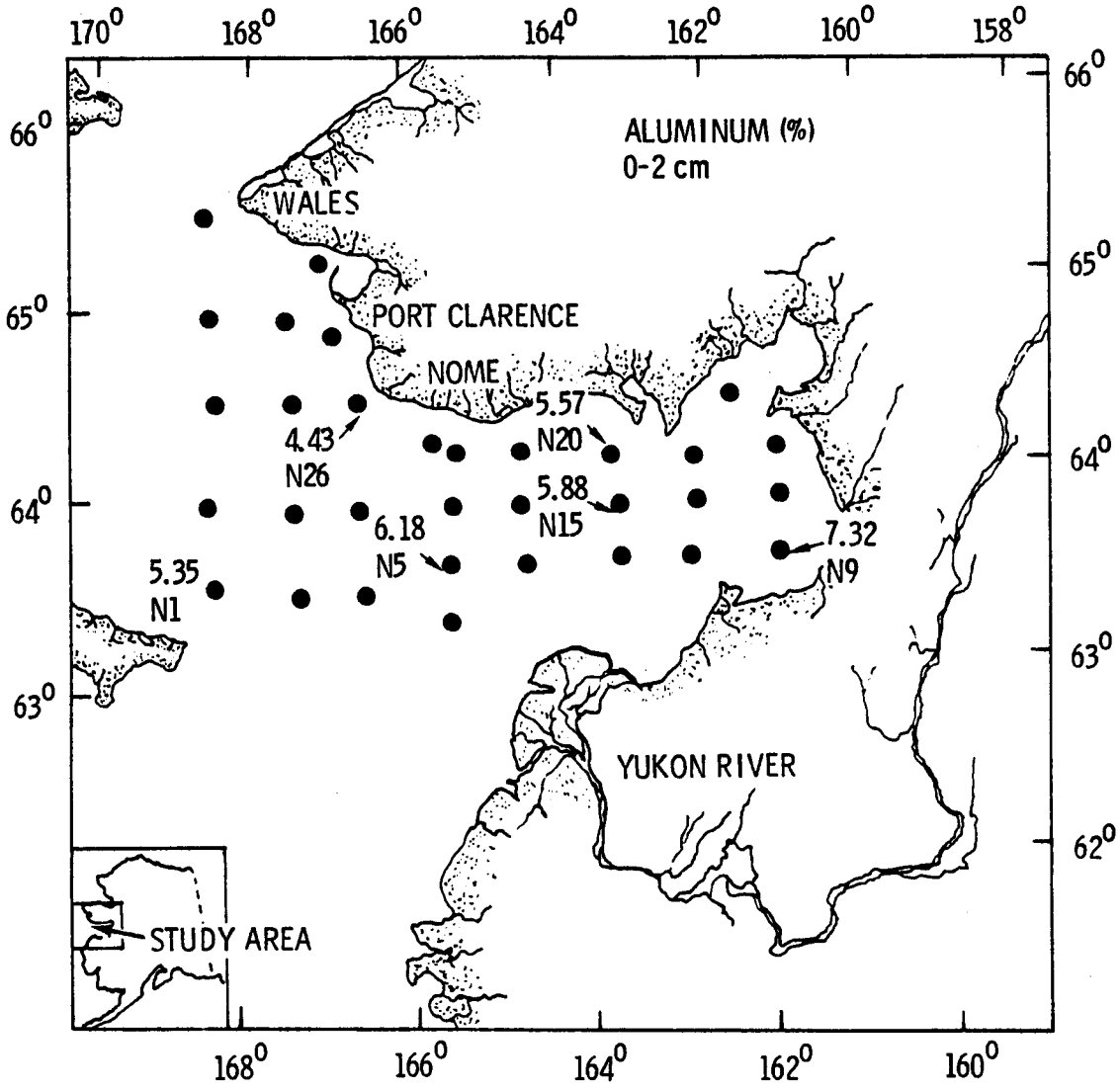


FIGURE D.44 Al Concentration in Norton Sound Sediments

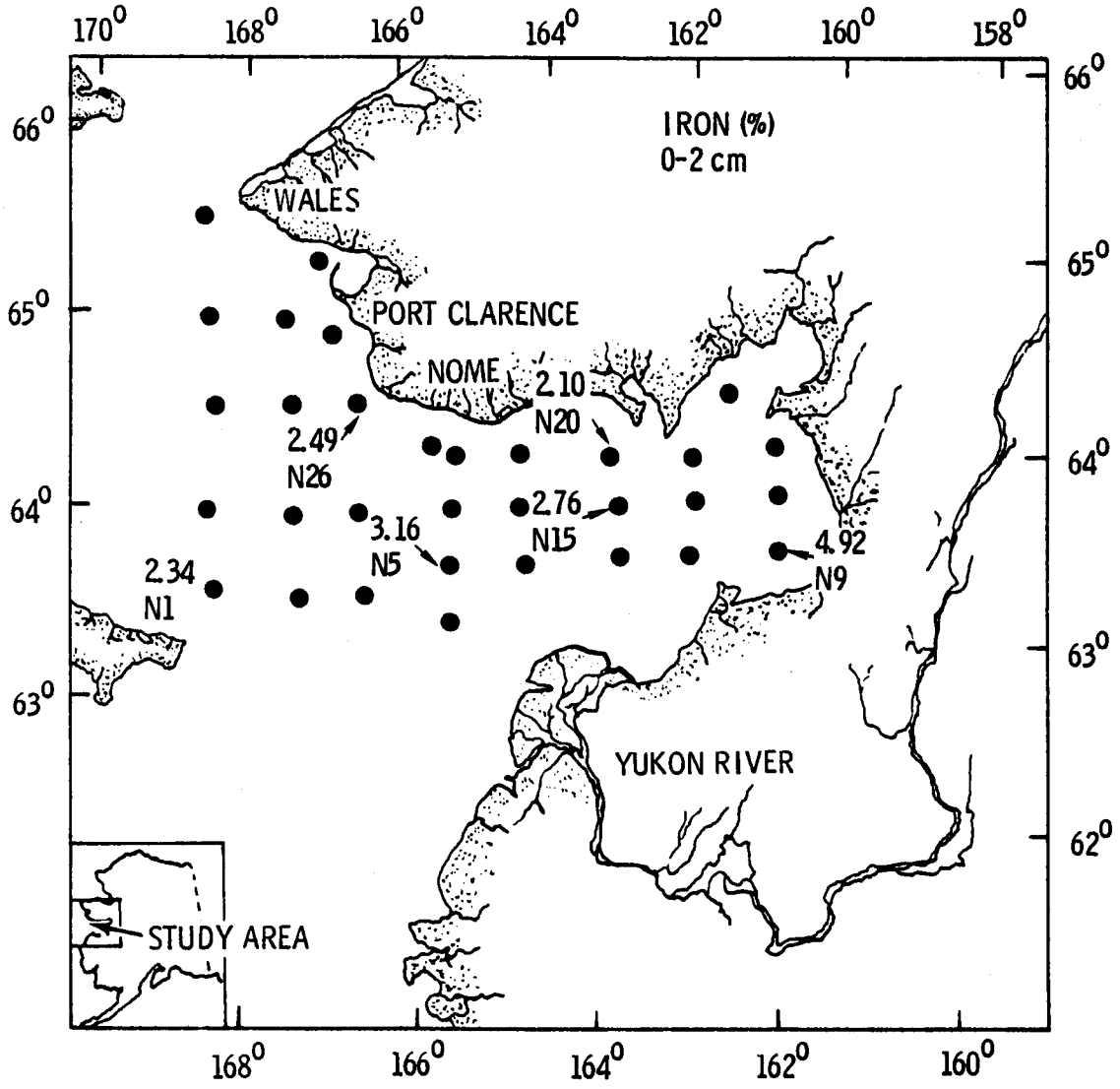


FIGURE D.45 Fe Concentration in Norton Sound Secdiments

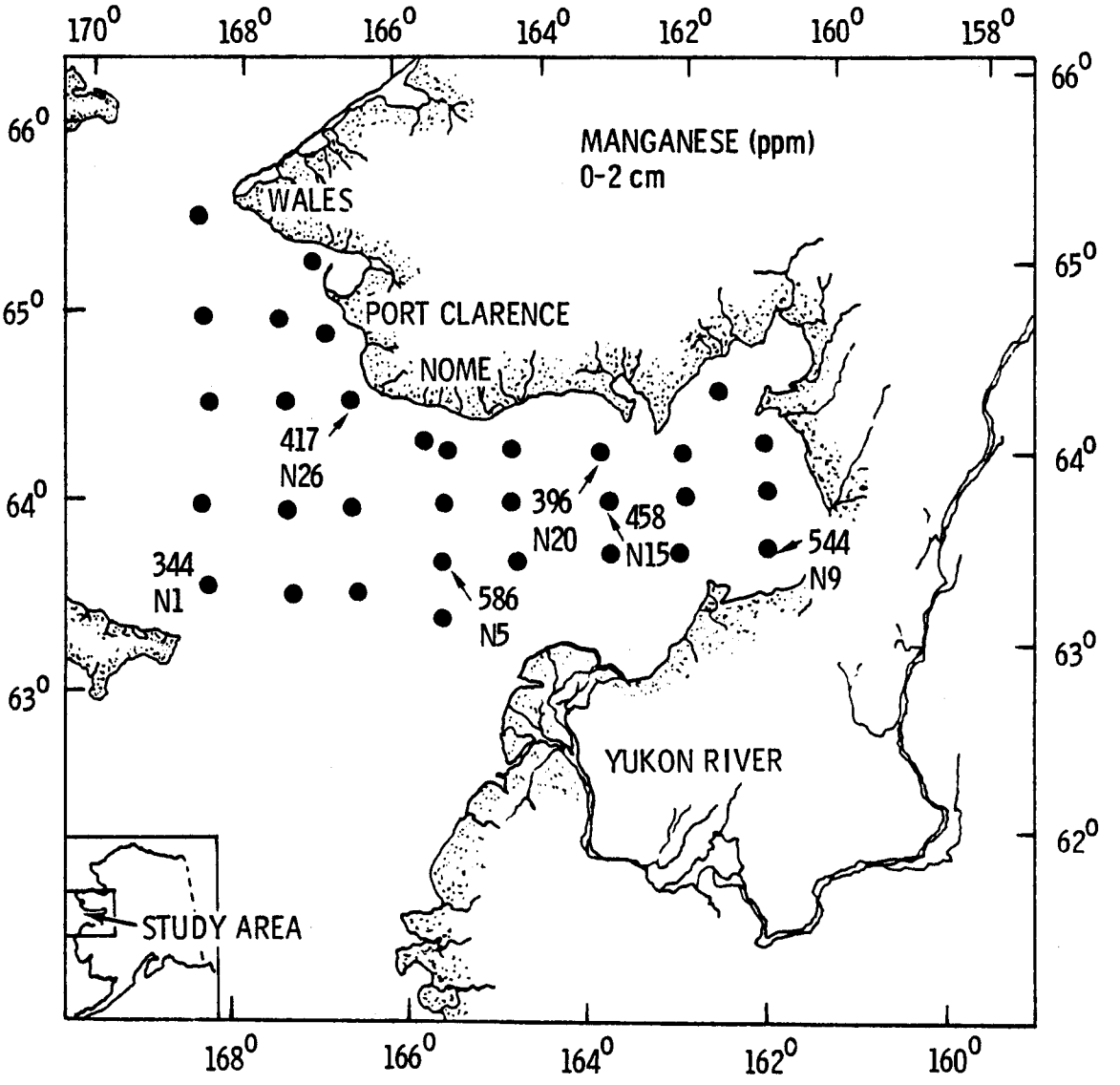


FIGURE D.46 Mn Concentration in Norton Sound Sediments

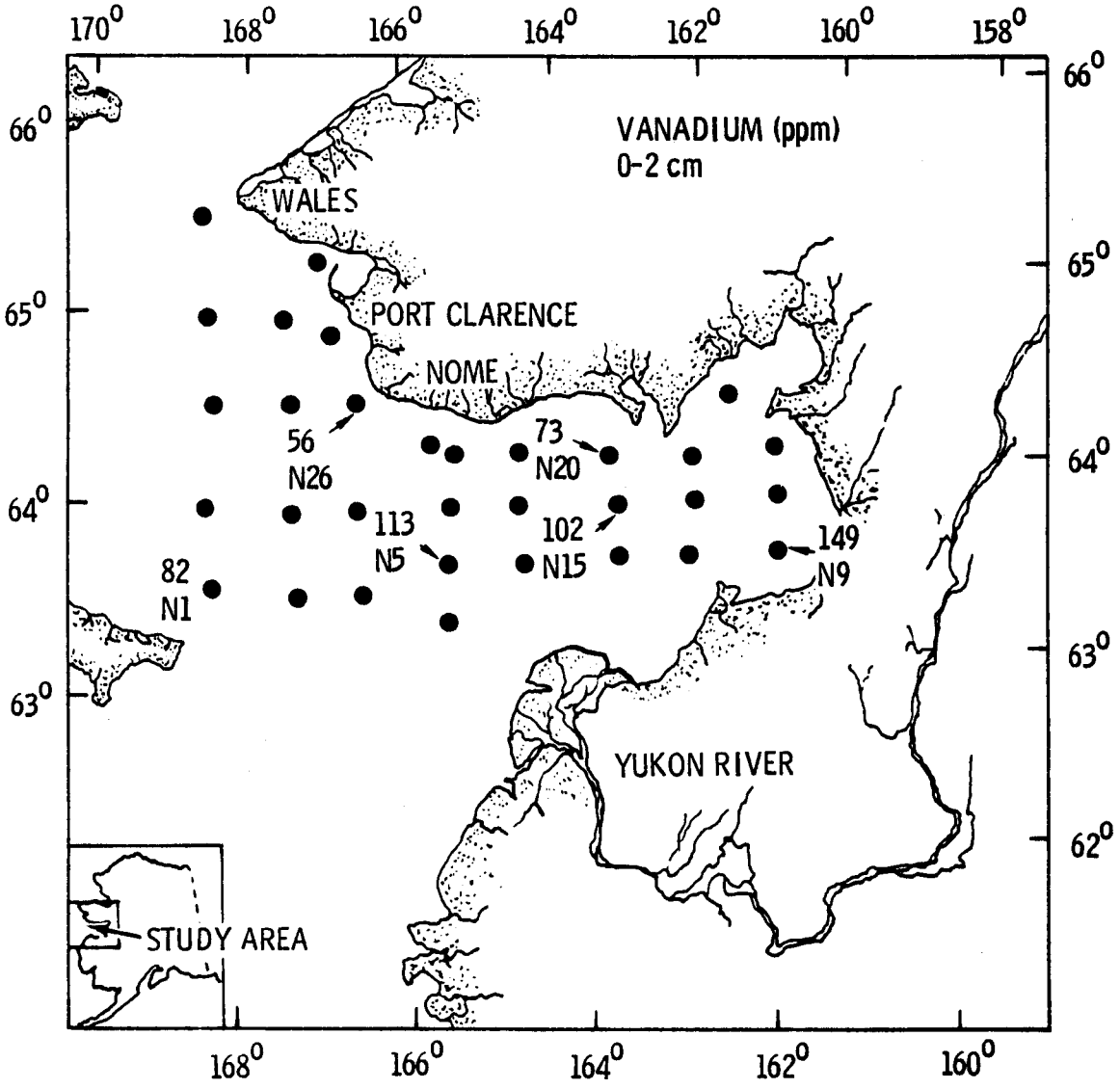


FIGURE D.47 V Concentration in Norton Sound Sediments

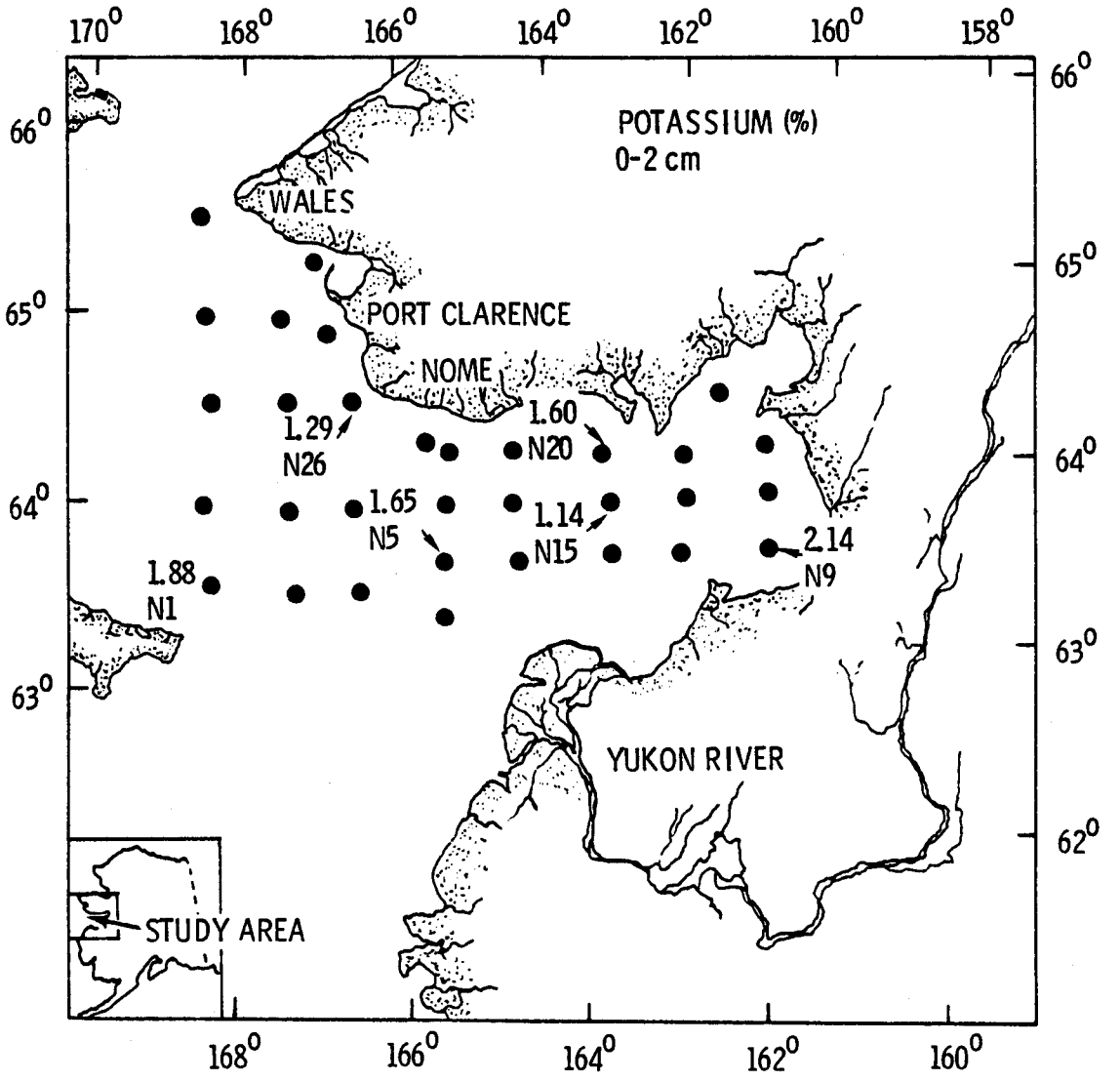


FIGURE D.48 K Concentration in Norton Sound Sediments

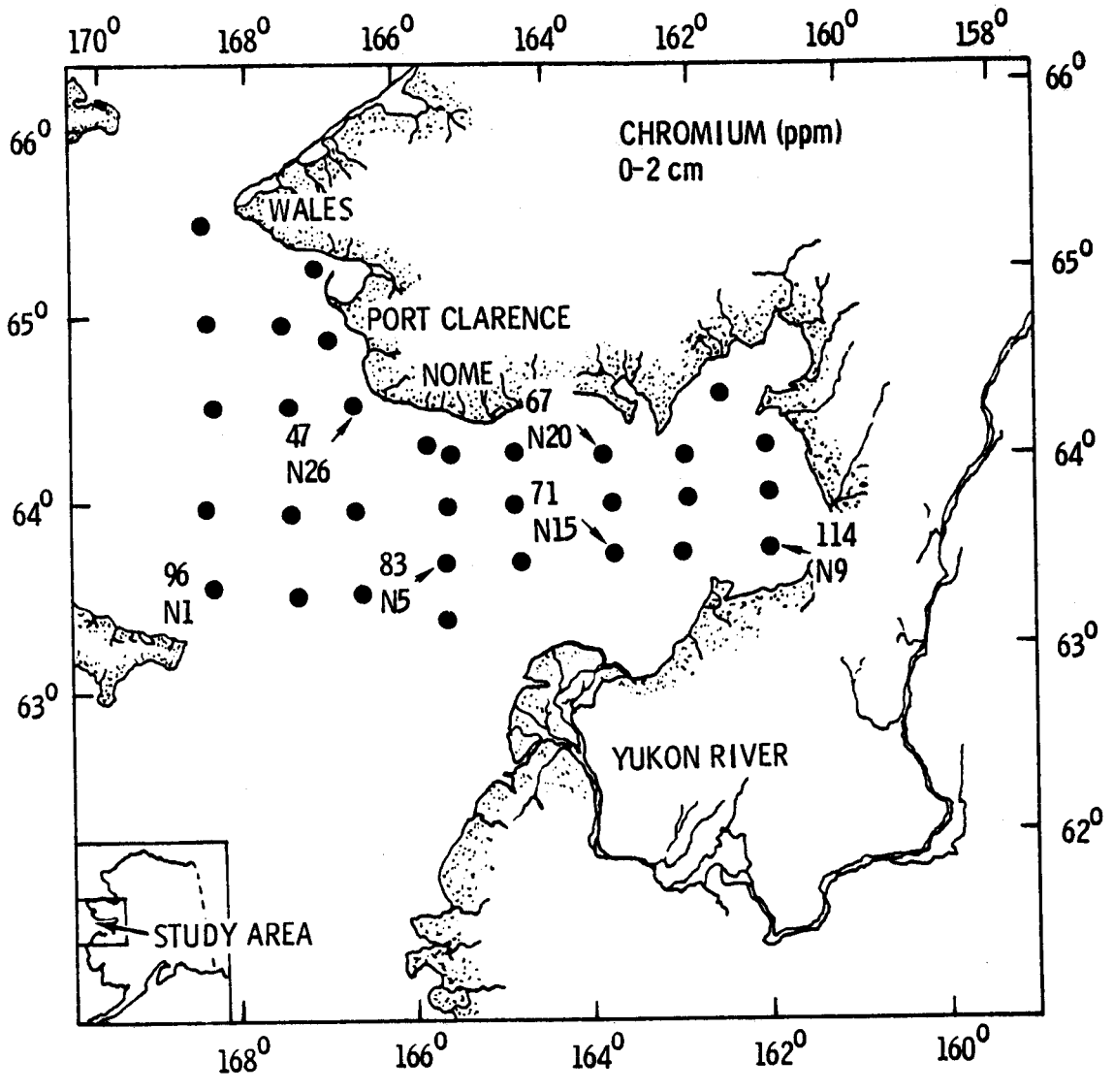


FIGURE D.49 Cr Concentration in Norton Sound Sediments

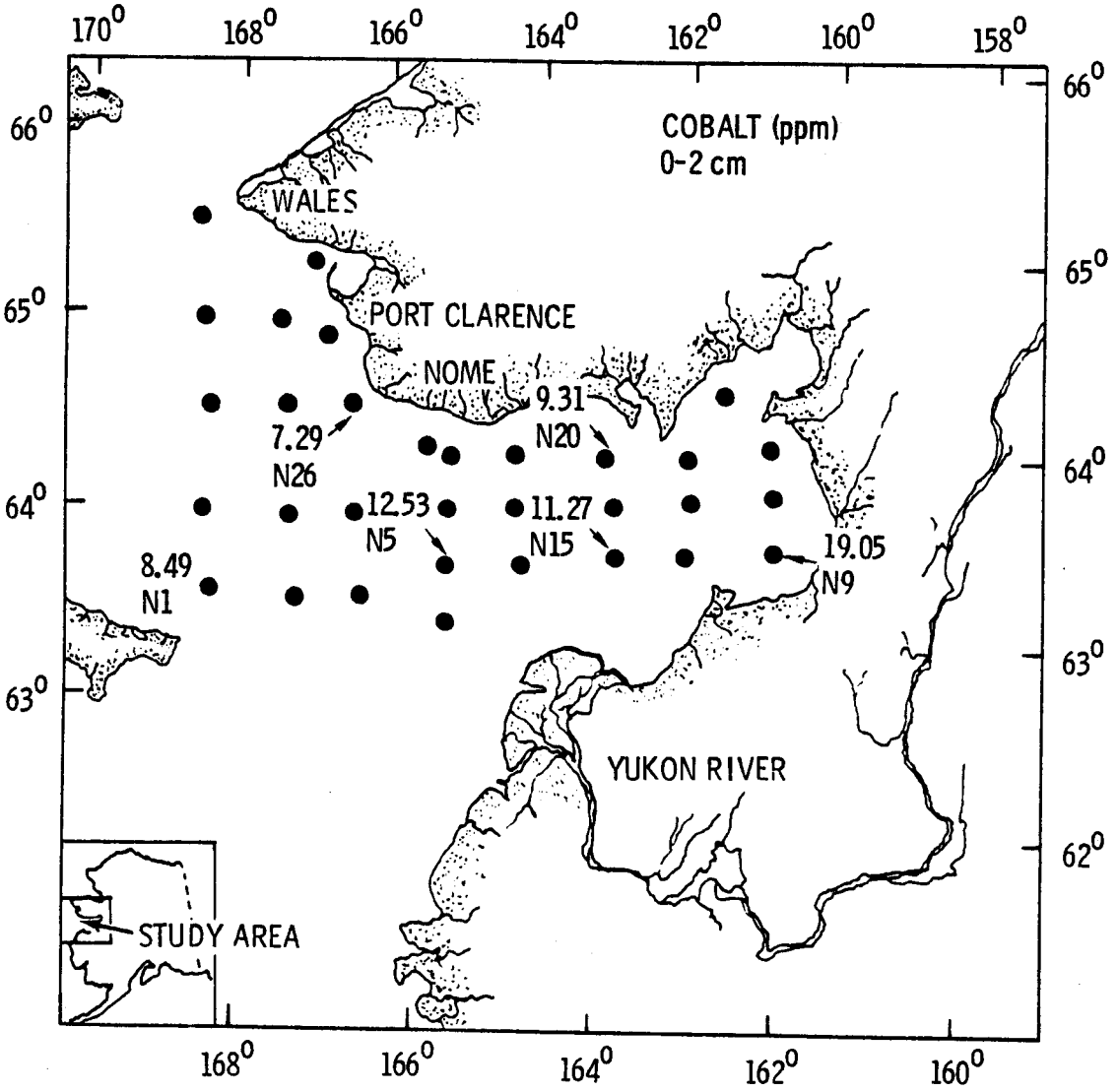


FIGURE D.50 Co Concentration in Norton Sound Sediments

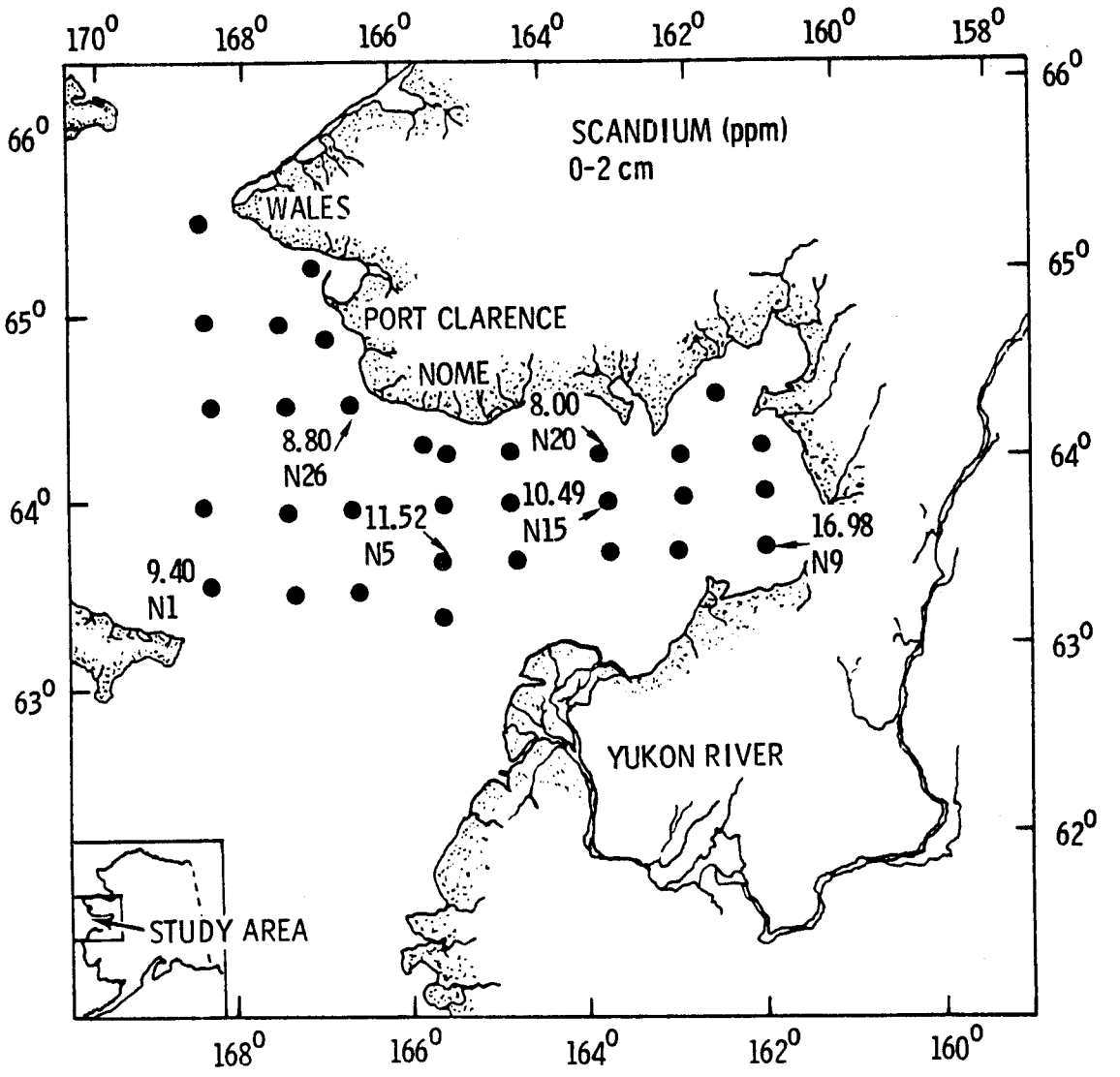


FIGURE D.51 Sc Concentration in Norton Sound Sediments

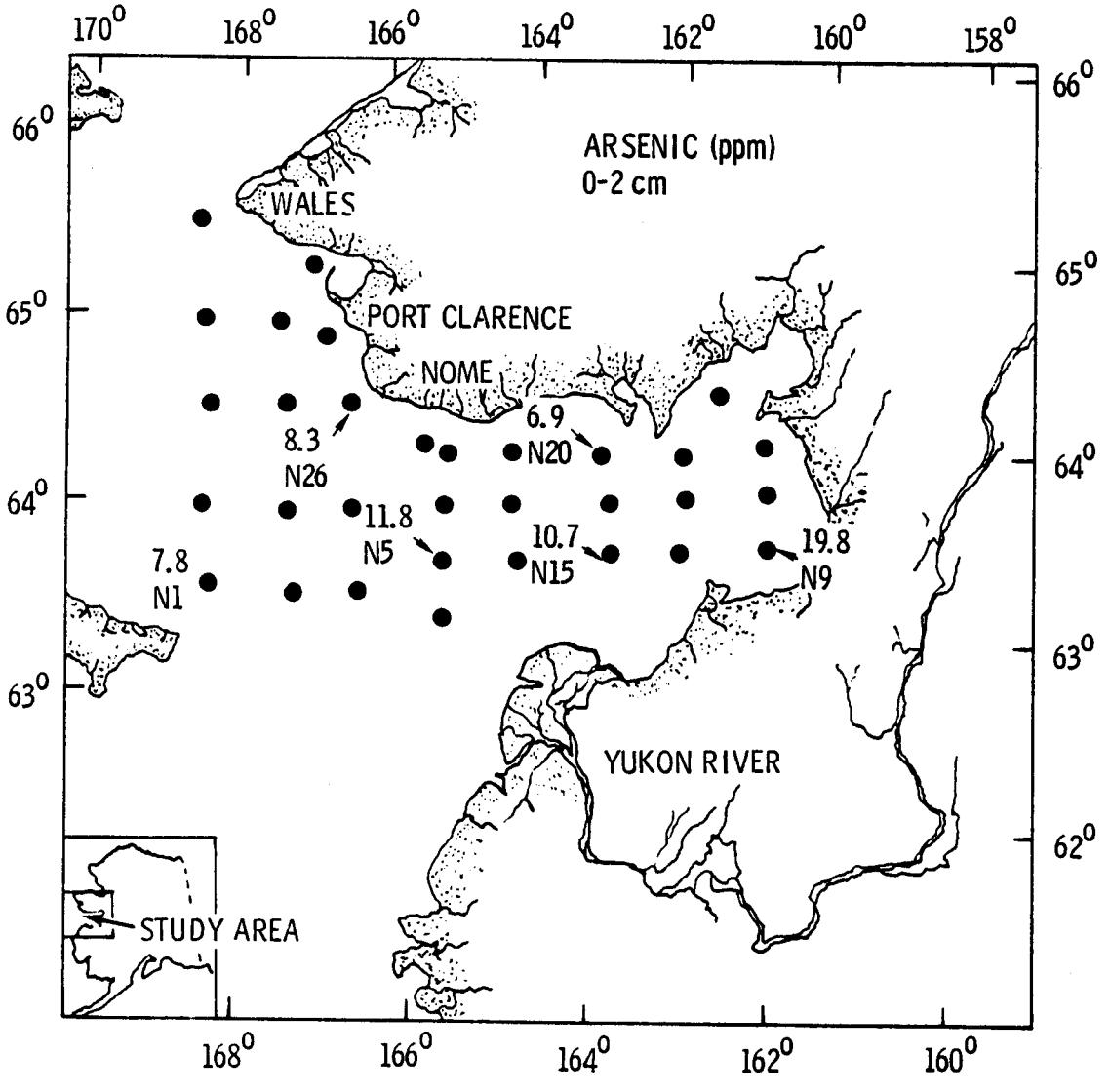


FIGURE D.52 As Concentration in Norton Sound Sediments

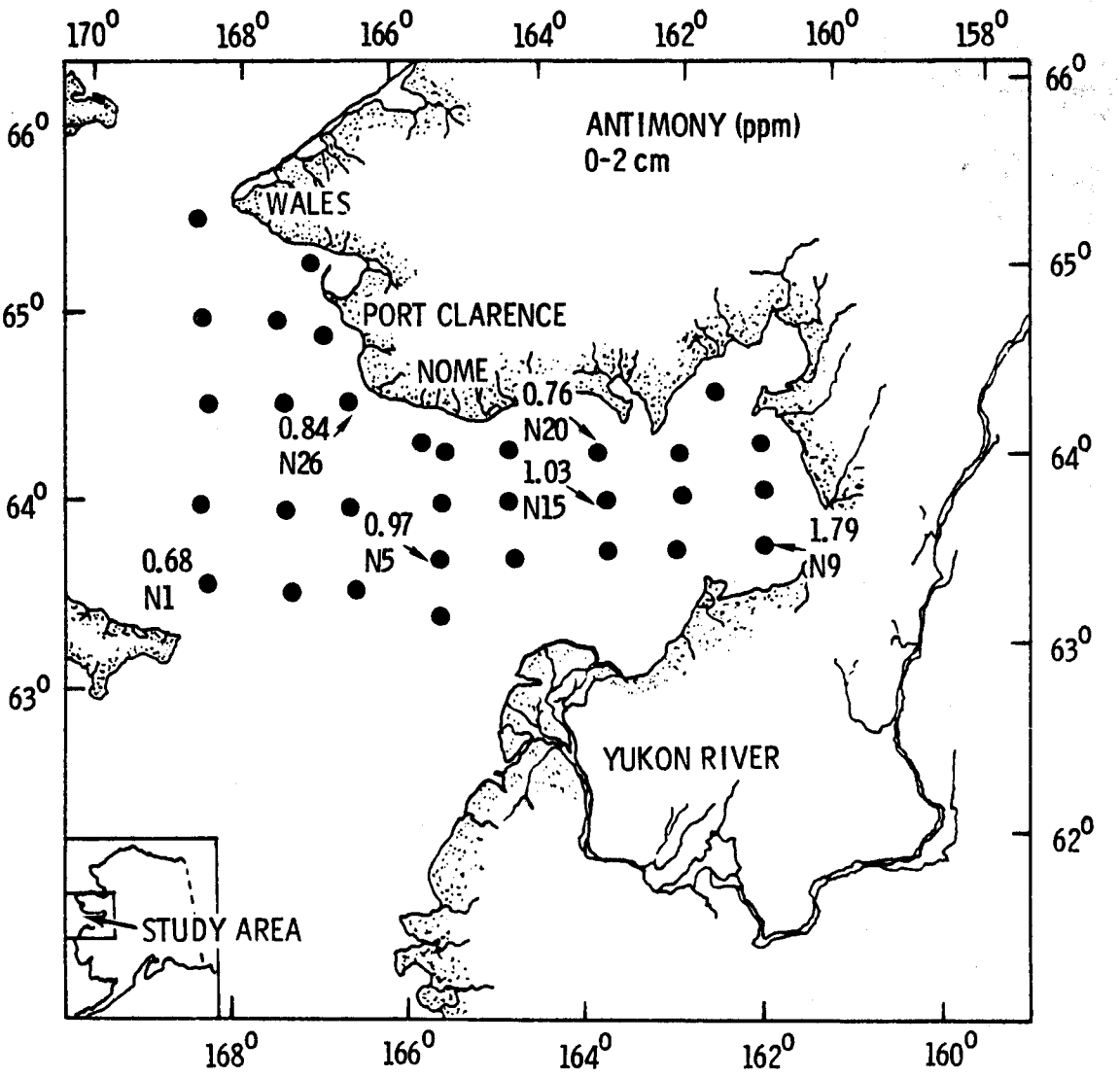


FIGURE D.53 Sb Concentration in Norton Sound Sediments

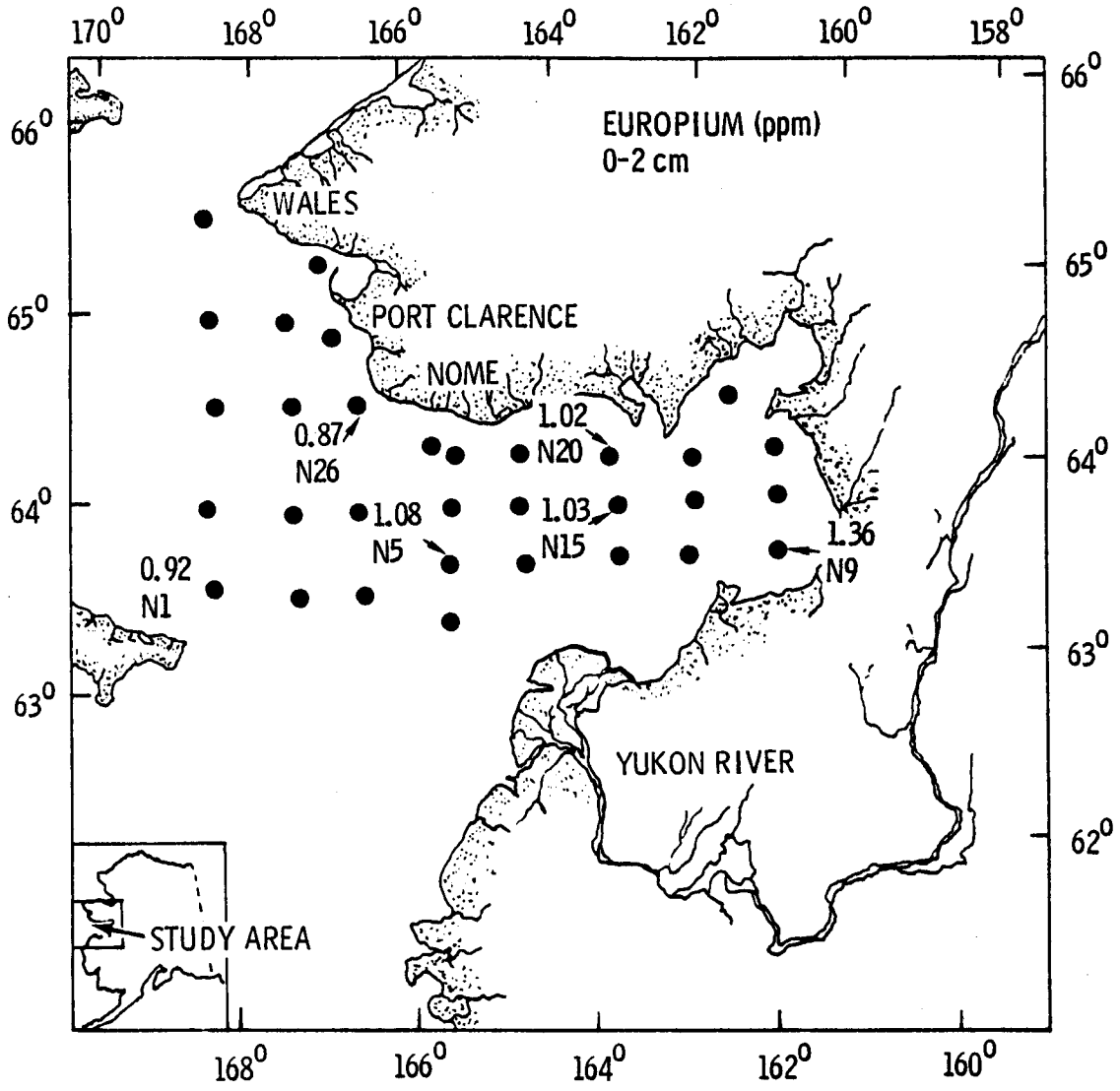


FIGURE D.54 Eu Concentrations in Norton Sound Sediments

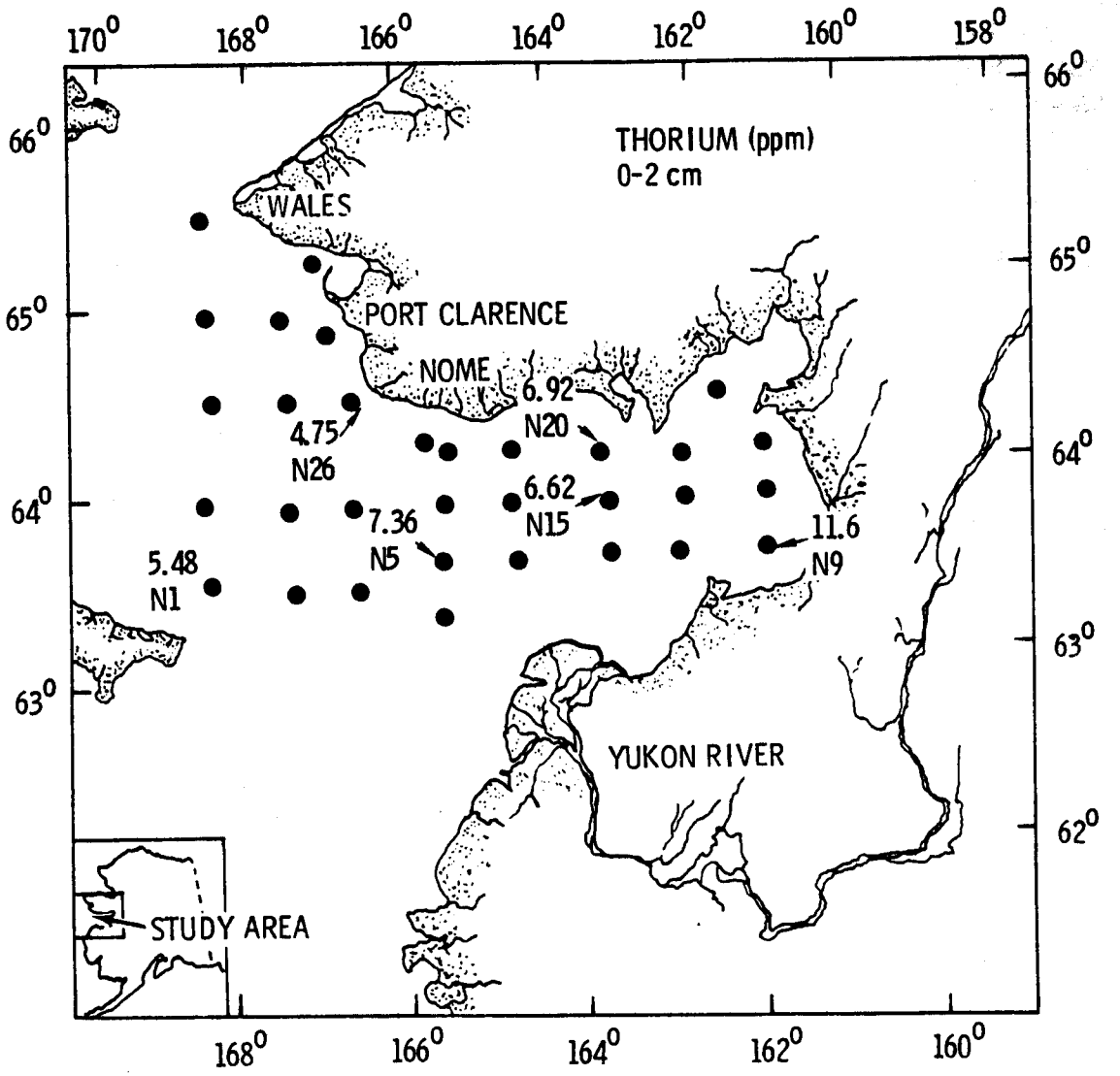


FIGURE D.55 Th Concentrations in Norton Sound Sediments

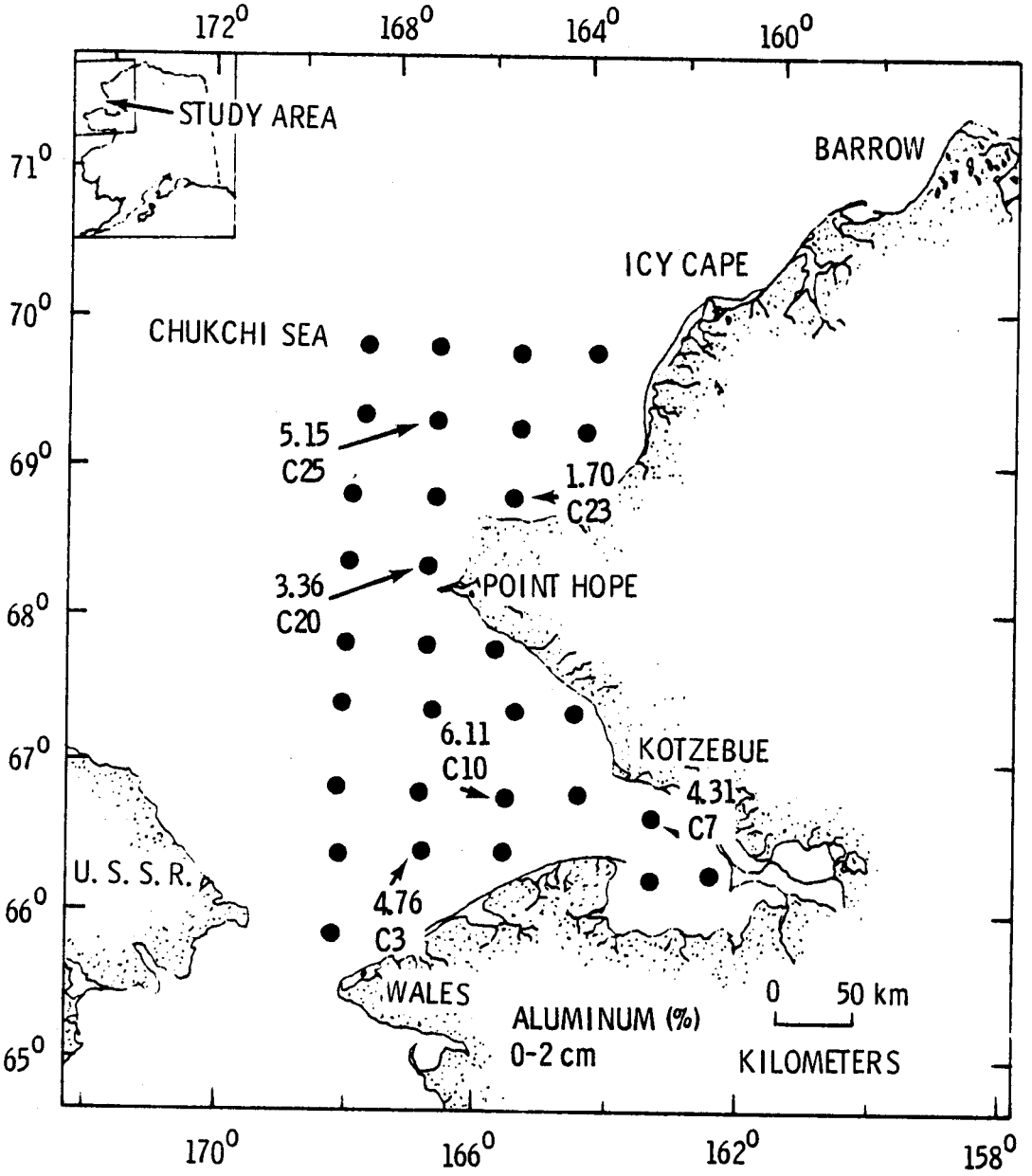


FIGURE D.56 Al Concentration in Chukchi Sea Sediments

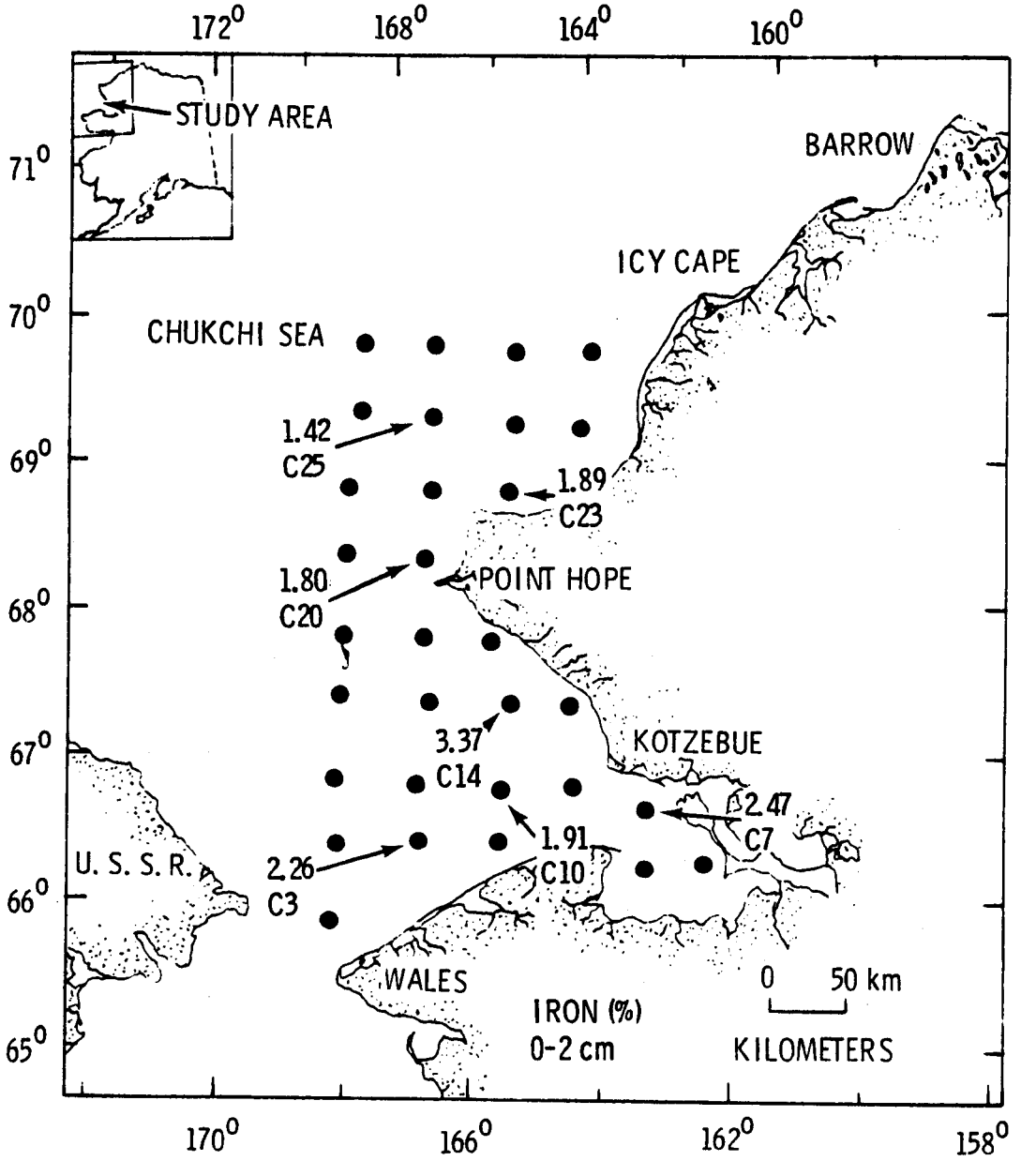


FIGURE D.57 Fe Concentration in Chukchi Sea Sediments

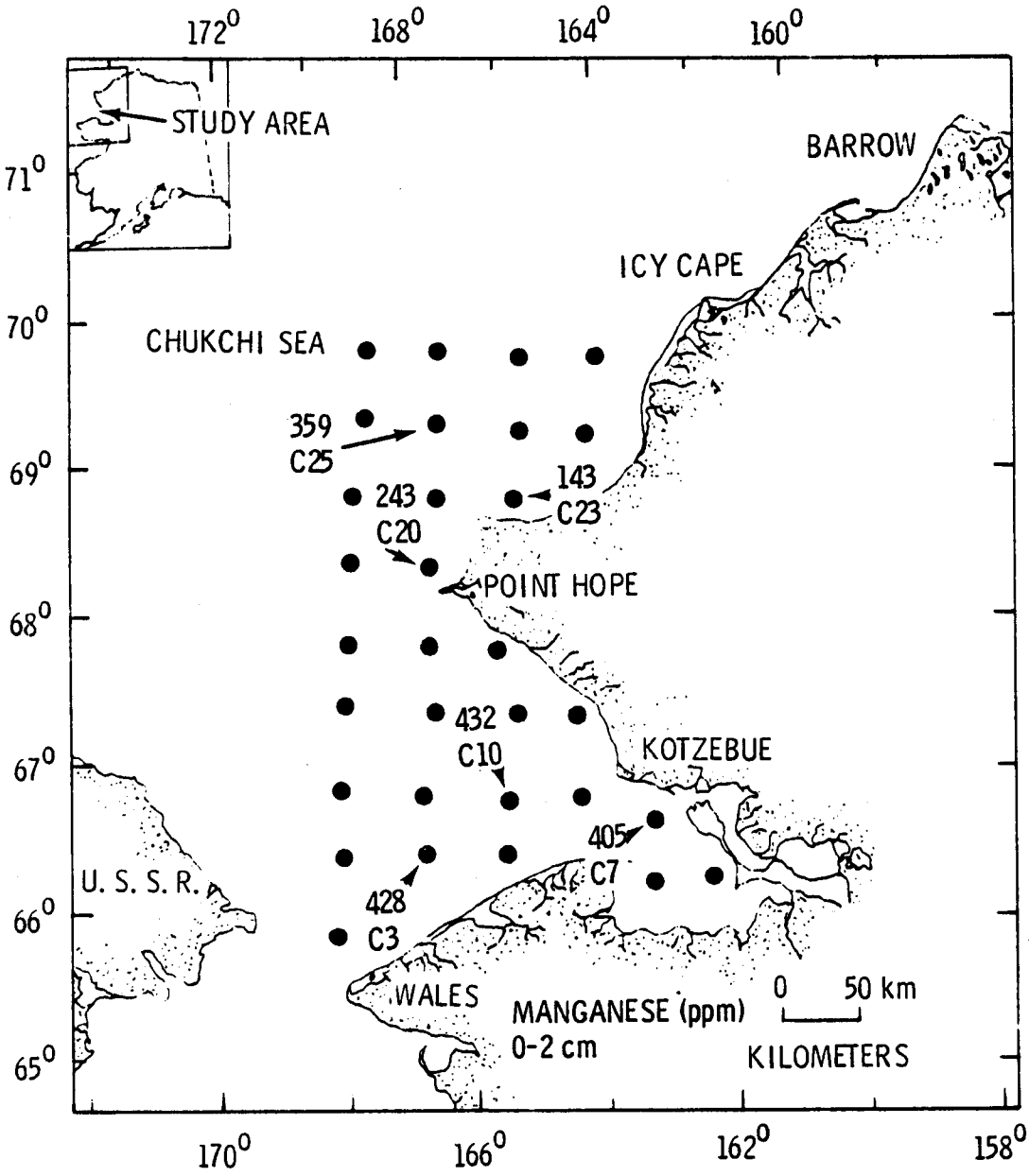


FIGURE D.58 Mn Concentration in Chukchi Sea Sediments

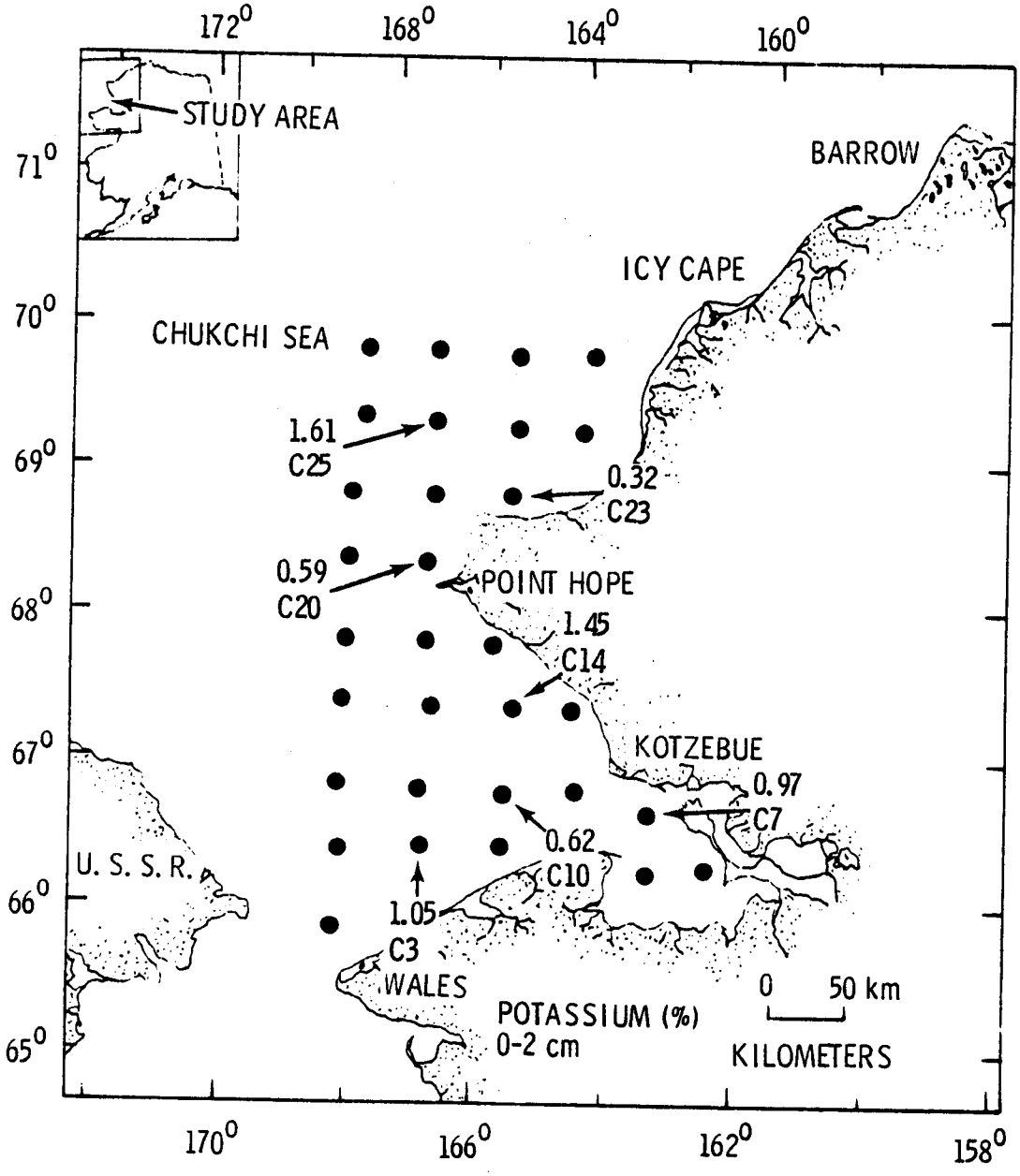


FIGURE D.60 K Concentration in Chukchi Sea Sediments

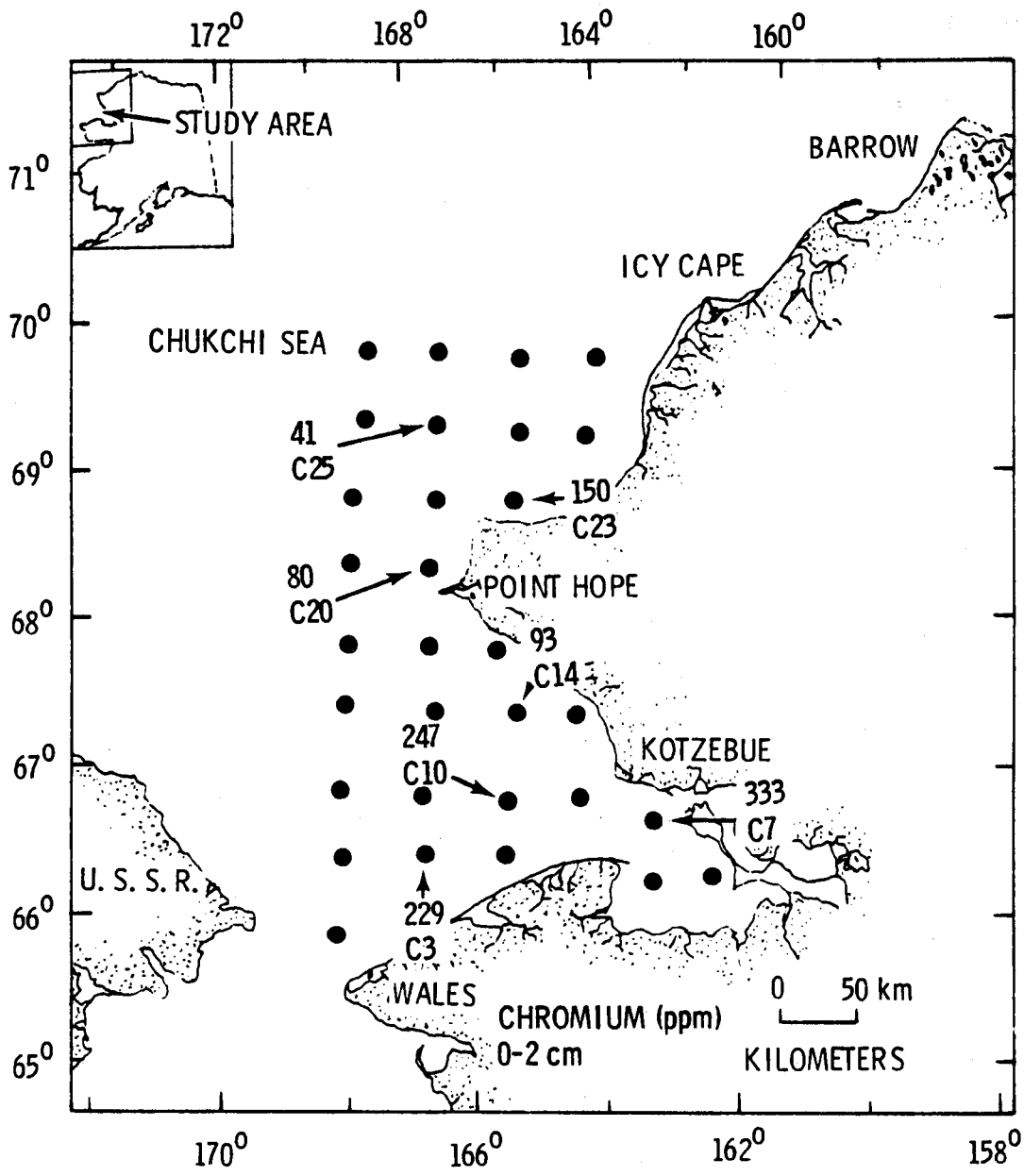


FIGURE D.61 Cr Concentration in Chukchi Sea Sediments

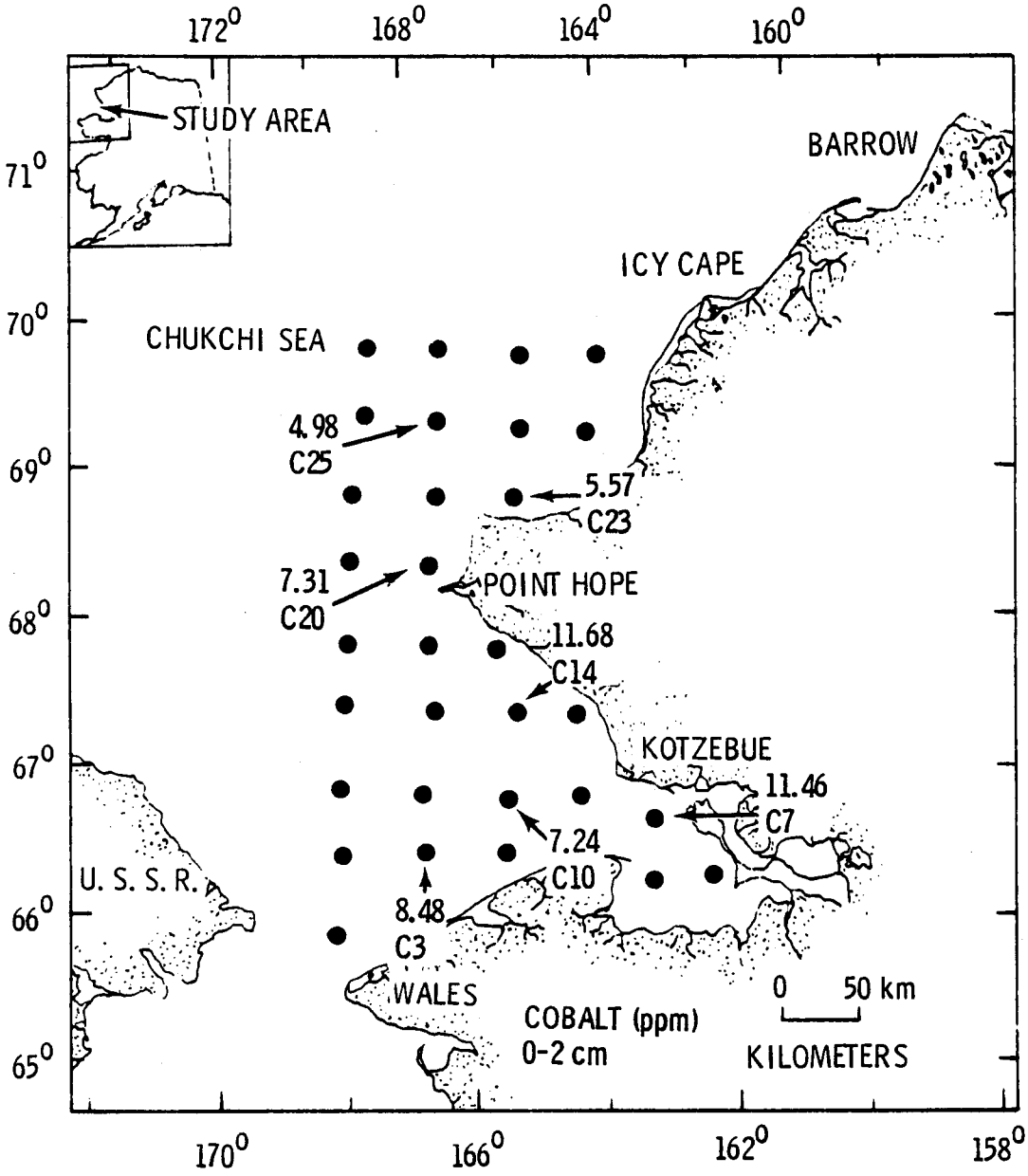


FIGURE D.62 Co Concentration in Chukchi Sea Sediments

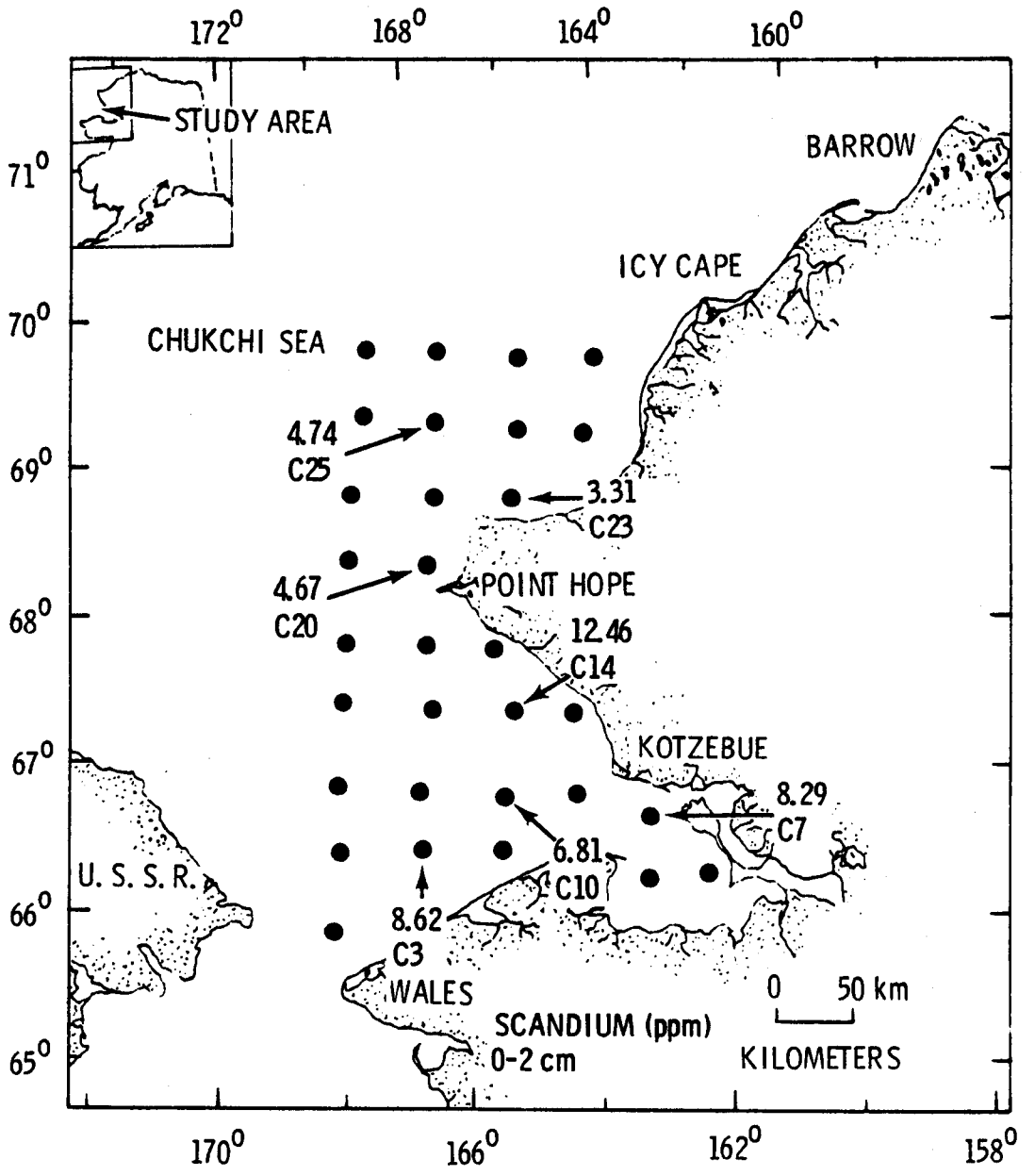


FIGURE D.63 Sc Concentration in Chukchi Sea Sediments

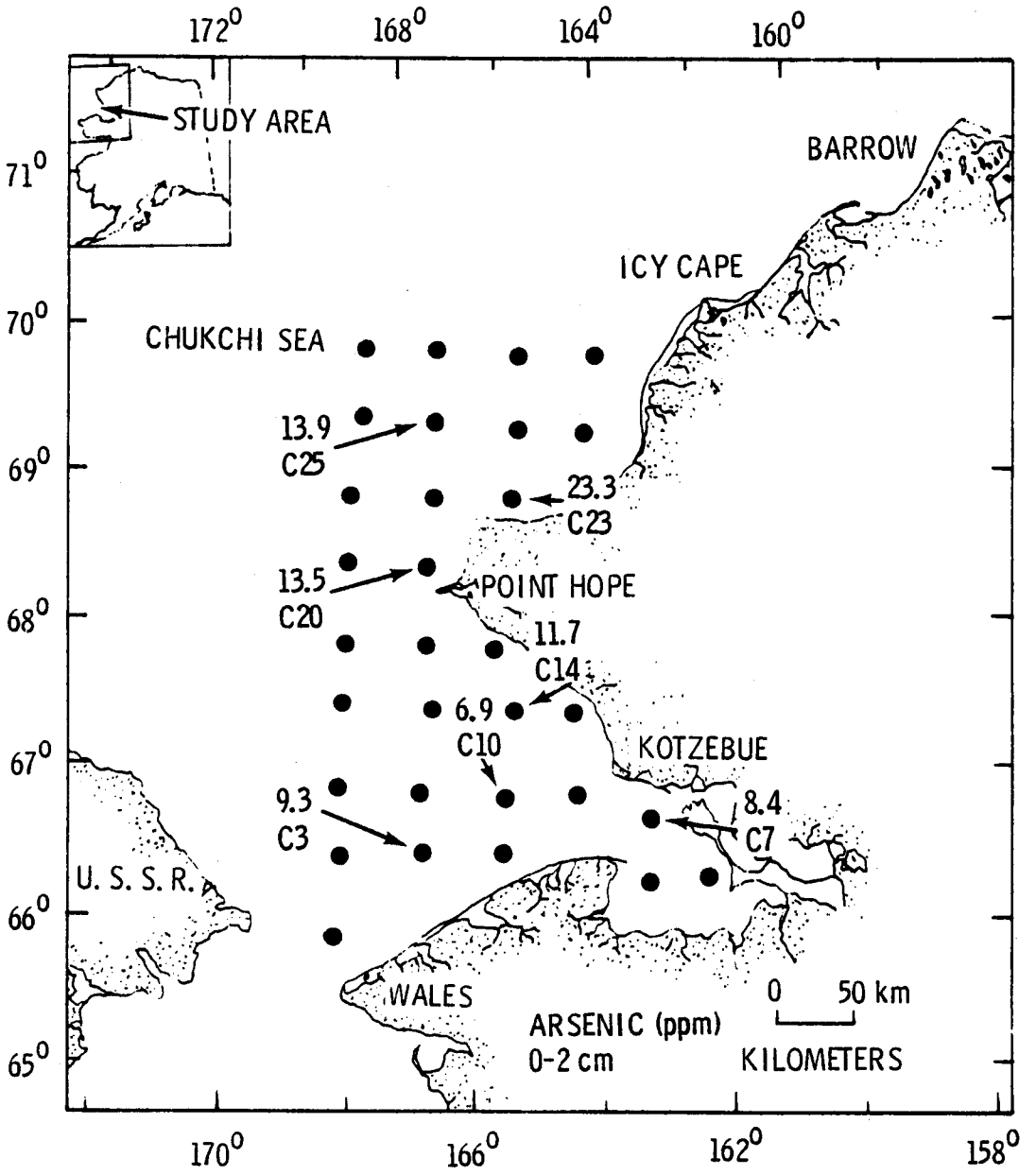


FIGURE D.64 As Concentration in Chukchi Sea Sediments

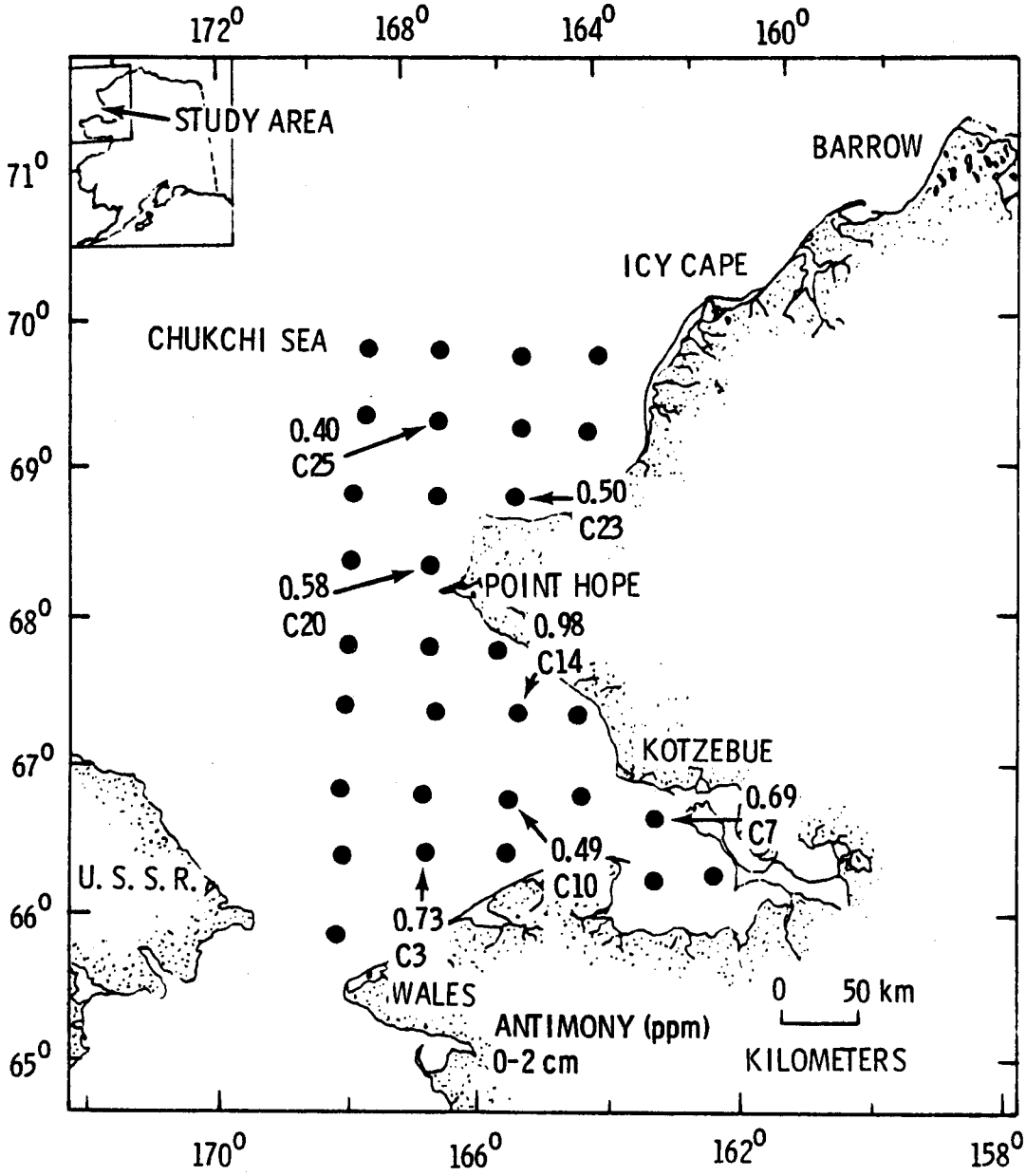


FIGURE D.65 Sb Concentration in Chukchi Sea Sediments

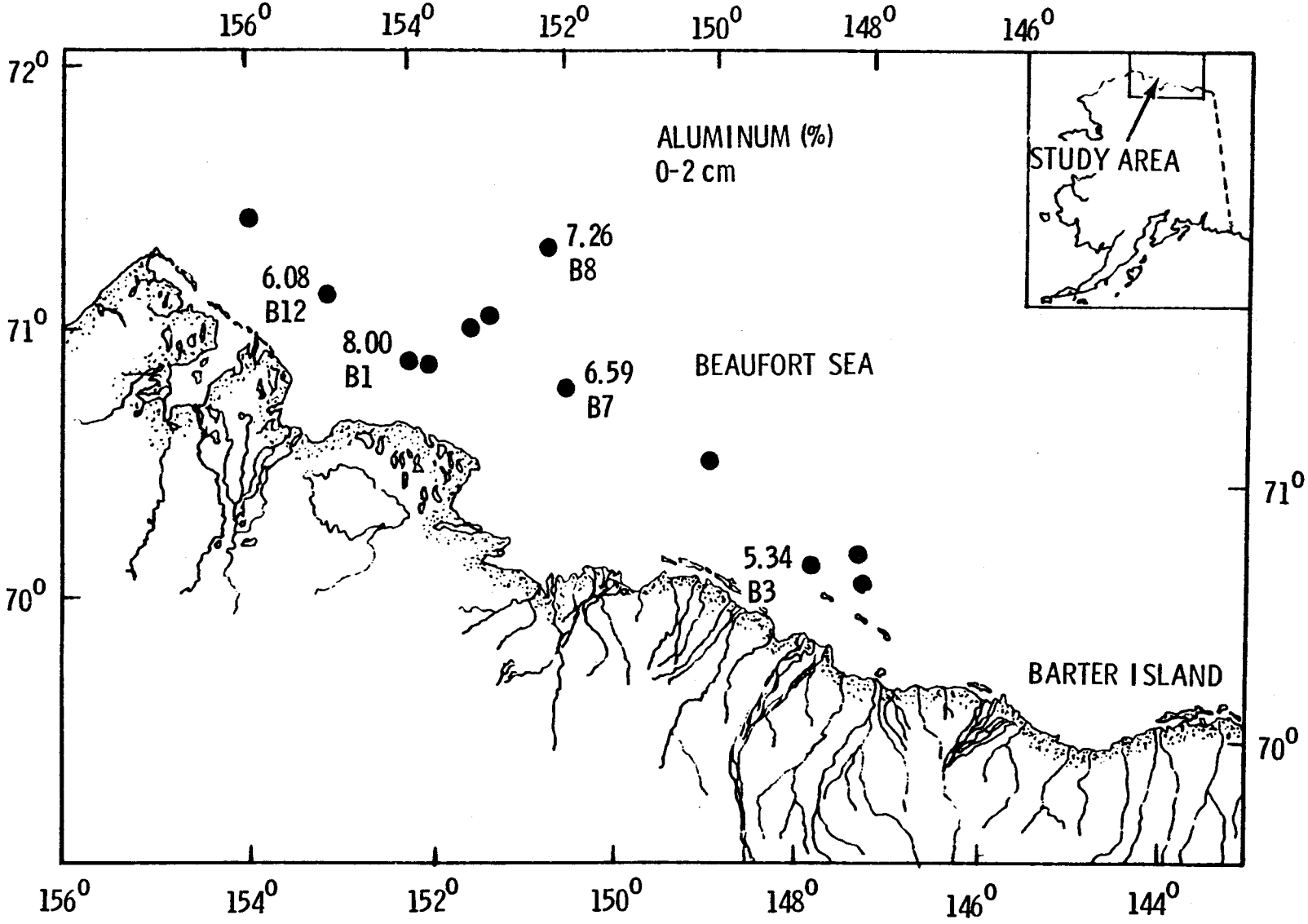


FIGURE D.66 Al Concentrations in Beaufort Sea Sediments

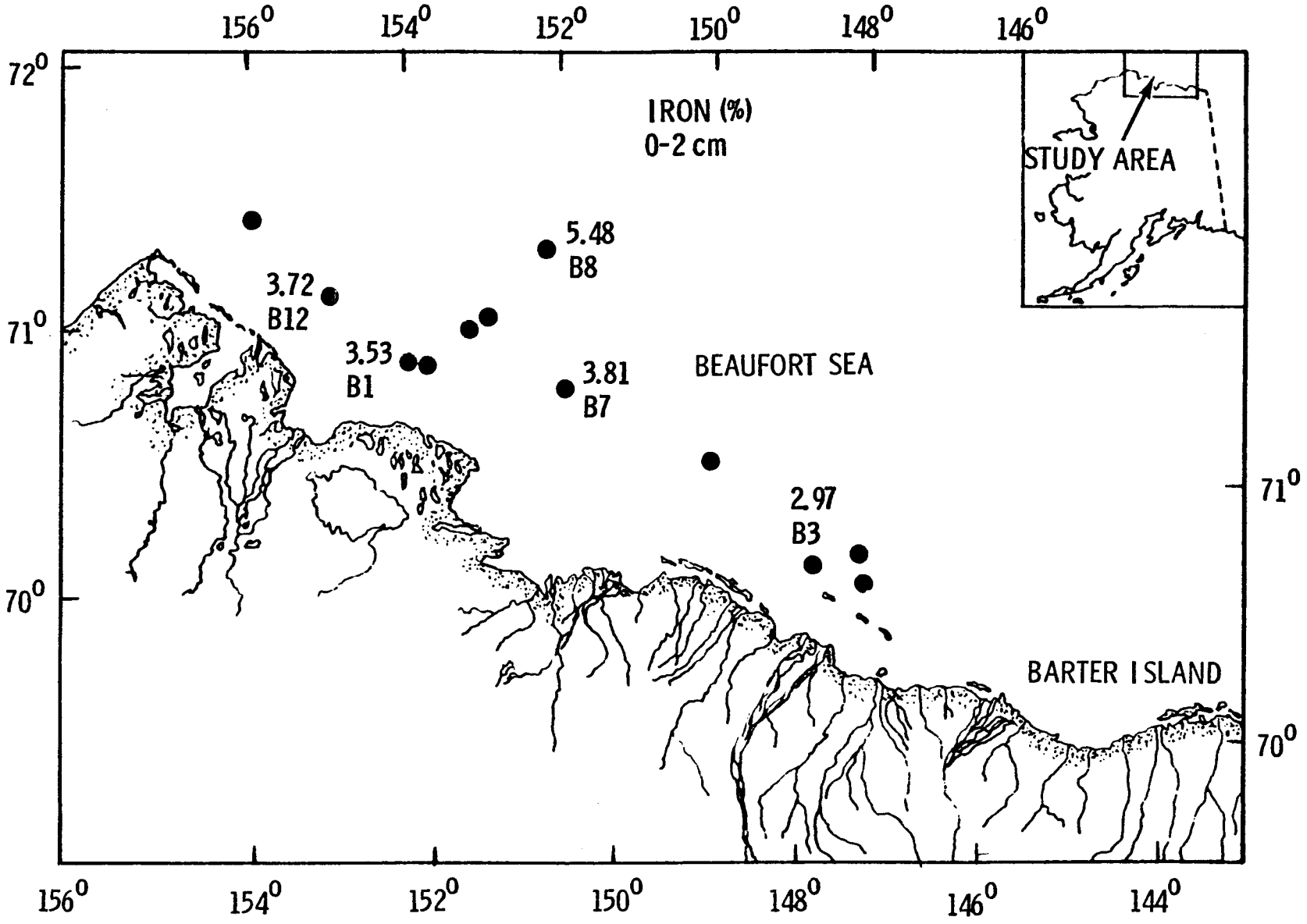


FIGURE D.67 Fe Concentrations in Beaufort Sea Sediments

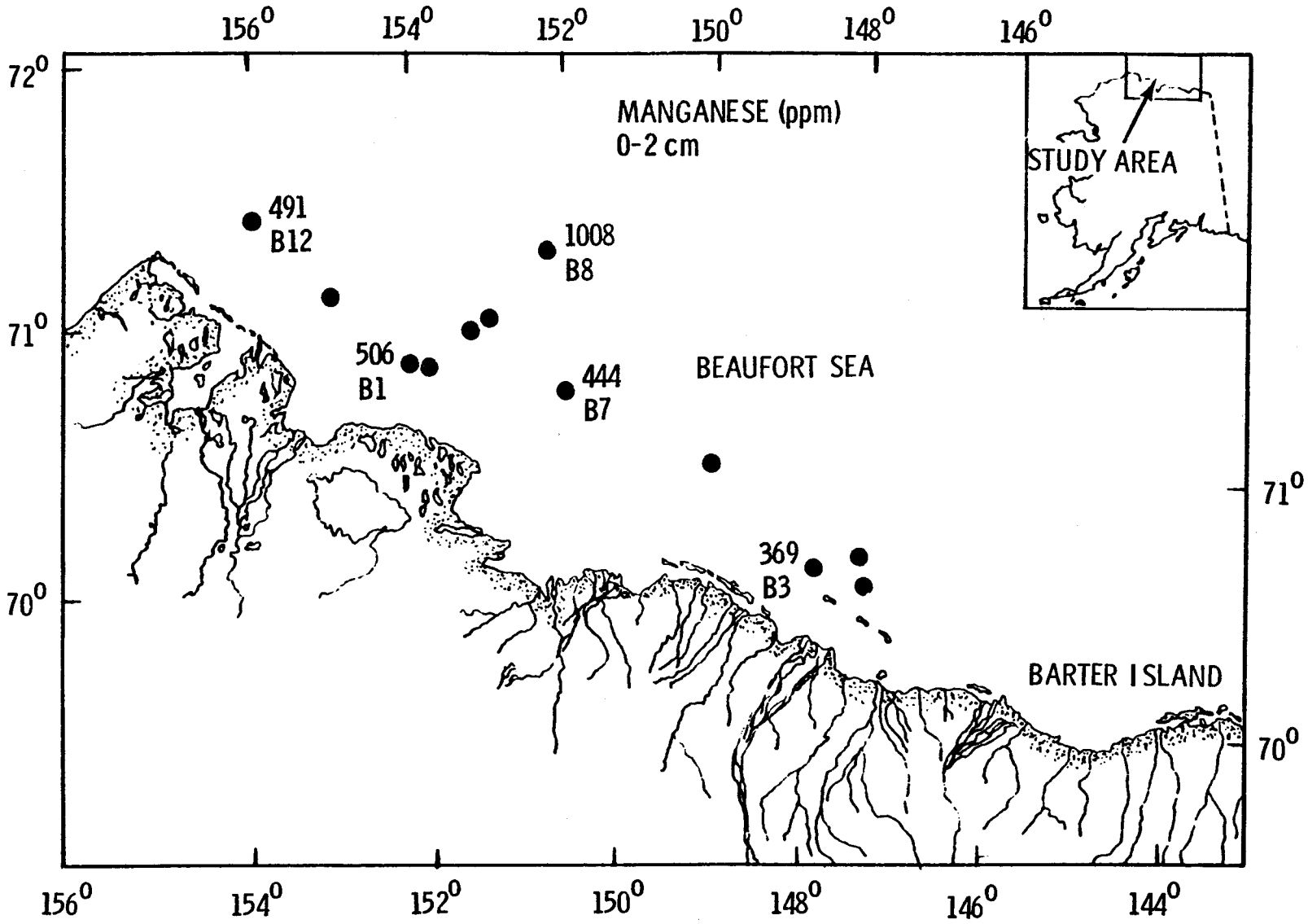


FIGURE D.68 Mn Concentrations in Beaufort Sea Sediments

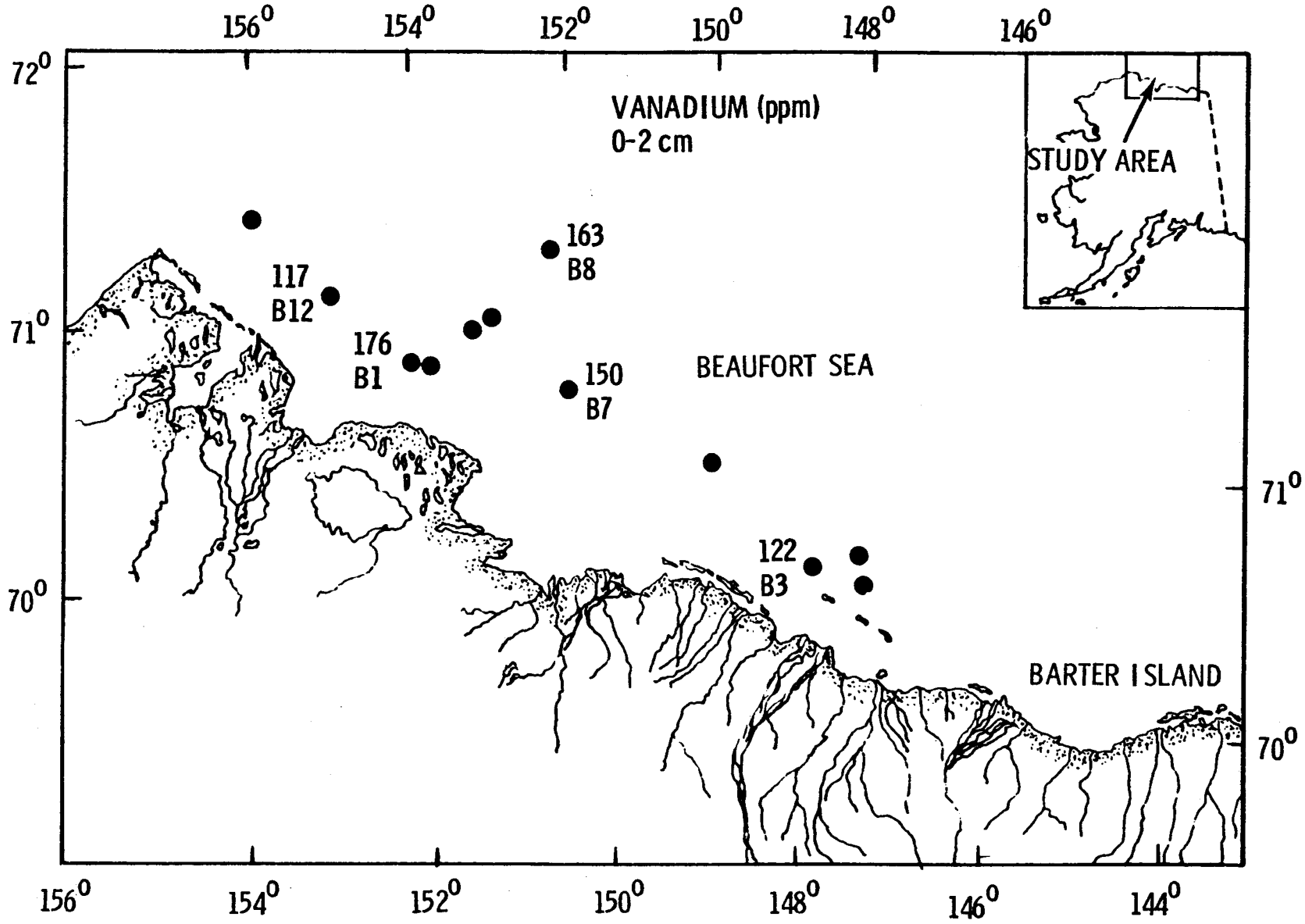


FIGURE D.69 V Concentrations in Beaufort Sea Sediments

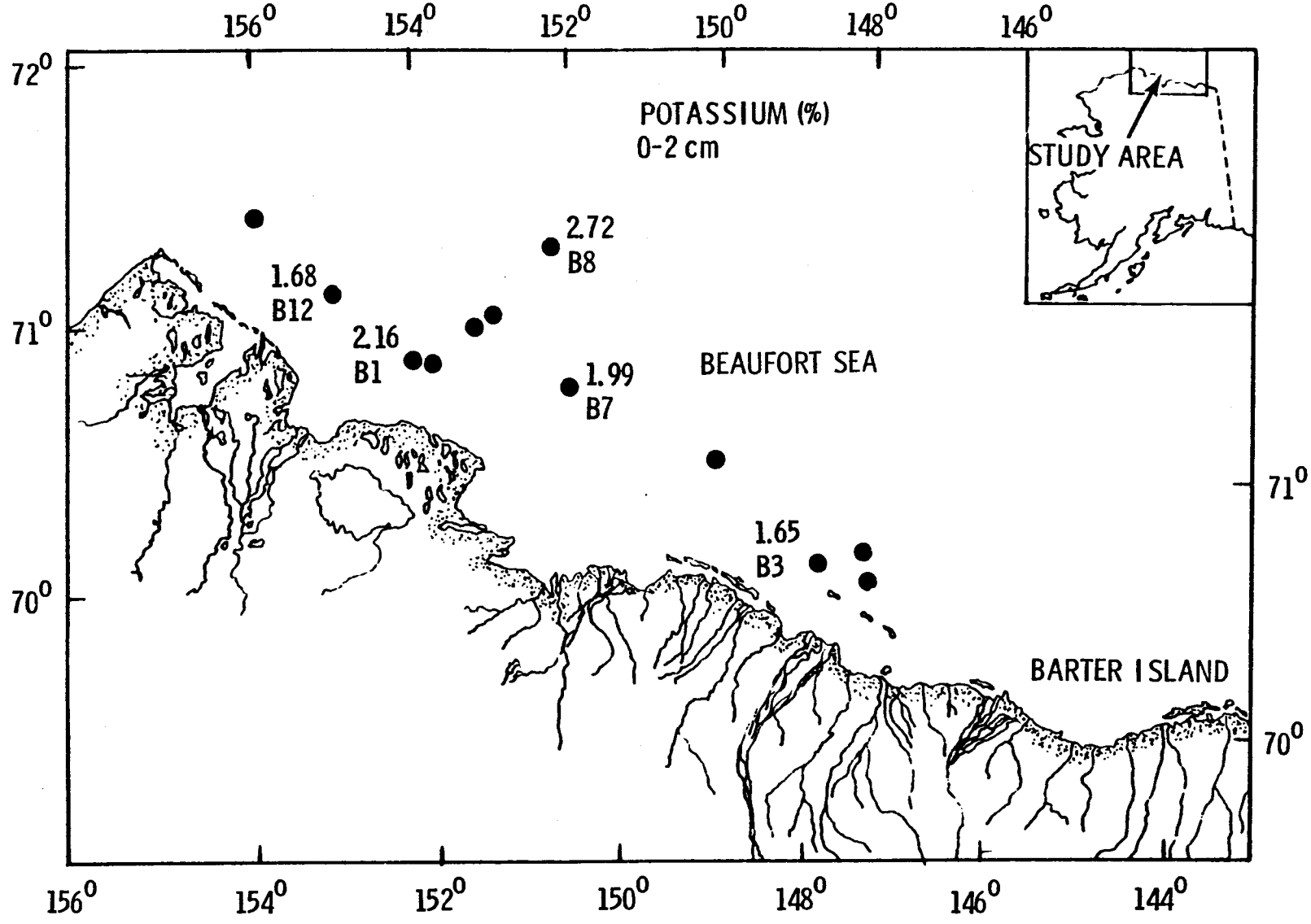


FIGURE D.70 K Concentrations in Beaufort Sea Sediments

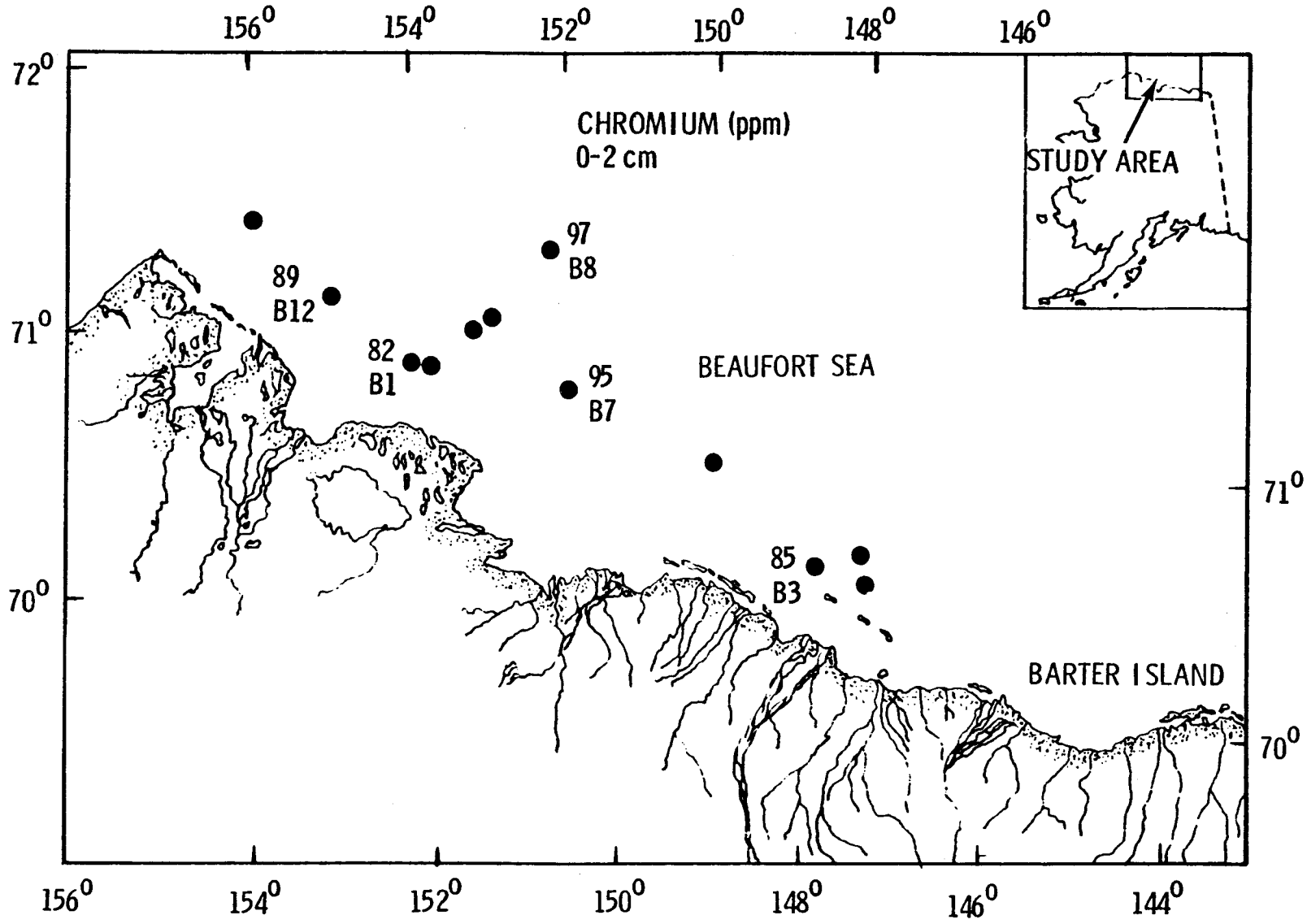


FIGURE D.71 Cr Concentrations in Beaufort Sea Sediments

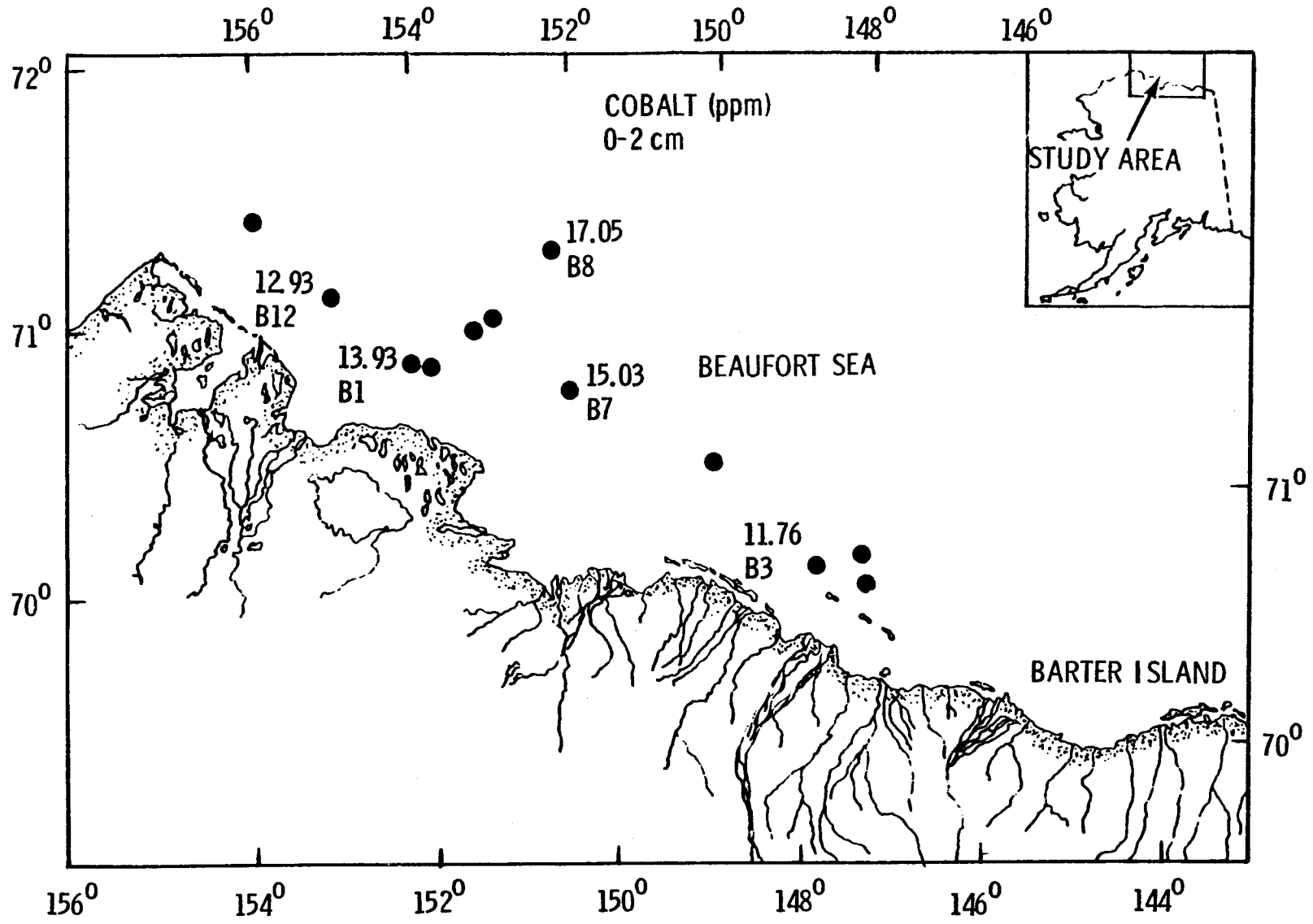


FIGURE D.72 Co Concentrations in Beaufort Sea Sediments

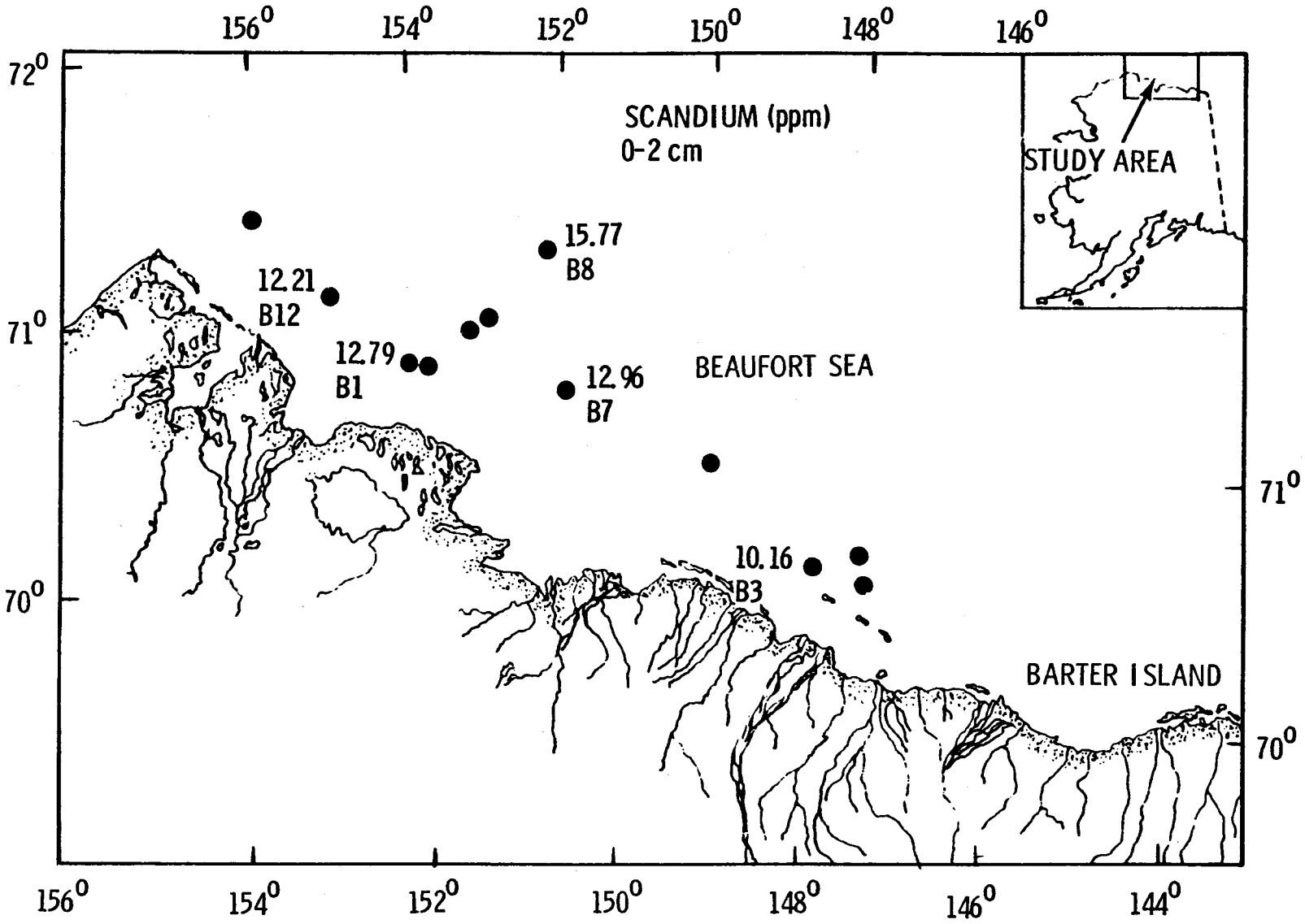


FIGURE D.73 Sc Concentrations in Beaufort Sea Sediments

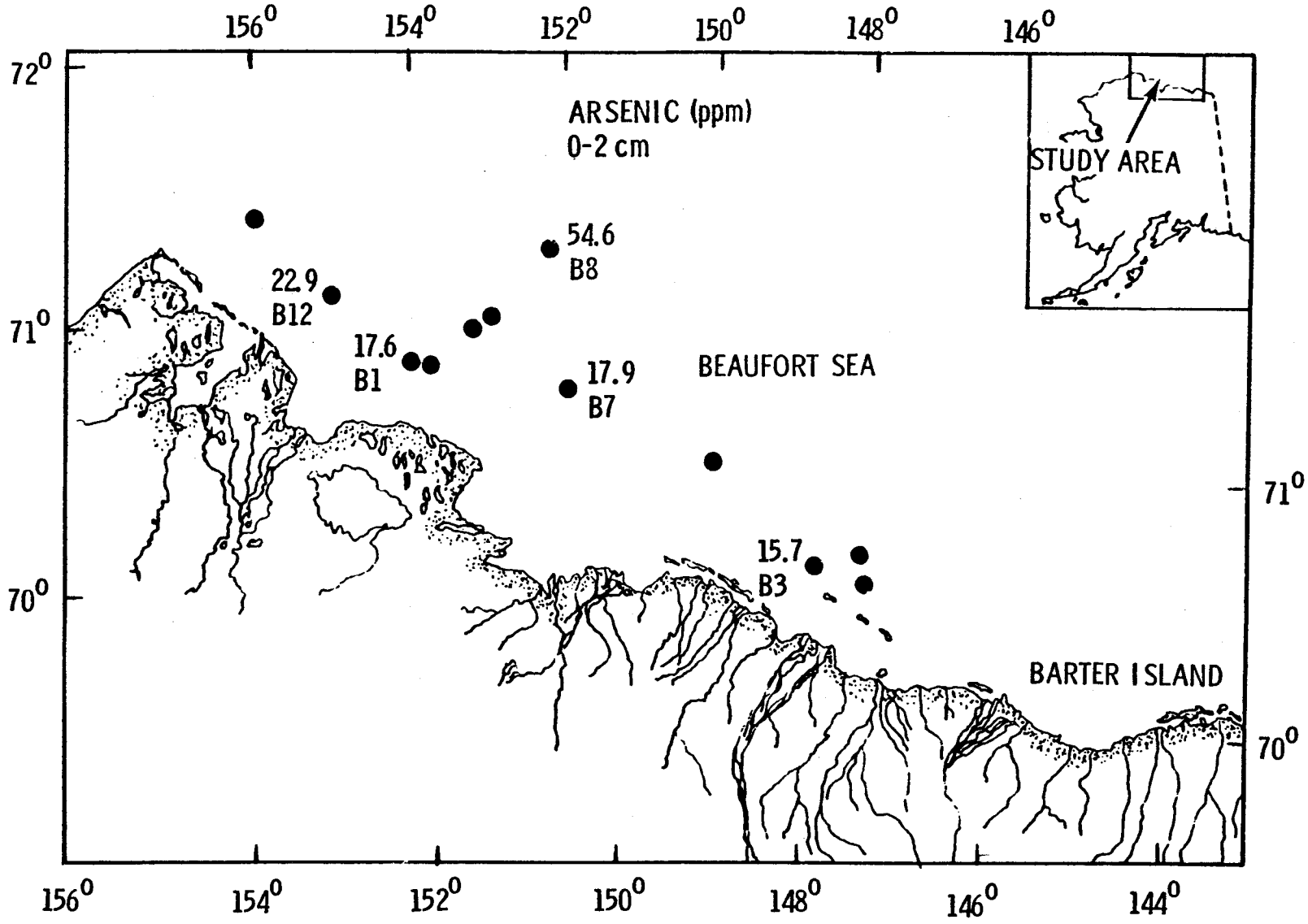


FIGURE D.74 As Concentrations in Beaufort Sea Sediments

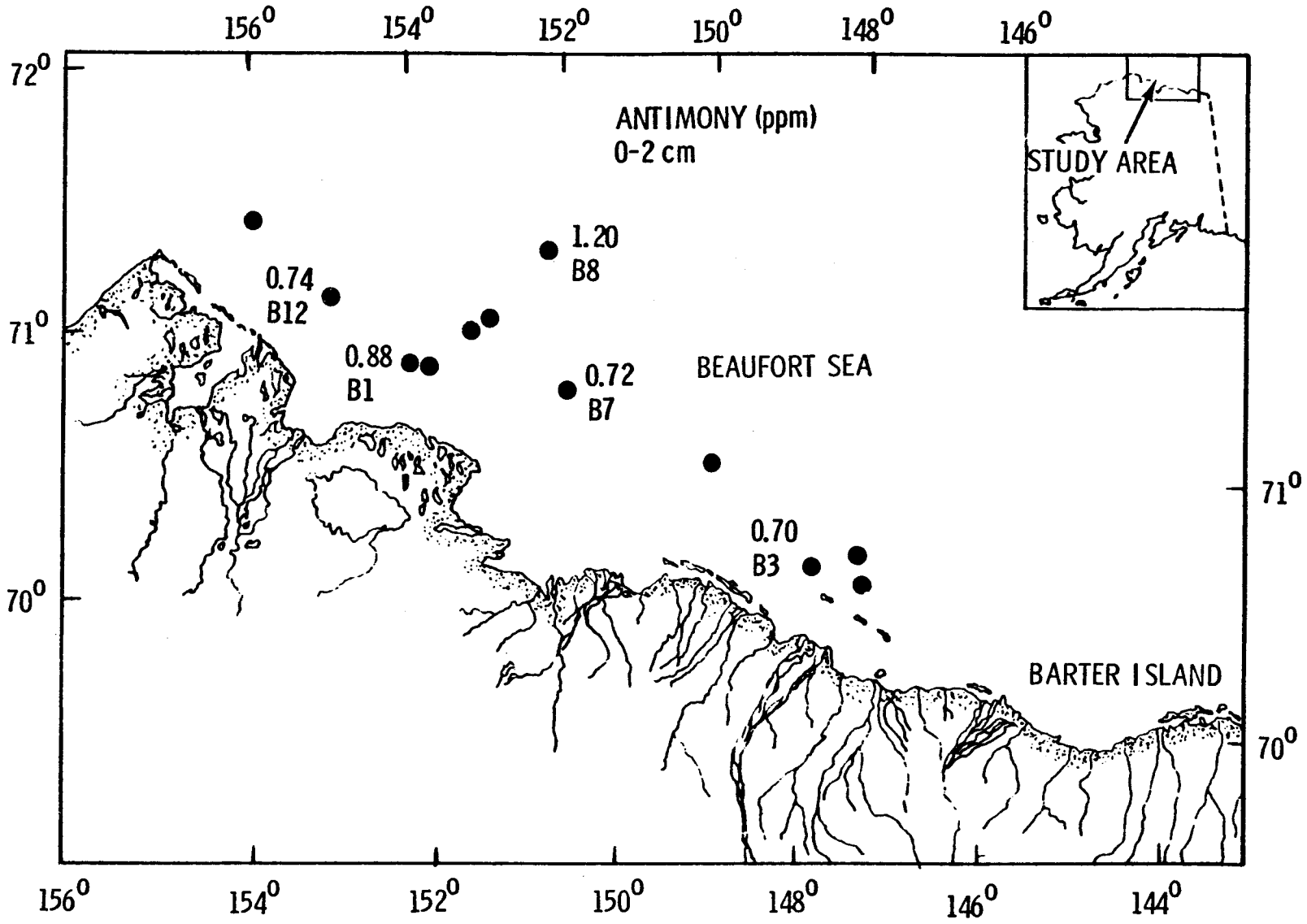


FIGURE D.75 Sb Concentrations in Beaufort Sea Sediments

APPENDIX E

"Available" Metals in Alaskan Shelf Sediments

TABLE E.1 "AVAILABLE" VANADIUM IN ALASKAN OCS SEDIMENTS (μg/g DRY WT SEDIMENT) DETERMINED BY A SEQUENTIAL HYDROGEN PEROXIDE AND 0.3 M HCl LEACHING TECHNIQUE*

	H_2O_2 Leachable	0.3M HCl Leachable	Total "Available" Vanadium	(%)**
COOK INLET				
Station CB-1	4.52±0.17	23.4±1.9	27.9±1.9	(29%)
CB-3	1.17±0.06	10.0±1.1	11.2±1.1	(10%)
CB-6	1.63±0.07	4.21±0.44	5.84±0.45	(10%)
CB-7	2.77±0.11	11.4±1.0	14.2±1.0	(12%)
CB-8	11.8±0.4	26.8±1.9	38.6±1.9	(26%)
SHELIKOF STRAIT				
Station SS-2	4.68±0.17	16.2±1.2	20.9±1.2	(14%)
SS-5	1.17±0.05	12.6±1.3	13.8±1.2	(10%)
SS-8	4.06±0.15	11.0±0.7	15.1±0.7	(10%)
SS-10	2.14±0.08	9.3±0.6	11.4±0.6	(10%)
BRISTOL BAY				
Station MB-8	6.84±0.26	28.3±2.2	35.1±2.2	(27%)
MB-12	4.17±0.16	16.1±1.4	20.3±1.4	(21%)
MB-41	5.91±0.23	24.8±2.0	30.7±2.0	(34%)
EASTERN GULF OF ALASKA				
Station EG-33	7.63±0.28	20.7±1.7	28.3±1.7	(24%)
EG-44	2.73±0.10	13.2±1.1	15.9±1.1	(12%)
EG-58	2.53±0.10	26.1±2.0	28.6±2.0	(16%)
WESTERN GULF OF ALASKA				
Station WG-105	2.18±0.09	11.2±1.0	13.4±1.0	(15%)
WG-120	2.81±0.10	11.9±0.8	14.7±0.8	(11%)
WG-133	3.36±0.13	7.7±0.9	11.1±0.9	(5%)
BLANK	<0.055	0.063±0.011	----	
	<0.053	0.080±0.013	----	
	<0.024			

*Malo, Environ, Sci. Technol. V.11, pp. 277, 1977.
**Percent of total vanadium in sediments

TABLE E.2

"AVAILABLE" MANGANESE IN ALASKAN OCS SEDIMENTS (μg/g DRY WT SEDIMENT) DETERMINED BY A SEQUENTIAL HYDROGEN PEROXIDE AND 0.3 M HCl LEACHING TECHNIQUE*

	H_2O_2 Leachable	0.3M HCl Leachable	Total "Available" Manganese (%)**	
COOK INLET				
Station CB-1	8.86±0.62	515±26	524±26	75%
CB-3	2.54±0.43	353±18	356±18	49%
CB-6	0.40±0.17	166±12	166±12	40%
CB-7	5.51±0.45	242±17	248±17	38%
CB-8	4.57±0.47	439±31	444±31	57%
SHELIKOF STRAIT				
Station SS-2	7.06±0.79	306±22	313±22	51%
SS-5	6.50±0.71	295±21	302±21	49%
SS-8	7.54±1.11	293±21	301±21	--
SS-10	13.0 ±1.3	241±17	254±17	37%
EASTERN GULF OF ALASKA				
Station EG-33	3.29±0.47	464±24	467±24	82%
EG-44	2.80±0.31	374±19	377±19	49%
EG-58	1.54±0.43	510±26	512±26	61%
WESTERN GULF OF ALASKA				
Station WG-105	--	714±37	714±37	106%
WG-120	6.03±0.31	350±18	356±18	40%
WG-133	10.1 ±0.8	280±14	290±14	21%
BRISTOL BAY				
Station MB-8	12.1 ±1.0	385±20	397±20	57%
MB-12	5.72±0.61	123±6	129±6	22%
MB-41	6.39±0.51	185±9	191±9	43%
BLANK	----	----		

*Malo, Environ. Sci. Technol. V.11, p 277
**Percentage of total manganese in sediments

TABLE E.3

"AVAILABLE" Fe, Co, Sc IN ALASKAN OCS SURFICIAL SEDIMENTS DETERMINED BY SEQUENTIAL LEACHING WITH H_2O_2 AND 0.1 N HCl

	H_2O_2						0.1 N HCl					
	Fe		Co		Sc		Fe		Co		Sc	
STATION	µg/g	% AVAILABLE	Ng/g	% AVAILABLE	Ng/g	% AVAILABLE	µg/g	% AVAILABLE	Ng/g	% AVAILABLE	Ng/g	% AVAILABLE
EG-33	3.09 ± 0.30	0.01	16.0 ± 0.6	0.10	0.57 ± 0.03	0.004	3180 ± 10	6.1	1.80 ± 0.01	11.3	0.283 ± 0.001	1.77
EG-44	6.72 ± 0.37	0.02	10.0 ± 0.6	0.07	0.87 ± 0.04	0.005	4510 ± 20	10.4	3.24 ± 0.28	21.6	0.553 ± 0.002	3.07
EG-58	5.35 ± 0.61	0.01	7.8 ± 0.7	0.04	1.14 ± 0.07	0.006	11870 ± 40	24.7	7.13 ± 0.04	39.6	1.800 ± 0.004	9.00
MB-8	19.9 ± 0.6	0.05	23.6 ± 0.7	0.18	4.49 ± 0.71	0.03	3490 ± 10	9.0	1.75 ± 0.01	13.4	0.277 ± 0.002	2.15
MB-12	43.9 ± 1.0	0.13	1.03 ± 2	0.94	5.04 ± 0.08	0.04	1540 ± 10	4.5	1.17 ± 0.01	10.6	0.212 ± 0.002	1.63
MB-41	24.2 ± 0.8	0.10	29.5 ± 0.8	0.33	2.74 ± 0.06	0.03	3105 ± 10	15.1	1.83 ± 0.01	20.6	0.328 ± 0.003	3.28
WG-105	3.97 ± 0.31	0.01	12.8 ± 0.1	0.08	0.94 ± 0.05	0.008	1680 ± 10	---	1.87 ± 0.02	---	0.178 ± 0.002	---
WG-120	4.98 ± 0.62	0.01	6.2 ± 1.4	0.03	0.69 ± 0.07	0.004	12180 ± 40	27.4	10.64 ± 0.03	59.1	0.687 ± 0.003	4.29
WG-133	6.27 ± 0.37	0.02	4.2 ± 0.7	0.03	3.24 ± 0.05	0.023	2581 ± 10	6.3	3.26 ± 0.03	20.4	0.366 ± 0.003	2.61
CB-1	7.31 ± 0.59	0.02	19.3 ± 0.9	0.15	0.99 ± 0.06	0.008	5870 ± 20	16.7	4.45 ± 0.03	34.7	0.564 ± 0.003	4.26
CB-3	6.28 ± 0.43	0.03	12.9 ± 0.5	0.16	1.26 ± 0.05	0.017	2850 ± 10	14.0	2.74 ± 0.03	33.3	0.328 ± 0.003	4.44
CB-6	5.93 ± 0.48	---	5.5 ± 0.5	---	0.65 ± 0.05	---	1210 ± 10	---	2.45 ± 0.03	---	0.190 ± 0.001	---
CB-7	3.08 ± 0.38	0.009	51 ± 1	0.35	0.48 ± 0.03	0.004	5310 ± 20	15.9	4.79 ± 0.03	32.6	0.438 ± 0.003	3.43
CB-8	28.0 ± 0.8	0.054	44 ± 1	0.21	7.6 ± 0.12	0.040	6910 ± 30	13.4	7.14 ± 0.04	34.3	0.942 ± 0.004	4.97
SS-2	9.24 ± 0.66	0.019	44 ± 1	0.22	1.6 ± 0.1	0.009	7380 ± 30	15.3	5.99 ± 0.04	30.5	0.701 ± 0.004	4.06
SS-5	5.52 ± 0.39	0.011	27 ± 1	0.14	0.75 ± 0.03	0.004	8490 ± 40	17.2	7.05 ± 0.03	35.9	0.600 ± 0.003	3.42
SS-8	9.22 ± 0.50	0.018	44 ± 1	0.21	2.1 ± 0.4	0.0011	8810 ± 40	16.9	7.12 ± 0.04	33.9	0.682 ± 0.004	3.70
SS-10	3.25 ± 0.24	0.008	7.2 ± 0.3	0.045	0.43 ± 0.02	0.003	5800 ± 30	13.5	4.66 ± 0.03	29.2	0.386 ± 0.003	2.38

APPENDIX F

Suspended Particulate Composition in Alaskan Shelf Waters

TABLE F:1

Elemental Concentrations* of Suspended Particulate Material (>0.4μ) from Alaska Outer Continental Shelf

	Station	Depth	Mn	Al	V
Western GOA	102	1	0.22 ± 0.02	10.03 ± 0.15	.019 ± 0.011
		98	0.27 ± 0.02	9.56 ± 0.08	0.018 ± 0.009
	103	1	0.13 ± 0.04	3.79 ± 0.43	<0.020
		125	0.26 ± 0.02	7.40 ± 0.19	0.021 ± 0.012
	104	1	0.061± 0.010	2.46 ± 0.08	<0.0056
		96	0.67 ± 0.03	27.38 ± 0.13	0.059 ± 0.014
	106				
		81	0.54 ± 0.12	26.3 ± 1.0	<0.057
	108	10	0.19 ± 0.12	4.53 ± 0.86	<0.052
		226	0.33 ± 0.13	30.1 ± 0.8	<0.055
	110	10	0.17 ± 0.10	4.42 ± 0.82	<0.046
		173	0.27 ± 0.20	17.1 ± 1.5	<0.080
	119	1	0.68 ± 0.09	32.4 ± 1.0	0.070 ± 0.051
		204	6.48 ± 0.08	35.3 ± 0.8	0.094 ± 0.045
	120	1	0.38 ± 0.07	16.5 ± 0.6	<0.036
		281	7.10 ± 0.09	103 ± 1	0.224 ± 0.063
	121	1	0.26 ± 0.04	15.0 ± 0.6	<0.025
		220	2.64 ± 0.08	69.9 ± 0.8	0.148 ± 0.051
	122	1	0.24 ± 0.04	15.1 ± 1.0	<0.036
		35	0.34 ± 0.04	28.3 ± 0.5	0.053 ± 0.024
	124	1	0.28 ± 0.03	14.6 ± 0.4	0.028 ± 0.020
		105	0.30 ± 0.04	25.5 ± 0.6	0.030 ± 0.029
	133	1	0.11 ± 0.04	5.00 ± 0.58	<0.025
		68	0.44 ± 0.04	18.3 ± 0.5	<0.026
	135	1	0.066± 0.043	2.04 ± 0.65	<0.028
		141	0.36 ± 0.06	24.8 ± 2.1	<0.066
	137	1	0.21 ± 0.05	3.73 ± 1.15	<0.040
		95	0.57 ± 0.06	20.6 ± 1.0	<0.044
	145	1	0.33 ± 0.12	7.68 ± 2.19	<0.090
		63	0.23 ± 0.05	4.88 ± 0.70	<0.029

* μg/l of seawater

TABLE F.1 (contd)

Elemental Concentrations* of Suspended Particulate Material (>0.4μ) from Alaska Outer Continental Shelf

	Station	Depth	Mn	Al	V
Western GOA	146	1	0.23 ± 0.04	3.63 ± 0.54	<0.023
		63	0.35 ± 0.07	6.79 ± 0.75	<0.036
	147	1	0.090± 0.064	<2.25	<0.069
		94	0.38 ± 0.04	11.0 ± 0.5	0.026 ± 0.023
	148	1	0.15 ± 0.04	4.30 ± 0.60	<0.028
		100	0.26 ± 0.04	15.5 ± 0.6	0.030 ± 0.026
	156	1	0.29 ± 0.05	11.0 ± 0.9	<0.036
		150	0.94 ± 0.15	56.4 ± 2.1	0.120 ± 0.099
	157	1	0.16 ± 0.01	5.65 ± 0.16	0.021 ± 0.008
		59	0.22 ± 0.04	17.1 ± 1.1	<0.040
	158	1	0.31 ± 0.11	4.95 ± 2.28	<0.093
		92	0.44 ± 0.11	12.2 ± 2.0	<0.081
	159	1			
		96	0.28 ± 0.06	9.25 ± 0.94	<0.038
	160	1	0.073± 0.034	1.30 ± 0.46	<0.020
		132	0.43 ± 0.03	10.3 ± 0.6	<0.024
	EGA-2	10	0.59 ± 0.12	18.7 ± 0.8	<0.051
		178	0.82 ± 0.13	32.2 ± 1.0	0.063 ± 0.061
	EGA-5	10	0.47 ± 0.14	26.9 ± 1.2	<0.070
		162	0.72 ± 0.19	40.6 ± 1.8	<0.091
	EGA-8	10	0.27 ± 0.11	16.8 ± 0.9	0.080 ± 0.051
		274	0.79 ± 0.21	81.5 ± 1.4	0.16 ± 0.09
	EGA-11	10	<0.12	5.7 ± 1.2	<0.061
		1350	<0.11	7.0 ± 1.1	<0.056
Eastern GOA	EGA-15	10	<0.12	8.4 ± 1.1	<0.058
		1500	<0.11	3.9 ± 1.1	<0.055
	EGA-24	10	0.10 ± 0.10	1.3 ± 0.8	<0.044
		410	<0.11	5.4 ± 0.9	<0.047
	EGA-26	10	0.15 ± 0.12	8.9 ± 1.0	<0.057
		136	0.63 ± 0.09	34.9 ± 0.7	0.095 ± 0.045
	EGA-29				
		71	0.47 ± 0.11	43.9 ± 0.8	0.11 ± 0.05

TABLE F.1 (contd)

Elemental Concentrations* of Suspended Particulate Material (>0.4μ) from Alaska Outer Continental Shelf

	Station	Depth	Mn	Al	V
Eastern GOA	EGA-30	42	0.39 ± 0.35	395 ± 4	0.77 ± 0.23
	EGA-33	10	<0.084	0.91 ± 0.66	<0.035
		205	0.24 ± 0.11	9.0 ± 1.1	<0.060
	EGA-44	10	1.02 ± 0.20	107 ± 1	0.20 ± 0.09
		165	0.63 ± 0.12	46.2 ± 1.2	0.11 ± 0.07
	EGA-48	10	0.11 ± 0.10	3.4 ± 1.1	<0.053
		447	0.33 ± 0.12	26.0 ± 1.1	0.067 ± 0.061
	EGA-49	10	1.59 ± 0.21	141 ± 2	0.29 ± 0.10
		120	0.97 ± 0.23	84.9 ± 1.7	0.16 ± 0.10
	EGA-50	10	0.81 ± 0.18	74.6 ± 1.7	0.12 ± 0.09
		161	0.60 ± 0.09	58.6 ± 0.5	0.14 ± 0.04
	EGA-51	10	0.59 ± 0.13	42.6 ± 1.1	0.090 ± 0.065
		133	1.21 ± 0.21	83.1 ± 1.1	0.15 ± 0.08
	EGA-52	74	0.62 ± 0.12	38.0 ± 0.9	<0.058
	EGA-53	10	0.78 ± 0.12	35.9 ± 1.2	0.067 ± 0.065
		284	3.79 ± 0.25	222 ± 3	0.42 ± 0.14
	EGA-54	10	0.96 ± 0.22	57.3 ± 1.6	0.11 ± 0.09
		212	1.03 ± 0.19	66.2 ± 1.5	0.11 ± 0.09
	EGA-55	10	0.97 ± 0.21	83.1 ± 1.1	0.19 ± 0.07
		110	1.13 ± 0.20	87.8 ± 1.9	0.15 ± 0.10
	EGA-56	58	0.86 ± 0.12	63.9 ± 1.0	0.16 ± 0.06
	EGA-57	67	0.56 ± 0.12	44.7 ± 1.8	0.13 ± 0.08
	EGA-58	82	0.74 ± 0.19	76.7 ± 1.3	0.21 ± 0.08
	EGA-59A	10	1.02 ± 0.20	97.3 ± 1.3	0.18 ± 0.08
		370	<0.18	17.6 ± 1.5	<0.076
Bering Sea	MB-8	S	1.41 ± 0.02	64.4 ± 0.2	0.072 ± 0.016
		B	2.22 ± 0.60	68.0 ± 0.4	0.12 ± 0.03
	MB-2	S	0.56 ± 0.03	9.4 ± 0.2	0.019 ± 0.014
		B	0.50 ± 0.04	20.6 ± 0.2	0.051 ± 0.016

TABLE F.1 (contd)

Elemental Concentrations* of Suspended Particulate Material (>0.4μ) from Alaska Outer Continental Shelf

	Station	Depth	Mn	Al	V
Bering Sea	MB-14	S	0.096 ± 0.064	10.1 ± 0.6	<0.017
		B	0.17 ± 0.02	24.1 ± 0.2	<0.007
	MB-17	B	0.51 ± 0.02	72.2 ± 0.2	0.085 ± 0.016
	MB-19	B	1.45 ± 0.13	114 ± 1	0.31 ± 0.06
	MB-24	B	2.80 ± 0.03	77.4 ± 0.6	0.12 ± 0.02
	MB-31	S	0.040 ± 0.014	6.32± 0.20	<0.007
		B	0.13 ± 0.01	18.3 ± 0.2	0.019 ± 0.008
	MB-30	B	0.89 ± 0.05	102 ± 1	0.18 ± 0.04
	MB-34	S	0.054 ± 0.014	12.0 ± 0.2	<0.008
		B	0.12 ± 0.01	18.4 ± 0.1	0.016 ± 0.008
	MB-37	B	0.51 ± 0.02	28.8 ± 0.2	0.030 ± 0.010
	MB-41	B	0.93 ± 0.02	21.0 ± 0.2	0.034 ± 0.010
	MB-43	B	0.60 ± 0.02	23.0 ± 0.2	0.028 ± 0.010
	MB-48	S	0.082 ± 0.012	15.4 ± 0.1	0.014 ± 0.007
		B	0.14 ± 0.03	14.4 ± 0.1	0.019 ± 0.014
	MB-53	S	0.046 ± 0.028	7.34± 0.14	<0.012
		B	0.15 ± 0.03	14.0 ± 0.1	0.044 ± 0.014
	MB-56	B	1.48 ± 0.04	13.8 ± 0.1	0.044 ± 0.014
	MB-59	B	0.51 ± 0.04	17.2 ± 0.2	0.021 ± 0.019
	MB-64	B	1.00 ± 0.03	16.0 ± 0.1	0.049 ± 0.014

TABLE F.2

ELEMENTAL COMPOSITION OF SUSPENDED PARTICULATE MATERIAL (>0.4 μ) IN ALASKAN SHELF WATERS (ng/l EXCEPT WHERE NOTED)

STATION IDENTIFICATION			As	Ba (μg/l)	Co	Cs	Fe (μg/l)	Hg	Rb	Sb	Sc	Se	Sr
WESTERN GULF OF ALASKA	101	SURFACE	0.51 ± 0.11	<0.76	3.16 ± 0.08	0.42 ± 0.06	5.31 ± 0.14	2.8 ± 0.6	50 ± 30	0.26 ± 0.10	1.74 ± 0.01	<0.38	60 ± 40
		BOTTOM	3.4 ± 0.5	<0.67	5.30 ± 0.06	0.73 ± 0.05	8.71 ± 0.09	2.6 ± 0.3	<20	0.49 ± 0.11	3.20 ± 0.01	0.5 ± 0.2	860 ± 40
	104	SURFACE	4.7 ± 0.5	<0.64	1.74 ± 0.03	0.12 ± 0.03	1.58 ± 0.05	5.5 ± 0.2	<10	<0.73	0.59 ± 0.002	1.0 ± 0.1	400 ± 20
		BOTTOM	2.3 ± 0.4	<0.56	7.85 ± 0.09	1.1 ± 0.1	16.2 ± 0.1	7.4 ± 0.8	<40	0.48 ± 0.12	5.17 ± 0.01	1.5 ± 0.5	140 ± 50
	108	SURFACE	<1.8	<0.84	1.66 ± 0.13	0.23 ± 0.03	3.16 ± 0.01	1.9 ± 0.2	<20	0.19 ± 0.05	1.20 ± 0.01	0.46 ± 0.12	540 ± 10
		BOTTOM	<1.5	<0.69	7.18 ± 0.06	1.3 ± 0.1	16.8 ± 0.1	8.3 ± 0.7	70 ± 40	0.29 ± 0.11	6.30 ± 0.01	1.2 ± 0.4	560 ± 50
	119	SURFACE	7.5 ± 1.3	2.4 ± 1.0	10.3 ± 0.1	2.2 ± 0.1	22.0 ± 0.1	18 ± 1	50 ± 10	1.2 ± 0.1	8.77 ± 0.01	0.91 ± 0.28	300 ± 30
		BOTTOM	13 ± 1	<1.0	18.8 ± 0.1	2.6 ± 0.1	26.5 ± 0.2	16 ± 1	70 ± 40	0.94 ± 0.15	8.07 ± 0.02	1.4 ± 0.5	310 ± 60
	121	SURFACE	8.3 ± 1.3	<1.1	5.27 ± 0.01	1.0 ± 0.1	9.76 ± 0.06	14 ± 1	30 ± 10	4.7 ± 0.1	3.94 ± 0.01	1.4 ± 0.2	250 ± 20
	122	BOTTOM	<0.53	<0.69	6.31 ± 0.05	1.5 ± 0.1	16.8 ± 0.2	9.2 ± 0.8	80 ± 40	0.81 ± 0.13	6.18 ± 0.02	1.0 ± 0.5	210 ± 50
	124	SURFACE	5.0 ± 1.4	<1.2	6.14 ± 0.04	0.91 ± 0.05	9.17 ± 0.06	16 ± 1	30 ± 10	1.0 ± 0.1	3.91 ± 0.01	1.0 ± 0.2	200 ± 20
		BOTTOM	<0.52	<0.86	5.73 ± 0.07	1.2 ± 0.1	1.33 ± 0.01	9.4 ± 0.7	<40	0.37 ± 0.12	4.82 ± 0.01	0.99 ± 41	280 ± 40
	133	SURFACE	<3.3	<1.3	1.64 ± 0.03	0.21 ± 0.03	2.53 ± 0.08	20 ± 1	<30	0.42 ± 0.09	0.82 ± 0.06	1.2 ± 0.2	150 ± 20
		BOTTOM	<1.5	<1.0	4.63 ± 0.05	1.1 ± 0.1	10.0 ± 0.1	11 ± 1	60 ± 20	1.0 ± 0.1	3.64 ± 0.01	<0.58	140 ± 30
	135	SURFACE	5.6 ± 3.3	<1.3	2.07 ± 0.03	<0.05	0.85 ± 0.07	17 ± 1	<20	0.56 ± 0.08	0.30 ± 0.05	1.7 ± 0.2	200 ± 20
		BOTTOM	<2.5	<1.1	6.03 ± 0.06	1.3 ± 0.1	15.1 ± 0.1	10 ± 1	50 ± 20	1.7 ± 0.2	5.34 ± 0.01	<0.52	360 ± 30
	137	SURFACE	<3.6	<1.4	1.55 ± 0.03	0.14 ± 0.03	1.89 ± 0.07	15 ± 1	<20	0.57 ± 0.08	0.66 ± 0.05	<0.30	200 ± 20
		BOTTOM	<2.5	<1.1	6.13 ± 0.06	1.0 ± 0.1	11.7 ± 0.1	9.2 ± 0.5	50 ± 20	2.7 ± 0.2	4, 13 ± 0.01	0.85 ± 0.33	270 ± 30
	145	SURFACE	<4.5	<1.8	2.57 ± 0.04	0.21 ± 0.04	3.65 ± 0.09	21 ± 1	<30	0.58 ± 0.10	1.27 ± 0.01	0.73 ± 0.23	780 ± 20
		BOTTOM	<2.2	<0.95	3.44 ± 0.04	0.18 ± 0.04	2.90 ± 0.13	12 ± 1	<20	1.5 ± 0.1	1.05 ± 0.01	0.77 ± 0.21	230 ± 20
	148	SURFACE	<3.4	<1.5	1.20 ± 0.03	0.12 ± 0.02	1.40 ± 0.07	17 ± 1	<20	2.2 ± 0.1	0.48 ± 0.05	0.64 ± 0.10	170 ± 20
		BOTTOM	3.0 ± 1.5	<1.2	5.33 ± 0.05	0.71 ± 0.05	8.00 ± 0.10	13 ± 1	<30	0.77 ± 0.14	2.86 ± 0.01	0.92 ± 0.28	180 ± 30
	157	SURFACE	<1.2	<0.51	3.60 ± 0.04	0.18 ± 0.03	3.66 ± 0.09	14 ± 1	<30	0.98 ± 0.11	1.19 ± 0.01	<0.46	100 ± 20
		BOTTOM	<1.2	<1.1	4.27 ± 0.05	0.24 ± 0.05	6.59 ± 0.09	14 ± 1	<30	1.3 ± 0.01	2.40 ± 0.01	0.59 ± 0.20	210 ± 20
	160	SURFACE	<8.0	<3.4	1.79 ± 0.06	0.089 ± 0.049	1.49 ± 0.17	34 ± 1	<10	1.2 ± 0.1	---	1.2 ± 0.3	350 ± 30
		BOTTOM	<2.8	<2.3	3.66 ± 0.04	0.44 ± 0.04	5.82 ± 0.12	14 ± 1	50 ± 40	0.52 ± 0.16	2.03 ± 0.01	0.73 ± 0.09	120 ± 30
BERING SEA	MB-2	SURFACE	7.4 ± 2.3	<1.1	2.63 ± 0.06	0.13 ± 0.06	6.06 ± 0.17	2.6 ± 0.7	---	0.53 ± 0.16	1.82 ± 0.01	0.82 ± 0.35	<100
		BOTTOM	6.3 ± 1.6	<1.2	3.27 ± 0.06	0.30 ± 0.07	10.1 ± 0.2	2.4 ± 0.9	90 ± 50	1.3 ± 0.2	3.81 ± 0.01	0.93 ± 0.45	180 ± 50
	MB-8	SURFACE	23 ± 2	1.9 ± 0.9	8.57 ± 0.09	1.29 ± 0.10	2.52 ± 0.03	<1.3	---	0.61 ± 0.26	8.46 ± 0.02	2.5 ± 0.6	340 ± 70
		BOTTOM	16 ± 2	<1.2	9.49 ± 0.09	1.33 ± 0.11	27.3 ± 0.2	3.8 ± 1.4	<10	0.89 ± 0.35	10.2 ± 0.1	0.81 ± 0.68	330 ± 70
	MB-14	SURFACE	<7.5	<2.9	2.43 ± 0.10	0.40 ± 0.08	3.65 ± 0.27	6.9 ± 1.1	---	2.0 ± 0.2	1.22 ± 0.02	1.4 ± 0.6	230 ± 60
		BOTTOM	2.7 ± 0.6	<1.4	1.06 ± 0.04	0.27 ± 0.04	2.35 ± 0.12	1.4 ± 0.6	---	0.78 ± 0.17	1.06 ± 0.01	0.58 ± 0.30	---
	MB-17	BOTTOM	13 ± 2	<1.4	9.53 ± 0.10	1.6 ± 0.1	32.21 ± 0.33	2.3 ± 1.5	---	0.87 ± 0.29	12.3 ± 0.1	2.1 ± 0.7	350 ± 80
	MB-24	BOTTOM	24 ± 2	<1.2	14.6 ± 0.1	1.8 ± 0.1	38.1 ± 0.3	<1.8	---	1.4 ± 0.4	13.2 ± 0.1	2.2 ± 0.8	250 ± 90
	MB-37	BOTTOM	13 ± 2	<0.77	3.78 ± 0.07	0.95 ± 0.08	12.9 ± 2	2.8 ± 1.0	---	0.64 ± 0.19	4.30 ± 0.01	1.7 ± 0.5	160 ± 50
	MB-41	BOTTOM	8.7 ± 1.2	<0.80	3.52 ± 0.07	1.9 ± 0.1	9.86 ± 0.17	2.8 ± 0.9	70 ± 50	0.84 ± 0.26	3.17 ± 0.01	1.2 ± 0.4	90 ± 50
	MB-43	BOTTOM	11 ± 2	<1.1	3.3 ± 0.1	0.49 ± 0.06	8.1 ± 0.2	3.5 ± 0.9	<79	0.96 ± 0.31	2.9 ± 0.1	1.0 ± 0.3	<480
	MB-53	SURFACE	6.4 ± 1.2	<1.1	1.2 ± 0.1	0.21 ± 0.05	4.3 ± 0.2	3.4 ± 0.7	<57	1.6 ± 0.2	0.73 ± 0.03	1.9 ± 0.3	670 ± 350
		BOTTOM	11 ± 2	<1.8	2.2 ± 0.1	0.40 ± 0.07	12 ± 1	3.9 ± 0.8	<52	0.80 ± 0.24	2.3 ± 0.1	1.1 ± 0.4	<420
	MB-59	BOTTOM	13 ± 2	<1.1	3.0 ± 0.1	0.58 ± 0.07	9.0 ± 0.2	2.5 ± 0.8	<58	0.42 ± 0.28	2.9 ± 0.1	2.1 ± 0.4	150 ± 50

TABLE F.2 (contd)

ELEMENTAL COMPOSITION OF SUSPENDED PARTICULATES (>0.4 μ) IN ALASKAN SHELF WATERS (ng/l EXCEPT WHERE NOTED) (CONTINUED)

EASTERN GULF OF ALASKA		Co	Cs	Fe(μg/l)	Hg	Rb	Sb	Sc	Se	Sr	Zn
EGA-2	SURFACE	8.1 ± 0.1	0.98 ± 0.09	13 ± 1	10 ± 1	<170	4.2 ± 0.4	4.2 ± 0.1	<0.6	430 ± 70	0.09 ± 0.01
	BOTTOM	10 ± 1	1.6 ± 0.1	24 ± 1	5.2 ± 1.0	<120	0.74 ± 0.28	6.0 ± 0.1	0.71 ± 0.42	270 ± 50	0.11 ± 0.01
EGA-5	SURFACE	8.8 ± 0.1	1.3 ± 0.1	20 ± 1	9.6 ± 0.9	<200	0.96 ± 0.25	6.2 ± 0.1	0.64 ± 0.39	610 ± 50	0.19 ± 0.01
	BOTTOM	13 ± 1	1.8 ± 0.1	12 ± 1	4.3 ± 1.0	620 ± 120	0.82 ± 0.28	7.4 ± 0.1	0.63 ± 0.45	630 ± 60	0.19 ± 0.01
EGA-8	SURFACE	5.0 ± 0.1	0.71 ± 0.08	11 ± 1	<1.3	<160	0.54 ± 0.35	3.6 ± 0.1	1.0 ± 0.5	390 ± 60	0.08 ± 0.01
	BOTTOM	22 ± 1	2.8 ± 0.1	54 ± 1	32 ± 1	280 ± 140	0.73 ± 0.36	15 ± 1	<2.3	460 ± 80	0.17 ± 0.01
EGA-15	SURFACE	7.4 ± 0.1	0.33 ± 0.09	6.2 ± 0.2	3.1 ± 1.1	<120	3.6 ± 0.2	2.0 ± 0.1	0.93 ± 0.44	650 ± 50	4.74 ± 0.01
	BOTTOM	1.7 ± 0.1	0.25 ± 0.03	3.8 ± 0.1	7.9 ± 0.5	<100	0.43 ± 0.13	0.93 ± 0.01	0.34 ± 0.21	460 ± 20	0.14 ± 0.01
EGA-26	SURFACE	3.8 ± 0.1	0.12 ± 0.03	3.4 ± 0.1	2.0 ± 0.5	<64	0.49 ± 0.12	0.95 ± 0.01	0.94 ± 0.20	340 ± 20	0.10 ± 0.01
	BOTTOM	7.1 ± 0.1	5.4 ± 0.5	15 ± 1	<0.91	<100	0.30 ± 0.25	4.9 ± 0.1	0.68 ± 0.40	230 ± 50	0.22 ± 0.01
EGA-29	BOTTOM	15 ± 1	1.5 ± 0.1	33 ± 1	8.5 ± 1.2	<150	0.83 ± 0.32	11 ± 1	1.3 ± 0.5	570 ± 60	0.61 ± 0.01
EGA-30	BOTTOM	93 ± 1	14 ± 1	220 ± 10	<3.0	<350	1.8 ± 0.8	57 ± 1	2.1 ± 1.2	1380 ± 150	0.91 ± 0.01
EGA-33	SURFACE	1.1 ± 0.1	0.12 ± 0.04	0.9 ± 0.1	2.3 ± 0.2	<97	0.50 ± 0.18	0.30 ± 0.01	<0.3	300 ± 30	0.09 ± 0.01
	BOTTOM	3.2 ± 0.1	0.26 ± 0.03	6.9 ± 0.1	<0.66	<80	0.26 ± 0.16	2.3 ± 0.1	0.63 ± 0.22	400 ± 30	0.12 ± 0.01
EGA-44	SURFACE	36 ± 1	5.4 ± 0.1	86 ± 1	4.1 ± 1.9	<300	1.6 ± 0.5	29 ± 1	<0.98	680 ± 100	0.34 ± 0.01
	BOTTOM	13 ± 1	1.2 ± 0.1	33 ± 1	<1.8	<260	<0.49	11 ± 1	1.6 ± 0.7	510 ± 100	0.20 ± 0.01
EGA-48	SURFACE	1.6 ± 0.1	0.16 ± 0.03	2.4 ± 0.1	2.4 ± 0.5	<72	0.60 ± 0.14	0.79 ± 0.01	0.86 ± 0.18	330 ± 20	0.12 ± 0.01
	BOTTOM	9.1 ± 0.1	0.83 ± 0.03	21 ± 1	3.6 ± 0.5	<210	<0.44	7.5 ± 0.1	<0.62	440 ± 30	0.15 ± 0.01
EGA-52	BOTTOM	11 ± 1	1.1 ± 0.1	25 ± 1	1.3 ± 0.9	<130	<0.25	8.5 ± 0.1	0.44 ± 0.37	200 ± 30	0.12 ± 0.01
EGA-53	SURFACE	13 ± 1	2.1 ± 0.1	24 ± 1	<1.1	<180	<0.29	7.8 ± 0.1	1.0 ± 0.4	320 ± 50	0.12 ± 0.01
	BOTTOM	51 ± 1	5.3 ± 0.1	120 ± 10	<2.8	<450	1.4 ± 0.4	39 ± 1	2.9 ± 0.5	920 ± 70	0.44 ± 0.01
EGA-55	SURFACE	32 ± 1	4.7 ± 0.1	69 ± 1	8.7 ± 1.6	<260	2.0 ± 0.4	23 ± 1	1.1 ± 0.6	750 ± 80	0.37 ± 0.01
	BOTTOM	27 ± 1	2.5 ± 0.1	63 ± 1	6.7 ± 1.4	<300	1.1 ± 0.4	21 ± 1	0.78 ± 0.57	540 ± 80	0.24 ± 0.01
EGA-58	BOTTOM	27 ± 1	2.6 ± 0.1	59 ± 1	4.5 ± 1.5	<250	1.2 ± 0.4	20 ± 1	0.83 ± 0.59	490 ± 80	0.23 ± 0.01
10 ℓ BLANK (144 mm)		0.19	<0.013	0.24	0.90	<2	0.20	0.04	<0.13	15	0.03
10 ℓ BLANK (144 mm)		0.23	<0.012	0.29	6.9	<2	0.53	0.02	<0.09	<10	0.007
10 ℓ BLANK (144 mm)		0.19	<0.017	0.21	1.4	<2	0.29	0.08	<0.13	14	0.054
10 ℓ BLANK (144 mm)		0.14	<0.013	0.12	0.40	<2	0.13	0.005	<0.12	<10	0.037
10 ℓ BLANK (144 mm)		0.17	<0.012	0.23		<2	0.39	0.008	---	24	0.03

TABLE F.3

ELEMENTAL CONCENTRATIONS (>0.4 μm) IN COOK INLET AND SHELIKOF STRAIT SUSPENDED PARTICULATES (μg/ℓ OF SEAWATER)

COOK INLET	Date	Depth	Al	Ti	Na	Mn	V
Station CB-1	5/78	Sfc.	235±9	10.3±6.0	440±30	3.05±0.13	0.56±0.12
CB-1	8/78	15M	13.5±4.9	8.8±5.6	650±40	0.39±0.06	<0.18
CB-2	5/78	Sfc.	192±5	11.4±4.5	380±30	2.10±0.10	0.25±0.07
CB-2	8/78	20M	185±5	9.5±4.8	570±40	2.39±0.11	0.40±0.09
CB-3	8/78	20M	16.7±2.0	<4.8	230±20	0.18±0.03	<0.08
CB-4	8/78	15M	41.6±1.6	4.6±2.1	210±10	0.52±0.03	<0.06
CB-5	8/78	30M	10.3±2.8	7.7±4.3	570±40	0.54±0.07	<0.14
CB-6	5/78	Sfc	19.2±1.7	5.7±3.3	260±20	0.40±0.05	<0.09
CB-6	8/78	20M	9.0±2.2	<8.4	410±30	0.34±0.06	<0.12
CB-7	5/78	Sfc	29.6±3.5	<11.4	670±50	0.73±0.07	<0.17
CB-7	8/78	15M	23.2±3.4	10.4±5.1	660±70	0.69±0.07	<0.15
CB-8	5/78	Sfc	119±5	9.1±5.7	520±40	3.46±0.14	0.31±0.08
CB-8	8/78	15M	153±5	10.7±4.2	280±20	3.85±0.15	0.36±0.07
SHELIKOF STRAIT							
Station SS-2	8/78	267M	411±11	24.2±9.0	680±50	14.6±0.5	0.66±0.14
SS-4	8/78	131M	37.7±1.7	<4.0	170±10	0.93±0.04	0.11±0.03
SS-6	8/78	203M	142±6	<12	510±30	11.4±0.4	0.27±0.09
SS-11	8/78	130M	21.2±1.5	3.3±1.6	150±10	0.59±0.03	<0.06
SS-13	8/78	147M	74±3	<6.2	260±20	6.5±0.2	0.15±0.05

TABLE F.4

COOK INLET -TIME SERIES - SUSPENDED PARTICULATE MATTER >0.4 μm. STATION CB-10

Discoverer, August 1978

	Al(%)	Ti(%)	Mn (ppm)	V (ppm)
t = 0 hr	8.57±0.29	0.73±0.13	1139±53	168±16
t = 0 hr	8.16±0.28	0.49±0.11	1098±51	177±16
t = 0 hr	8.24±0.28	0.44±0.10	1081±50	151±15
t = 8 hr	9.79±0.33	0.32±0.11	1090±51	158±17
t = 8 hr	8.25±0.29	0.55±0.12	1133±54	154±18
t = 16 hr	8.08±0.29	0.48±0.11	1023±48	142±15
t = 24 hr	7.70±0.27	0.52±0.12	927±44	136±15
t = 32 hr	7.68±0.26	0.46±0.11	986±46	141±15
t = 40 hr	6.64±0.23	0.36±0.09	1009±47	127±14
t = 40 hr	8.52±0.28	0.36±0.09	1064±49	151±16
t = 40 hr	8.31±0.29	0.52±0.09	1006±48	140±16
t = 48 hr	7.89±0.27	0.56±0.12	994±47	143±16

Station	Na(%)	K(%)	As(ppm)	La(ppm)	Sm(ppm)
t = 0 hr	3.43±0.01	2.86±0.36	26.1±1.4	27.9±0.8	5.1±0.1
t = 0 hr	3.27±0.01	2.60±0.32	21.9±1.3	25.6±0.7	4.6±0.1
t = 8 hr	3.61±0.01	2.97±0.39	22.4±1.5	26.6±0.8	5.1±0.1
t = 16 hr	3.20±0.01	2.68±0.39	19.1±1.4	23.3±0.7	4.2±0.1
t = 24 hr	4.57±0.01	2.52±0.44	19.3±1.6	26.3±0.8	4.9±0.1
t = 32 hr	3.50±0.01	2.51±0.41	20.5±1.4	25.1±0.8	4.6±0.1
t = 40 hr	2.70±0.01	1.48±0.20	17.8±1.0	23.5±0.6	4.4±0.1

TABLE F.4 (contd)

VARIATION OF ELEMENTAL COMPOSITION IN SUSPENDED PARTICULATES (>0.4 μ) WITH TIME

(ppm EXCEPT WHERE NOTED)

	Sc	Cr	Fe(%)	Co	Sb	Cs	Eu	Tb	Ta	Th
COOK INLET										
TIME SERIES CB-10										
t = 0 hr	21.52 ± 0.07	122 ± 4	6.40 ± 0.03	25.92 ± 0.23	1.91 ± 0.08	7.04 ± 0.10	1.19 ± 0.02	0.67 ± 0.04	0.92 ± 0.07	8.92 ± 0.15
t = 0 hr	20.84 ± 0.06	120 ± 4	6.14 ± 0.04	24.77 ± 0.25	1.75 ± 0.08	6.77 ± 0.10	1.20 ± 0.02	0.70 ± 0.04	0.91 ± 0.07	8.67 ± 0.15
t = 8 hr	19.17 ± 0.05	109 ± 4	5.68 ± 0.02	23.17 ± 0.18	1.54 ± 0.07	6.47 ± 0.09	1.09 ± 0.01	0.59 ± 0.04	0.86 ± 0.07	7.66 ± 0.14
t = 16 hr	17.23 ± 0.06	98 ± 4	4.97 ± 0.04	19.55 ± 0.21	1.41 ± 0.09	5.29 ± 0.11	1.01 ± 0.02	0.54 ± 0.04	0.76 ± 0.05	6.81 ± 0.19
t = 24 hr	21.07 ± 0.03	123 ± 4	6.14 ± 0.03	24.44 ± 0.11	1.71 ± 0.11	6.75 ± 0.14	1.21 ± 0.02	0.75 ± 0.05	0.93 ± 0.09	8.55 ± 0.20
t = 32 hr	19.21 ± 0.02	114 ± 4	5.68 ± 0.05	23.25 ± 0.31	1.56 ± 0.10	6.28 ± 0.12	1.10 ± 0.02	0.63 ± 0.04	0.93 ± 0.09	7.60 ± 0.21
t = 40 hr	16.08 ± 0.08	88 ± 2	4.65 ± 0.02	19.56 ± 0.10	1.43 ± 0.08	4.88 ± 0.09	0.96 ± 0.02	0.46 ± 0.03	0.74 ± 0.07	6.77 ± 0.12

TABLE F.5

ELEMENTAL CONCENTRATION RANGES* IN SUSPENDED PARTICULATE MATERIAL (> 0.4 um) FROM THE ALASKA OUTER CONTINENTAL SHELF STUDY AREAS

	NUMBER OF SAMPLES	Mn	V	Al
WESTERN GULF OF ALASKA	44	0.061 - 7.1	<0.006 - 0.224	1.3 - 103
EASTERN GULF OF ALASKA	40	<0.084 - 1.59	<0.035 - 0.77	0.91 - 222
BERING SEA - BRISTOL BAY	24	0.040 - 2.8	<0.007 - 0.31	6.3 - 114

*CONCENTRATION RANGES IN µg/ℓ OF SEAWATER

FIGURE F.1 ERTS Sattelite Photograph of N. E. Gulf of Alaska

APPENDIX G

Elemental Composition of Alaskan OCS Biological Materials

TABLE G.1

ELEMENTAL COMPOSITION OF BIOLOGICAL MATERIALS FROM ALASKA CONTINENTAL SHELF STUDY AREAS (ppm DRY WEIGHT EXCEPT WHERE NOTED)

	SPECIMEN	LOCATION	Ag	As	Br	Co	Cr	Cs	Fe	Hg	K(%)	Na(%)	Rb	Sb	Sc	Se	Sr	Zn
1	ROCK SOLE	MF 34	<0.038	14 ± 1	31 ± 1	0.014 ± 0.002	2.0 ± 0.1	0.065 ± 0.004	14 ± 3	0.37 ± 0.10	1.86 ± 0.09	0.53 ± 0.07	3.7 ± 0.1	<0.004	0.009 ± 0.001	1.5 ± 0.1	11 ± 2	38
2		MF 5	<0.034	21 ± 1	47 ± 1	0.018 ± 0.005	5.6 ± 0.2	0.084 ± 0.005	19 ± 5	0.47 ± 0.10	2.54 ± 0.13	0.85 ± 0.11	4.9 ± 0.2	0.010 ± 0.007	<0.005	3.4 ± 0.1	20 ± 3	36
3		MF 13	<0.014	39 ± 1	22 ± 1	0.111 ± 0.002	1.2 ± 0.1	0.078 ± 0.002	14 ± 2	0.28 ± 0.03	1.98 ± 0.08	0.52 ± 0.06	3.7 ± 0.1	0.008 ± 0.001	<0.0002	1.7 ± 0.1	5 ± 1	27
4		MF 27	<0.011	19 ± 1	30 ± 1	0.021 ± 0.001	0.30 ± 0.05	0.068 ± 0.002	15 ± 2	0.27 ± 0.03	1.68 ± 0.08	0.57 ± 0.07	2.9 ± 0.1	0.030 ± 0.001	0.0021 ± 0.0003	1.7 ± 0.1	7 ± 1	30
5		MF 23	<0.061	18 ± 1	33 ± 1	0.026 ± 0.003	0.75 ± 0.02	0.069 ± 0.004	43 ± 3	0.19 ± 0.06	1.72 ± 0.09	0.57 ± 0.07	3.4 ± 0.1	0.011 ± 0.004	0.0110 ± 0.0002	1.8 ± 0.1	14 ± 2	38
6		MF 41	<0.012	23 ± 1	30 ± 1	0.012 ± 0.001	0.15 ± 0.05	0.044 ± 0.002	6 ± 2	0.27 ± 0.03	1.62 ± 0.09	0.54 ± 0.07	3.6 ± 0.1	<0.002	0.0004 ± 0.0002	2.7 ± 0.1	13 ± 1	33
7		MF 43	<0.015	10 ± 1	27 ± 1	0.013 ± 0.002	0.12 ± 0.07	0.042 ± 0.002	13 ± 2	0.28 ± 0.03	1.81 ± 0.08	0.46 ± 0.07	3.9 ± 0.1	<0.003	0.0013 ± 0.0004	2.3 ± 0.1	11 ± 1	31
8		MF 44	<0.010	6.5 ± 0.3	24 ± 1	0.008 ± 0.001	0.13 ± 0.04	0.043 ± 0.001	10 ± 1	0.13 ± 0.03	1.52 ± 0.07	0.43 ± 0.06	3.4 ± 0.1	<0.002	0.0004 ± 0.0002	1.4 ± 0.1	7 ± 1	27
9		MF 47	<0.030	8.6 ± 0.4	27 ± 1	0.015 ± 0.004	<0.01	0.046 ± 0.004	33 ± 4	0.18 ± 0.06	1.56 ± 0.09	0.43 ± 0.07	3.6 ± 0.1	0.011 ± 0.004	0.0085 ± 0.0004	1.4 ± 0.1	12 ± 3	26
10	NEPTUNIA	MF 15	85	93 ± 1	173 ± 1	4.9	1.8 ± 0.1	0.011 ± 0.009	1620 ± 10	3.4 ± 0.1	0.68 ± 0.10	1.25 ± 0.10	5.4 ± 0.6	0.078 ± 0.008	0.018 ± 0.001	119	150 ± 5	2260
11		MF 19	40	98 ± 1	363 ± 1	4.4	1.0 ± 0.2	<0.013	2080 ± 30	0.19 ± 0.07	0.82 ± 0.16	1.89 ± 0.16	4.5 ± 0.6	0.110 ± 0.010	0.067 ± 0.002	13	250 ± 5	2520
12		MF 22	15	36 ± 1	83 ± 1	4.0	1.8 ± 0.4	<0.035	2640 ± 30	3.9 ± 0.2	0.14 ± 0.04	0.40 ± 0.03	4.6 ± 1.8	0.088 ± 0.022	0.104 ± 0.004	19	2600 ± 60	7890
13		MF 31	8.6	10 ± 1	87 ± 1	1.2	0.69 ± 0.06	<0.005	1130 ± 10	0.61 ± 0.03	0.40 ± 0.03	0.60 ± 0.03	2.8 ± 0.3	0.110 ± 0.005	0.052 ± 0.001	3.7 ± 0.1	103 ± 2	870
14		MF 50A	3.4	140 ± 1	400 ± 10	1.3	0.62 ± 0.10	0.012 ± 0.006	950 ± 10	2.6 ± 0.1	<0.12	2.32 ± 0.27	5.9 ± 0.6	0.033 ± 0.006	0.036 ± 0.001	2.7 ± 0.1	43 ± 3	160
15		MF 50B	57	49 ± 1	91 ± 1	7.6	0.56 ± 0.05	<0.020	1190 ± 10	1.2 ± 0.1	0.44 ± 0.06	0.50 ± 0.04	4.7 ± 0.8	0.034 ± 0.011	0.133 ± 0.001	8.4 ± 0.1	58 ± 5	2760
16	POLLOCK	MF 4	0.022 ± 0.009	3.4 ± 0.3	39 ± 1	0.016 ± 0.001	0.34 ± 0.05	0.058 ± 0.001	11 ± 1	0.07 ± 0.03	1.72 ± 0.05	0.59 ± 0.04	4.6 ± 0.1	0.008 ± 0.001	<0.0002	0.87 ± 0.02	10 ± 1	22
17		MF 4	<0.012	3.5 ± 0.3	39 ± 1	0.015 ± 0.002	<0.4	0.091 ± 0.002	13 ± 1	0.6 ± 0.03	1.84 ± 0.05	0.59 ± 0.05	4.1 ± 0.1	0.009 ± 0.002	0.0005 ± 0.0002	0.82 ± 0.03	5 ± 1	22
18		MF 6	<0.017	2.0 ± 0.3	29 ± 1	0.014 ± 0.003	0.46 ± 0.10	0.107 ± 0.002	12 ± 3	0.10 ± 0.05	1.63 ± 0.05	0.46 ± 0.04	4.8 ± 0.2	0.015 ± 0.004	0.0011 ± 0.0003	0.71 ± 0.05	6 ± 2	18
19		MF 11	<0.027	3.1 ± 0.3	36 ± 1	0.010 ± 0.002	0.40 ± 0.06	0.095 ± 0.002	10 ± 2	0.11 ± 0.03	1.91 ± 0.05	0.52 ± 0.05	3.9 ± 0.1	0.010 ± 0.001	0.0005 ± 0.0002	1.04 ± 0.03	19 ± 1	22
20		MF 17	<0.014	4.0 ± 0.3	34 ± 1	0.034 ± 0.001	0.15 ± 0.05	0.086 ± 0.001	30 ± 1	0.04 ± 0.02	1.77 ± 0.04	0.43 ± 0.04	4.7 ± 0.1	0.009 ± 0.002	0.0070 ± 0.0002	0.78 ± 0.02	4 ± 1	19
21		MF 21	<0.022	5.6 ± 0.3	37 ± 1	0.017 ± 0.003	0.29 ± 0.11	0.111 ± 0.004	15 ± 3	0.09 ± 0.06	2.00 ± 0.06	0.56 ± 0.04	4.3 ± 0.1	0.011 ± 0.006	0.0013 ± 0.0004	0.92 ± 0.06	5 ± 2	23
22		MF 25	<0.015	11 ± 1	30 ± 1	0.058 ± 0.021	0.24 ± 0.08	0.091 ± 0.002	6 ± 2	0.15 ± 0.04	1.70 ± 0.04	0.43 ± 0.04	4.5 ± 0.1	0.019 ± 0.002	<0.0003	0.97 ± 0.01	6 ± 1	18
23		MF 28	<0.015	5.3 ± 0.3	37 ± 1	0.017 ± 0.002	0.22 ± 0.06	0.161 ± 0.002	20 ± 2	0.16 ± 0.01	1.84 ± 0.05	0.54 ± 0.03	4.5 ± 0.1	0.019 ± 0.002	0.0016 ± 0.0002	1.05 ± 0.03	10 ± 1	29
24		MF 36	<0.009	2.4 ± 0.3	35 ± 1	0.014 ± 0.001	0.17 ± 0.10	0.075 ± 0.001	13 ± 2	0.34 ± 0.02	1.87 ± 0.05	0.52 ± 0.05	4.3 ± 0.1	0.010 ± 0.002	0.0025 ± 0.0002	0.78 ± 0.02	8 ± 1	23
25		MF 39	0.032 ± 0.010	4.6 ± 0.2	38 ± 1	0.017 ± 0.001	<0.6	0.105 ± 0.002	8 ± 2	0.04 ± 0.03	1.65 ± 0.04	0.58 ± 0.04	4.5 ± 0.1	0.012 ± 0.002	<0.0003	1.15 ± 0.03	20 ± 1	31
26		MF 42	<0.015	6.9 ± 0.2	32 ± 1	0.0097 ± 0.0018	0.22 ± 0.09	0.105 ± 0.002	14 ± 3	<0.02	1.86 ± 0.03	0.53 ± 0.03	5.7 ± 0.1	0.018 ± 0.005	<0.0001	4.7 ± 0.2	9 ± 2	22
27		MF 45	<0.006	3.5 ± 0.1	31 ± 1	0.0075 ± 0.0008	0.21 ± 0.04	0.082 ± 0.001	5 ± 1	0.12 ± 0.01	1.45 ± 0.03	0.46 ± 0.03	3.9 ± 0.1	0.051 ± 0.002	<0.0003	0.91 ± 0.02	5 ± 1	17
28		MF 46	<0.011	2.5 ± 0.2	39 ± 1	0.018 ± 0.001	0.17 ± 0.03	0.083 ± 0.001	39 ± 2	0.05 ± 0.01	1.36 ± 0.04	0.68 ± 0.07	5.2 ± 0.1	0.020 ± 0.002	0.0070 ± 0.0002	3.5 ± 0.1	8 ± 1	23
29		MF 49	<0.025	7.3 ± 0.2	41 ± 1	0.021 ± 0.002	<0.10	0.114 ± 0.003	14 ± 2	0.16 ± 0.04	1.53 ± 0.04	0.66 ± 0.07	4.5 ± 0.2	0.008 ± 0.005	0.0007 ± 0.0003	1.5 ± 0.1	9 ± 1	27
30	CRAB	3	0.82 ± 0.03	<0.25	<0.34	1.32 ± 0.01	<0.10	0.019 ± 0.004	17 ± 8	0.31 ± 0.02	<0.04	—	7.4 ± 1.0	0.028 ± 0.006	0.0017 ± 0.0008	10.7 ± 0.2	48 ± 2	134
31		7	0.86 ± 0.01	23 ± 1	80 ± 1	0.40	<0.08	0.011 ± 0.002	7 ± 2	0.21 ± 0.02	1.54 ± 0.19	1.54 ± 0.12	5.4 ± 0.2	0.010 ± 0.002	<0.0003	2.9 ± 0.1	18 ± 1	127
32		MF 12	1.71 ± 0.01	53 ± 1	120 ± 10	0.74	<0.05	0.0080 ± 0.002	5 ± 4	0.20 ± 0.01	1.64 ± 0.16	1.96 ± 0.12	6.6 ± 0.4	0.038 ± 0.003	<0.0007	41 ± 1	46 ± 1	129
33		MF 14	0.95 ± 0.02	41 ± 1	130 ± 10	0.42	<0.08	0.012 ± 0.004	8 ± 4	0.29 ± 0.03	1.25 ± 0.24	2.23 ± 0.12	4.5 ± 0.4	0.039 ± 0.004	0.0017 ± 0.0005	2.7 ± 0.1	38 ± 2	124
34		MF 20	1.52 ± 0.01	49 ± 1	130 ± 10	0.64	<0.06	0.012 ± 0.002	9 ± 3	0.17 ± 0.01	1.57 ± 0.16	2.14 ± 0.12	6.7 ± 0.4	0.025 ± 0.002	0.0016 ± 0.0003	11 ± 1	44 ± 2	119
35		MF 26	2.22 ± 0.01	45 ± 1	102 ± 10	0.74	<0.05	0.010 ± 0.002	4 ± 3	0.43 ± 0.02	1.22 ± 0.23	1.85 ± 0.12	6.2 ± 0.3	0.034 ± 0.003	<0.0006	7 ± 1	58 ± 1	133
36		MF 29	0.93 ± 0.01	34 ± 1	106 ± 10	0.57	0.44 ± 0.05	0.012 ± 0.002	26 ± 3	0.20 ± 0.01	1.44 ± 0.16	1.87 ± 0.12	6.5 ± 0.4	0.009 ± 0.003	0.0041 ± 0.0004	13 ± 1	43 ± 1	136

MF = MILLER FREEMAN STATION NUMBER

TABLE G.1 (contd)

ELEMENTAL COMPOSITION OF BIOLOGICAL MATERIALS FROM ALASKA CONTINENTAL SHELF STUDY AREAS
(ppm DRY WEIGHT EXCEPT WHERE NOTED)

			Ag	As	Br	Co	Cr	Cs	Fe	Hg	K(%)	Na(%)	Rb	Sb	Sc	Se	Sr	Zn
37	CRAB LEG	MF 48	1.20 ± 0.02	57 ± 1	80 ± 10	0.31 ± 0.01	<0.067	0.0099 ± 0.0033	<7.5	0.39 ± 0.03	1.49 ± 0.21	1.37 ± 0.01	5.8 ± 0.8	0.087 ± 0.004	0.0007 ± 0.001	4.45 ± 0.03	32 ± 2	83
38		MF 16	0.80 ± 0.02	43 ± 1	140 ± 10	0.33 ± 0.01	<0.070	0.011 ± 0.004	32 ± 5	0.30 ± 0.04	1.69 ± 0.42	2.18 ± 0.01	3.6 ± 0.7	0.011 ± 0.004	0.007 ± 0.001	3.35 ± 0.02	32 ± 2	124
39		MF 40	0.65 ± 0.01	38 ± 1	79 ± 10	0.19 ± 0.01	<0.045	0.0097 ± 0.0018	6.0 ± 2.1	0.32 ± 0.02	1.32 ± 0.28	1.40 ± 0.01	7.1 ± 0.4	0.042 ± 0.002	<0.0013	3.76 ± 0.01	19 ± 1	92
40		MF 33	0.81 ± 0.01	29 ± 1	140 ± 10	0.47 ± 0.01	0.010 ± 004	0.012 ± 0.002	15 ± 3	0.64 ± 0.02	1.06 ± 0.38	1.92 ± 0.01	3.8 ± 0.4	0.009 ± 0.002	0.0033 ± 0.0008	2.53 ± 0.01	24 ± 1	106
41		MF 37	1.53 ± 0.02	35 ± 1	130 ± 10	0.32 ± 0.01	0.20 ± 0.07	0.011 ± 0.004	14 ± 5	0.49 ± 0.04	1.15 ± 0.41	2.13 ± 0.01	7.3 ± 0.9	0.046 ± 0.004	0.0020 ± 0.004	2.55 ± 0.03	44 ± 2	96
42	FUCUS	CAPE NUKSHAK	0.27 ± 0.01	20 ± 1	240 ± 10	1.35 ± 0.03	<0.094	0.023 ± 0.003	63 ± 5	<0.026	1.79 ± 0.38	2.43 ± 0.01	9.11 ± 0.7	0.035 ± 0.004	0.034 ± 0.003	0.069 ± 0.017	500 ± 10	19
43		PORT DICK	0.18 ± 0.01	9.0 ± 0.6	150 ± 10	1.11 ± 0.01	0.55 ± 0.03	0.021 ± 0.002	29 ± 3	0.055 ± 0.014	2.04 ± 0.43	3.05 ± 0.01	16 ± 1	0.023 ± 0.003	0.013 ± 0.001	0.017 ± 0.011	570 ± 10	16
44		SUNDSTROM ISLAND	0.13 ± 0.01	28 ± 1	260 ± 10	0.76 ± 0.01	3.53 ± 0.04	0.025 ± 0.002	36 ± 3	<0.018	4.85 ± 0.56	3.72 ± 0.01	13 ± 1	0.023 ± 0.003	0.010 ± 0.001	0.021 ± 0.011	460 ± 10	16
45		LaTOUCHE	0.15 ± 0.02	16 ± 1	160 ± 10	2.05 ± 0.01	0.082 ± 0.055	0.019 ± 0.003	33 ± 6	0.045 ± 0.02	1.70 ± 0.37	2.56 ± 0.01	16 ± 1	0.023 ± 0.005	0.012 ± 0.001	0.032 ± 0.018	470 ± 10	18
46		UNIMACK ISLAND - CAPE LUPIN	0.083 ± 0.015	22 ± 1	190 ± 10	0.74 ± 0.01	0.38 ± 0.07	0.023 ± 0.003	48 ± 6	0.055 ± 0.03	2.29 ± 0.55	3.06 ± 0.01	9.4 ± 0.8	0.028 ± 0.005	0.025 ± 0.001	0.048 ± 0.020	420 ± 10	12
47		McLEOD HARBOR	0.17 ± 0.01	20 ± 1	130 ± 10	1.18 ± 0.01	1.24 ± 0.04	0.023 ± 0.002	146 ± 4	0.030 ± 0.018	1.79 ± 0.47	2.80 ± 0.0	13 ± 1	0.014 ± 0.003	0.055 ± 0.001	0.025 ± 0.013	450 ± 10	15
48		OTTER ISLAND	0.068 ± 0.007	3.0 ± 1.0	320 ± 10	0.42 ± 0.01	0.84 ± 0.04	0.032 ± 0.001	26 ± 3	0.036 ± 0.017	2.38 ± 0.58	3.18 ± 0.01	10 ± 1	0.045 ± 0.003	0.0079 ± 0.003	0.043 ± 0.011	710 ± 20	8
49		ANCHOR COVE	0.15 ± 0.01	18 ± 1	200 ± 10	1.68 ± 0.14	0.82 ± 0.01	0.021 ± 0.002	32 ± 4	0.054 ± 0.019	2.48 ± 0.38	4.40 ± 0.01	7.1 ± 0.6	0.034 ± 0.003	0.027 ± 0.001	0.040 ± 0.01	480 ± 10	12
50		UNALASKA ISLAND - EIDER POINT	0.077 ± 0.006	13 ± 1	260 ± 10	0.30 ± 0.01	2.88 ± 0.04	0.032 ± 0.002	17 ± 2	0.032 ± 0.019	4.02 ± 0.54	3.19 ± 0.01	11 ± 1	0.018 ± 0.002	0.0082 ± 0.0001	0.074 ± 0.015	480 ± 10	13
51	SEAWEED	KAYAK ISLAND	0.080 ± 0.016	20 ± 1	140 ± 10	2.77 ± 0.16	1.87 ± 0.04	0.027 ± 0.002	89 ± 5	<0.022	1.80 ± 0.25	1.94 ± 0.01	5.6 ± 0.8	0.036 ± 0.004	0.050 ± 0.001	0.051 ± 0.014	570 ± 10	13
52	FUCUS	ZALKOF BAY	0.14 ± 0.01	14 ± 1	180 ± 10	1.41 ± 0.05	0.92 ± 0.07	0.021 ± 0.004	43 ± 7	<0.036	2.96 ± 0.44	2.62 ± 0.01	6 ± 1	0.025 ± 0.007	0.018 ± 0.001	<0.028	450 ± 10	12
53		SAINTS BAY	0.13 ± 0.01	25 ± 1	230 ± 10	0.85 ± 0.04	5.37 ± 0.04	0.021 ± 0.002	32 ± 4	<0.022	3.26 ± 0.49	4.73 ± 0.01	11 ± 1	0.025 ± 0.003	0.011 ± 0.001	0.063 ± 0.013	510 ± 10	15
54		SAINTS BAY	0.16 ± 0.01	14 ± 1	270 ± 10	0.98 ± 0.04	0.78 ± 0.04	0.029 ± 0.002	37 ± 3	0.095 ± 0.020	3.77 ± 0.47	2.69 ± 0.01	10 ± 1	0.032 ± 0.003	0.011 ± 0.001	0.086 ± 0.016	530 ± 10	15
55		LaCOON POINT	0.079 ± 0.015	23 ± 1	170 ± 10	0.57 ± 0.03	5.25 ± 0.07	0.027 ± 0.003	48 ± 6	<0.055	3.35 ± 0.55	4.96 ± 0.01	9 ± 1	0.026 ± 0.005	0.016 ± 0.001	<0.035	460 ± 10	11
56		CAPE PASSASHAK	0.11 ± 0.01	11 ± 1	210 ± 10	0.75 ± 0.03	0.35 ± 0.05	0.028 ± 0.003	42 ± 5	0.11 ± 0.03	3.03 ± 0.43	2.77 ± 0.01	8.1 ± 0.9	0.015 ± 0.005	0.0089 ± 0.0004	<0.25	340 ± 10	14
57		UNIMACK ISLAND - SONNETT POINT	0.11 ± 0.01	21 ± 1	190 ± 10	0.47 ± 0.02	3.30 ± 0.04	0.023 ± 0.002	42 ± 3	0.052 ± 0.020	3.13 ± 0.56	5.51 ± 0.01	9.8 ± 0.5	0.019 ± 0.003	0.020 ± 0.001	0.062 ± 0.012	350 ± 10	11
58	SEAWEED	KATALLA	0.064 ± 0.013	11 ± 1	340 ± 10	2.71 ± 0.12	4.26 ± 0.06	0.041 ± 0.004	101 ± 6	0.056 ± 0.030	3.82 ± 0.48	2.52 ± 0.01	10 ± 1	0.027 ± 0.005	0.076 ± 0.001	0.070 ± 0.021	820 ± 20	11
59		ANCHOR COVE	0.15 ± 0.03	20 ± 1	510 ± 10	2.22 ± 0.11	2.55 ± 0.11	0.19 ± 0.01	780 ± 10	0.11 ± 0.06	2.96 ± 0.53	4.77 ± 0.01	11 ± 2	0.087 ± 0.010	0.26 ± 0.01	0.22 ± 0.03	590 ± 10	17
60		SPECTACLE ISLAND	0.058 ± 0.006	6.1 ± 0.3	160 ± 10	0.64 ± 0.03	0.27 ± 0.04	0.039 ± 0.002	52 ± 3	0.034 ± 0.018	2.84 ± 0.36	1.60 ± 0.01	4.2 ± 0.5	0.026 ± 0.003	0.0042 ± 0.004	<0.018	620 ± 20	8.0
61		PORT DICK	0.073 ± 0.07	12 ± 1	220 ± 10	0.093 ± 0.02	1.51 ± 0.55	0.032 ± 0.002	149 ± 10	0.029 ± 0.015	1.72 ± 0.04	2.17 ± 0.01	8.1 ± 0.8	0.045 ± 0.001	0.0563 ± 0.003	0.086 ± 0.011	120 ± 10	7.2
62		MAKUSHIN BAY	0.019 ± 0.007	17 ± 1	170 ± 10	0.96 ± 0.04	0.30 ± 0.01	0.023 ± 0.001	68 ± 3	0.020 ± 0.014	1.39 ± 0.43	2.10 ± 0.01	7.2 ± 0.5	0.019 ± 0.003	0.0263 ± 0.0002	0.013 ± 0.009	400 ± 10	5.7
63		CAPE NUKSHAK	0.070 ± 0.009	10 ± 1	290 ± 10	0.92 ± 0.02	0.38 ± 0.07	0.014 ± 0.002	21 ± 6	<0.022	4.90 ± 0.48	2.23 ± 0.01	7.6 ± 1.1	0.024 ± 0.005	0.0169 ± 0.002	0.021 ± 0.01	150 ± 10	6.4
64		SUNDSTROM ISLAND	0.046 ± 0.006	7.5 ± 0.7	230 ± 10	0.45 ± 0.01	1.3 ± 0.1	0.025 ± 0.001	36 ± 3	0.028 ± 0.013	1.46 ± 0.46	2.56 ± 0.01	7.5 ± 0.6	0.031 ± 0.002	0.0097 ± 0.0002	0.038 ± 0.009	530 ± 10	6.4
65		LaTOUCHE	0.029 ± 0.006	7.9 ± 0.4	130 ± 10	1.02 ± 0.01	3.2 ± 0.1	0.018 ± 0.001	58 ± 4	<0.014	1.25 ± 0.3	1.95 ± 0.01	5.9 ± 0.8	0.028 ± 0.003	0.0131 ± 0.0003	0.032 ± 0.009	210 ± 10	5.3
66		LaTOUCHE	0.033 ± 0.012	11 ± 1	130 ± 10	0.79 ± 0.01	1.5 ± 0.1	0.020 ± 0.002	42 ± 7	<0.025	1.13 ± 0.46	2.37 ± 0.01	6.5 ± 1.4	0.015 ± 0.006	0.0082 ± 0.0003	0.048 ± 0.016	500 ± 10	5.7
67	MYTILUS	SAINTS BAY	0.11 ± 0.02	5.5 ± 0.6	190 ± 10	0.49 ± 0.01	1.3 ± 0.1	0.026 ± 0.004	310 ± 10	0.24 ± 0.04	0.56 ± 0.43	2.61 ± 0.01	5.4 ± 1.5	0.013 ± 0.007	0.106 ± 0.001	3.0 ± 0.1	21 ± 1	75
68		KATALLA	<0.033	5.3 ± 0.9	290 ± 10	2.9 ± 0.1	9.9 ± 0.2	0.195 ± 0.006	4300 ± 10	0.23 ± 0.06	1.20 ± 0.55	3.02 ± 0.03	12 ± 3	0.057 ± 0.013	1.60 ± 0.01	2.5 ± 0.1	120 ± 10	86
69		PORT ETCHES	0.029 ± 0.017	4.8 ± 0.6	200 ± 10	0.82 ± 0.01	2.2 ± 0.1	0.048 ± 0.003	970 ± 10	0.20 ± 0.02	<0.49	3.05 ± 0.01	5.5 ± 1.2	0.009 ± 0.006	0.335 ± 0.001	2.8 ± 0.1	27 ± 1	51
70		OTTER ISLAND	0.12 ± 0.02	6.2 ± 0.7	300 ± 10	0.28 ± 0.01	1.6 ± 0.1	0.018 ± 0.003	230 ± 10	0.12 ± 0.09	1.23 ± 0.38	1.69 ± 0.01	5.4 ± 1.3	0.008 ± 0.006	0.066 ± 0.001	2.3 ± 0.1	40 ± 1	77
71		MAKUSHIN BAY	0.075 ± 0.030	4.4 ± 1.0	320 ± 10	0.38 ± 0.01	4.7 ± 0.2	0.015 ± 0.006	530 ± 10	0.31 ± 0.05	<0.72	3.98 ± 0.01	7.0 ± 2.2	0.084 ± 0.01	0.165 ± 0.001	2.5 ± 0.1	38 ± 1	77
72		CAPE NUKSHAK	0.10 ± 0.02	7.4 ± 0.8	220 ± 10	0.66 ± 0.01	1.3 ± 0.1	0.041 ± 0.003	560 ± 10	0.23 ± 0.03	1.52 ± 0.62	3.37 ± 0.04	3.8 ± 1.2	0.015 ± 0.005	0.184 ± 0.001	3.9 ± 0.1	67 ± 3	81

MF = MILLER FREEMAN STATION NUMBER

TABLE G.1 (contd)

ELEMENTAL COMPOSITION OF BIOLOGICAL MATERIAL FROM ALASKA OCS STUDY AREAS ppm DRY WEIGHT (EXCEPT WHERE NOTED)

	SPECIMEN	LOCATION	As	Br	Co	Cr	Cs	Fe	Hg	Na (%)	K (%)	Rb	Sb	Sc	Se	Sr	Zn
73	MYTILUS	SUNDSTROM ISL.	11 ± 1	340 ± 10	0.97 ± 0.04	4.7 ± 0.3	0.046 ± 0.009	1840 ± 130	0.32 ± 0.08	3.38 ± 0.15	2.10 ± 0.68	13 ± 3	0.034 ± 0.029	0.69 ± 0.01	2.7 ± 0.1	200 ± 10	110
74		SUNDSTROM ISL.	13 ± 1	420 ± 10	0.65 ± 0.01	2.0 ± 0.1	0.031 ± 0.04	490 ± 50	0.46 ± 0.03	4.08 ± 0.23	1.73 ± 0.68	4.6 ± 1.3	0.045 ± 0.007	0.17 ± 0.01	2.9 ± 0.1	140 ± 10	100
75		CAPE NUKSHAK	8.4 ± 0.8	310 ± 10	2.1 ± 0.1	3.6 ± 0.2	0.21 ± 0.01	2280 ± 50	0.22 ± 0.06	2.40 ± 0.11	<1.22	22 ± 2	0.10 ± 0.02	0.97 ± 0.01	2.9 ± 0.1	150 ± 10	72
76		DAY HARBOR	7.1 ± 0.4	160 ± 10	1.1 ± 0.1	1.2 ± 0.1	0.028 ± 0.002	240 ± 10	0.13 ± 0.02	1.66 ± 0.09	0.74 ± 0.33	2.8 ± 0.9	0.016 ± 0.004	0.070 ± 0.001	2.1 ± 0.1	100 ± 10	50
77		BOSWELL BAY	8.0 ± 0.5	140 ± 10	3.0 ± 0.1	11.6 ± 0.2	0.26 ± 0.01	6000 ± 140	0.12 ± 0.06	1.22 ± 0.05	0.90 ± 0.31	12 ± 2	0.12 ± 0.02	2.5 ± 0.1	1.9 ± 0.1	160 ± 10	72
78		CAPE PASASHAK	8.7 ± 0.5	190 ± 10	1.2 ± 0.1	8.5 ± 0.2	0.095 ± 0.006	3960 ± 110	0.19 ± 0.05	2.42 ± 0.14	1.53 ± 0.50	8.7 ± 2.1	0.044 ± 0.015	1.4 ± 0.1	2.2 ± 0.1	51 ± 3	80
79		SENNETT POINT	10 ± 1	330 ± 10	0.55 ± 0.01	0.90 ± 0.13	0.027 ± 0.004	920 ± 40	0.37 ± 0.004	3.05 ± 0.15	<1.43	2.9 ± 1.4	<0.013	0.37 ± 0.01	2.4 ± 0.1	61 ± 3	110
80		CAPE HUPIT	7.0 ± 0.6	230 ± 10	0.37 ± 0.01	1.5 ± 0.1	0.015 ± 0.003	540 ± 20	0.16 ± 0.03	2.98 ± 0.17	1.88 ± 0.59	5.2 ± 1.1	0.018 ± 0.006	0.18 ± 0.01	1.9 ± 0.1	49 ± 2	97
81		EIDER POINT	1.0 ± 1	290 ± 10	0.30 ± 0.01	1.2 ± 0.1	0.015 ± 0.004	150 ± 10	0.19 ± 0.04	2.64 ± 0.12	<1.43	5.3 ± 1.1	<0.009	0.051 ± 0.002	2.5 ± 0.1	47 ± 2	170
82		LaTOUCHE POINT	8.6 ± 0.6	290 ± 10	1.3 ± 0.1	1.1 ± 0.1	0.016 ± 0.003	280 ± 10	0.12 ± 0.03	2.31 ± 0.13	<1.09	<1.5	0.021 ± 0.007	0.067 ± 0.001	2.6 ± 0.1	62 ± 2	68
83		PORT DICK	9.4 ± 0.7	290 ± 10	2.6 ± 0.1	12 ± 1	0.39 ± 0.01	5740 ± 160	0.31 ± 0.04	2.91 ± 0.13	<1.15	14 ± 2	0.22 ± 0.02	2.1 ± 0.1	3.2 ± 0.1	210 ± 10	130
84		LaCOON POINT	8.9 ± 0.5	220 ± 10	0.54 ± 0.01	1.2 ± 0.1	0.029 ± 0.003	380 ± 10	0.28 ± 0.03	2.73 ± 0.15	1.28 ± 0.56	4.8 ± 1.1	0.013 ± 0.005	0.13 ± 0.01	2.7 ± 0.1	62 ± 2	93

TABLE G.2

VANADIUM CONCENTRATIONS IN SELECTED ALASKAN OCS BIOLOGICAL MATERIALS

ROCK SOLE	Ng V/g Tissue (Dry Weight)
Miller Freeman Station	
#34	55 ± 19
#13	<10
#27	20 ± 16
#43	29 ± 13
#44	69 ± 18
POLLOCK	
Miller Freeman Station	
#11	97 ± 20
#17	44 ± 16
#36	23 ± 13
#39	<16
#42	<14
#45	<19
CRAB	
Miller Freeman Station	
#12	<14
#26	<18
#48	23 ± 11
#40	24 ± 16
#37	44 ± 14
FUCUS	
Cape Nukshak	830 ± 24
Sundstrom Isl.	483 ± 13
Otter Isl.	945 ± 14
Anchor Cove	319 ± 16
Unalaska Isl.	318 ± 48

TABLE G.2 (contd)

MYTILUS	Ng V/g Tissue (Dry Weight)
Otter Isl.	783 ± 13
Cape Nukshak	226 ± 33
Sundstrom Isl.	501 ± 20
Cape Nukshak	389 ± 18
Unalaska Isl.	520 ± 53
NEPTUNIA	
Miller Freeman Station	
#15	2670 ± 110
#19	2470 ± 100

TABLE G.3

MEAN CONCENTRATIONS OF SELECTED ELEMENTS IN ALASKA OCS BIOTA
(ppm dry weight)

	Number of Samples	Ag	As	Cr	Hg	Se	Zn
Crab	12	1.17±0.48	41±10	< 0.50	0.33±0.14	5.6±4.2	117±18
Rock Sole	9	< 0.038	18±9	1.3±1.9	0.27±0.10	2.0±0.7	32±5
Pollock	14	< 0.035	4.7±2.4	0.26±0.10	0.12±0.08	1.4±1.2	23±4
Neptunia	5	35±32	71±48	1.1±0.6	2.0±1.5	33±48	3260±2690
Mytilus	18	0.087±.036	7.5±2.8	3.9±3.9	0.23±0.09	2.6±0.5	88±29
Fucus	15	0.13±0.04	17±7	1.9±1.8	0.056±0.026	0.049±0.022	14±3
Seaweed	10	0.062±0.037	11±5	1.7±1.3	0.046±0.034	0.064±0.063	8.6±3.9

APPENDIX H

Dissolved Trace Element Concentrations in Alaskan Shelf Waters

TABLE H.1

Vanadium Concentration in Alaska Coastal Waters

Station	Vanadium (µg/l) Surface	Bottom
MB-17		1.0
24		1.3
34		1.3
37	1.3	
41	1.3	
43	1.5	
56	1.4	
59	1.3	
64	1.5	1.5, 1.4
EGA-2		1.6
5		1.7
8	1.3	1.6
15	1.4	1.6
26	1.6	1.6
29		1.5
30		1.3
33	1.1	1.6
44	1.2	1.4
48	1.3	1.6
52		1.3
53	1.3	1.4
55	1.3	1.2
58		1.4
GASW-101	1.2	1.4
104	1.6	1.4
108	1.5	1.6
119		1.5
121	1.3	1.7
124	1.6	1.7
133	1.3	1.3
135	1.4	1.3
137	1.3	1.6
145	1.4	1.5
148	1.3	1.3
157	1.4	1.2
160	1.5	1.6

TABLE H.2

DISSOLVED (<0.4 μm) VANADIUM CONCENTRATIONS (μg/ℓ) in
IN COOK INLET AND SHELIKOF STRAIT WATERS

	Cook Inlet	May 1978 - (Depth)	August 1978 - (Depth)
Station -	CB-1	1.54±0.11 (sfc)	1.15±0.10 (15 M)
	CB-2	---	---
	CB-3	---	1.14±0.10
	CB-4	1.49±0.10 (sfc)	1.19±0.10 (15 M)
	CB-5	---	1.11±0.18 (30 M)
	CB-6	1.53±0.11 (sfc)	1.36±0.09 (20 M)
	CB-7	1.99±0.13 (sfc)	1.26±0.09 (15 M)
	CB-8	1.51±0.10 (sfc)	1.26±0.09 (15 M)
	CB-9	1.44±0.10 (sfc)	---

Time Series Station CB-10 - August 1978 Depth = 15M

t = 0 hr	1.12±0.08
t = 8 hr	1.25±0.09
t = 16 hr	1.22±0.09
t = 40 hr	1.17±0.09
t = 48 hr	1.07±0.08

	Shelikof Strait	August 1978 - (Depth)
Station -	SS-2	1.28±0.14 (273 M)
	SS-4	1.44±0.15 (131 M)
	SS-6	1.41±0.15 (201 M)
	SS-11	1.42±0.12 (145 M)
	SS-13	0.62±0.05 (147 M)

TABLE H.3

DISSOLVED (<0.4 μm) MANGANESE CONCENTRATIONS (μg/ℓ) IN
COOK INLET AND SHELIKOF STRAIT WATERS

	Cook Inlet	May 1978 -(Depth)		August 1978 -(Depth)	
Station -	CB-1	0.48±0.06	(sfc)	1.85±0.20	(15 M)
	CB-2			1.23±0.13	(20 M)
	CB-3			0.29±0.04	(20 M)
	CB-4	0.25±0.04	(sfc)	0.79±0.09	(15 M)
	CB-5	<0.2	(sfc)	0.34±0.04	(30 M)
	CB-6	0.29±0.04	(sfc)	0.31±0.04	(20 M)
	CB-7	0.11±0.02	(sfc)	0.95±0.11	(15 M)
	CB-8	0.16±0.03	(sfc)	0.82±0.09	(15 M)
	CB-9	0.64±0.07	(sfc)		

	Shelikof Strait	August 1978 - (Depth)	
Station -	SS-2	7.28±0.74	(273 M)
	SS-4	0.55±0.07	(131 M)
	SS-6	6.8±0.7	(201 M)
	SS-13	0.03±0.01	(147 M)

TABLE H.4

VANADIUM CONCENTRATIONS IN ALASKA SHELF WATERS (ug/l)

	SURFACE	BOTTOM	WATER COLUMN
BERING SEA	1.38 ± 0.09 (6)*	1.34 ± 0.23 (4)*	1.37 ± 0.15
EASTERN GULF OF ALASKA	1.33 ± 0.14 (9)	1.48 ± 0.15 (14)	1.42 ± 0.16
WESTERN GULF OF ALASKA	1.40 ± 0.12 (12)	1.47 ± 0.17 (13)	1.43 ± 0.15
ALASKA SHELF AVERAGES	1.37 ± 0.12 (27)	1.46 ± 0.17 (31)	1.42 ± 0.15

*NUMBER OF SAMPLES

TABLE H.5

DISSOLVED TRACE ELEMENTS IN OCS SEA WATER, 1976

WESTERN GULF OF ALASKA

STATION IDENTIFY	STATION	DEPTH	micrograms / liter U	Rb	Fe	Zn	Co	Sb	Cs
4-30	WGA-101	SURFACE	3.21	105	9.75	26.6	1.97	0.184	0.253
5-35	WGA-101	BOTTOM	3.40	116	5.95	3.37	0.0488	0.223	0.292
10-71	WGA-135	SURFACE	2.96	111	22.6	3.31	0.0469	0.277	0.281
10-72	WGA-135	BOTTOM	3.48	121	5.59	2.63	0.0226	0.195	0.291
4-25	WGA-148	SURFACE	3.09	115	5.90	1.09	0.0417	0.181	0.269
4-26	WGA-148	BOTTOM	3.26	114	2.84	0.521	0.0180	0.170	0.261
4-28	WGA-157	SURFACE	3.68	119	11.9	0.863	0.0234	0.211	0.267
4-27	WGA-157	BOTTOM	3.26	115	6.12	1.58	0.0261	0.166	0.260
8-53	WGA-160	SURFACE	3.57	77	<4.83	0.968	0.0241	0.240	0.275
8-54	WGA-160	BOTTOM	3.84	113	5.07	0.596	0.0192	0.268	0.290

SOUTHWEST GULF OF ALASKA

5-37	GASW-104	SURFACE	3.12	121	12.5	0.714	0.0189	0.156	0.273
5-31	GASW-104	BOTTOM	2.99	104	14.1	0.617	0.0277	0.200	0.287
9-63	GASW-119	SURFACE	3.18	105	3.54	0.736	0.0462	0.200	0.262
9-64	GASW-119	BOTTOM	3.75	119	9.87	0.551	0.0201	0.209	0.296
4-29	GASW-121	SURFACE	3.17	110	17.0	1.07	0.0332	0.179	0.254
6-38	GASW-121	ZODIAC A SURF.	3.26	114	9.90	0.268	0.0472	0.187	0.305
5-33	GASW-121	ZODIAC B SURF.	3.28	114	8.22	0.386	0.0417	0.170	0.282
5-34	GASW-121	BOTTOM	3.55	121	6.82	0.698	0.0154	0.245	0.308
10-66	GASW-124	SURFACE	3.32	104	8.47	4.60	0.0319	0.245	0.268
9-65	GASW-124	BOTTOM	3.99	124	5.91	0.770	0.0210	0.200	0.308
10-69	GASW-133	SURFACE	3.04	107	7.80	2.21	0.0333	0.171	0.275
10-70	GASW-133	BOTTOM	3.00	110	17.5	2.68	0.0300	0.261	0.286
11-78	GASW-137	SURFACE	2.99	106	5.80	8.56	0.0290	0.270	0.260
11-77	GASW-137	BOTTOM	3.56	122	3.58	0.671	0.0211	0.228	0.306
11-73	GASW-145	SURFACE	3.56	118	3.23	1.54	0.0304	0.205	0.300
11-74	GASW-145	BOTTOM	3.72	125	<2.90	53.5	0.0524	0.226	0.312

TABLE H.5 (contd)

DISSOLVED TRACE ELEMENTS IN OCS SEA WATER, 1976

BERING SEA

SAMPLE IDENTIFY	STATION	DEPTH	micrograms/liter						
			U	Rb	Fe	Zn	Co	Sb	Cs
2-16	MB 2	SURFACE	2.82	92	11.9	5.70	0.0569	0.164	0.250
3-18	MB 2	SURFACE	3.79	108	8.49	0.934	0.0268	0.148	0.256
8-56	MB 8	SURFACE	2.96	102	6.11	2.93	0.0497	0.236	0.243
3-17	MB 8	BOTTOM	3.48	103	17.4	2.01	0.0451	0.155	0.235
2-12	MB 14	SURFACE	2.92	102	9.87	10.5	0.0431	0.158	0.264
2-13	MB 14	BOTTOM	3.02	106	4.78	1.76	0.0150	0.181	0.299
1-6	MB 17	BOTTOM	3.37	104	9.61	1.08	0.0240	0.181	0.261
3-21	MB 19	BOTTOM	3.75	115	16.6	1.01	0.0310	0.176	0.268
1-5	MB 24	BOTTOM	3.49	111	11.0	5.36	0.0420	0.172	0.255
4-24	MB 30	BOTTOM	3.59	121	7.92	0.859	0.0259	0.176	0.273
3-19	MB 31	SURFACE	3.92	122	60.0	1.36	0.0201	0.178	0.301
3-20	MB 31	BOTTOM	3.07	107	35.9	1.42	0.0181	0.170	0.283
8-55	MB 34	SURFACE	2.88	118	5.66	1.18	0.0195	0.190	0.293
2-10	MB 34	BOTTOM	2.36	109	16.4	0.959	0.0179	0.170	0.274
2-14	MB 37	BOTTOM	2.90	95	7.34	1.24	0.0287	0.177	0.254
2-11	MB 41	BOTTOM	3.07	105	8.04	1.39	0.0388	0.175	0.272
1-7	MB 43	BOTTOM	3.35	102	11.5	1.08	0.0294	0.152	0.264
3-22	MB 48	SURFACE	2.59	122	12.5	2.79	0.0247	0.188	0.281
3-23	MB 48	BOTTOM	3.50	122	12.7	1.81	0.0256	0.187	0.281
1-4	MB 56	BOTTOM	3.30	112	12.9	1.32	0.0364	0.171	0.272
2-8	MB 59	BOTTOM	2.98	104	15.2	1.29	0.0390	0.170	0.271
1-3	MB 64	SURFACE	3.63	110	11.6	6.28	0.0214	0.172	0.247
1-1	MB 64	BOTTOM A	3.55	112	24.3	16.1	0.0259	0.163	0.238
1-2	MB 64	BOTTOM B	2.92	102	16.7	1.21	0.0291	0.158	0.232

TABLE H.5 (contd)

DISSOLVED TRACE ELEMENTS IN OCS SEA WATER, 1976

EASTERN GULF OF ALASKA

SAMPLE IDENTIFY	STATION	DEPTH	micrograms/liter U	Rb	Fe	Zn	Co	Sb	Cs
8-52	EGA-2	BOTTOM	2.92	110	<5.30	0.752	0.0236	0.189	0.273
7-48	EGA-5	SURFACE	2.94	109	3.48	2.11	0.0401	0.171	0.248
7-49	EGA-5	BOTTOM	3.71	129	<2.50	0.684	0.0158	0.229	0.280
7-47	EGA-8	SURFACE	3.52	120	7.74	0.672	0.0090	0.235	0.264
7-51	EGA-8	BOTTOM	3.53	127	11.1	1.10	0.0182	0.238	0.256
11-76	EGA-15	SURFACE	3.35	120	7.89	10.3	0.0152	0.197	0.298
11-75	EGA-15	BOTTOM	3.13	111	5.49	1.69	0.0372	0.212	0.272
9-61	EGA-26	SURFACE	3.40	119	5.09	3.80	0.0176	0.197	0.305
9-62	EGA-26	BOTTOM	3.43	120	5.08	0.814	0.0139	0.219	0.294
8-58	EGA-29	71 m	3.55	118	<3.90	1.18	0.0167	0.183	0.317
9-60	EGA-30	BOTTOM	3.29	112	5.07	1.50	0.0272	0.205	0.283
8-57	EGA-33	SURFACE	3.56	114	21.7	0.815	0.0115	0.174	0.293
9-59	EGA-33	BOTTOM	3.66	116	10.5	1.28	0.0347	0.236	0.306
6-39	EGA-44	SURFACE	3.15	114	8.67	1.50	0.298	0.100	0.0642
7-46	EGA-44	BOTTOM	2.95	105	4.24	0.985	0.0114	0.266	0.257
6-41	EGA-48	SURFACE	3.17	112	5.51	0.822	0.0103	0.196	0.275
7-45	EGA-48	BOTTOM	3.25	111	2.55	1.34	0.0100	0.180	0.276
6-40	EGA-52	BOTTOM	3.31	114	<2.57	0.932	0.0827	0.262	0.294
6-44	EGA-53	SURFACE	2.81	102	5.01	21.4	0.276	0.301	0.244
5-36	EGA-53	BOTTOM	3.33	131	9.52	1.10			
6-43	EGA-55	SURFACE	3.06	110	3.05	1.15	0.0300	0.184	0.255
5-32	EGA-55	BOTTOM	3.12	103	10.1	0.594	0.0285	0.173	0.293
6-42	EGA-58	BOTTOM	2.72	111	10.7	2.54	0.0281	0.189	0.251
10-67	EGA-108	SURFACE	3.64	117	14.8	3.52	0.0181	0.194	0.274
10-68	EGA-108	BOTTOM	3.57	120	7.02	2.22	0.0226	0.263	0.310
11-79	EGA-110	SURFACE	3.39	117	12.4	1.18	0.0217	0.211	0.297

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