DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

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MISCELLANEOUS FIELD STUDIES
MAP MF-316

INTRODUCTION

Increasing interest in potentially harmful substances utilized and discarded by man has raised questions about the normal distribution of chemical elements in the natural environment. This interest prompted a baseline study of a pristine region off the northern coast of Alaska. Information was gathered on currents, water clarity, nutrients, temperature and salinity, zooplankton, benthic communities, neritic fauna, bird and mammal population and pesticide residues, sediment composition and chemistry of the sediments and their interstitial waters. This information will provide a base for ascertaining and evaluating future changes and for assessment of the potential hazard in this region and ecosystems elsewhere.

SAMPLING PROCEDURE

During September and October 1970, samples were collected with either a Van Veen grab, which collects over a surface area of about 1/7 m^2 and samples to a depth of about 20 cm, or a Shipek grab, which samples to a depth of about 10 cm over 1/25 m^2. Analytical samples were taken of surficial sediments (2-10 cm), which were readily selected on the basis of the orientation and disposition of the fauna and their markedly lighter color.

ANALYTICAL PROCEDURES

After screening out materials over 2 millimeters, splits were air dried and gently disaggregated in a mortar and pestle to reduce mercury evaporation. These samples were analyzed using a wet chemical method outlined by Ward and others (1963) for arsenic, an atomic absorption technique of Vaughn and McCarthy (1964) for mercury, and atomic absorption methods outlined by Ward and others (1969) for copper, lead and zinc. The limits of detection for these techniques are 10 ppm for arsenic, 5 ppm for copper, zinc and lead and 0.01 ppm for mercury. Standard sieve and hydrometer techniques were used in determining the textural distribution.

ELEMENTAL DISTRIBUTION

Concentrations of copper, lead and mercury were near or below the limit of detection and had a minimal range (Table 1). This, coupled with the errors encountered in obtaining a representative sample of the sediment and particle sparsity effects, wherein analysis in a particular sample depends more upon the random occurrence of an element in the analyzed portion of the sample than on the actual elemental abundance in the sample (Clifton and others, 1969), would imply that individual values may be suspect; however, averaging and grouping as done in this report increases confidence in the general trend of values and their meaning.

The distribution of these elements can be considered from several aspects. The areal distribution of elemental concentrations of copper, lead and zinc (Figs. 1-3) appears to be related to the sediment type, with concentrations highest in muds, intermediate in sand and lowest in gravels (Fig. 6, Table 1). A similar relationship has been recognized between coarse- and fine-grained rocks and is ascribed to organic enrichment and absorption on clays (Krauskopf, 1967, p. 592). The distribution of mercury appears more random and less influenced by sediment textures (Figs. 4 and 6, Table 1).

Arsenic is least abundant in relict gravels (Figs. 5-6, Table 1), while higher values occur in areas of modern sand and silt sedimentation (McManus and others, 1969; Barnes, 1971). This would suggest that either this element may be derived from a more modern source or that the distribution reflects the fact that arsenic tends to be tied up with iron (Rankama and Sahama, 1949, p. 741) which may be less abundant in the gravels.

The lack of baseline studies at this time, wherein many aspects of the environment are outlined and compared, makes for a formidable problem of integrating source, transport mechanism and depositional regime at this stage in our knowledge.

The averages reported here are close to values found in other marine sediments, except that arsenic is somewhat higher (Wedepohl, 1969), and would appear to be background concentrations for these elements for the region studied.

ACKNOWLEDGMENTS

Ship time for collection of the sediment samples was provided by the U.S. Coast Guard. We gratefully acknowledge the help and cooperation of the officers, crew and fellow scientists aboard the U.S.C.G.C. GLACIER, during the Western Beaufort Sea Environmental Cruise, 1970.

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Table 1. Concentration of elements in different sediment types
(Concentrations in parts per million)

	No. of Samples	Average	Range		No. of Samples	Average (see note a)	Range
		COPPER				ARSENIC	
Gravel	13	10 ppm	5 - 20 ppm	Gravel	13	14 ppm	<10 - 25 ppm
Sand	32	11	10 - 15	Sand	32	27	20 - 30
Mud	19	19	15 - 30	Mud	19	27	20 - 30
Total	64	13	5 - 30	Total	64	24	<10 - 30
		LEAD				MERCURY	
						Exclusive of values below 0.01 ppm (see note b)	
Gravel	13	10 ppm	5 - 20 ppm	Gravel	12	0.020 ppm	<.01 - 0.4 ppm
Sand	32	15	10 - 25	Sand	23	0.017	<.01 - .03
Mud	19	17	10 - 20	Mud	15	0.017	<.01 - .04
Total	64	14	5 - 25	Total	50	0.017	<.01 - .04
		ZINC				0.01 ppm	Percent
Gravel	13	47 ppm	25 - 80 ppm	Gravel	1		8%
Sand	32	44	25 - 80	Sand	9		28%
Mud	19	92	65 - 160	Mud	4		21%
Total	64	59	25 - 160	Total	14		21%

a) Values measured as less than 10 ppm were averaged in as 5 ppm.
b) Only samples with values greater than or equal to 0.01 ppm were used in average.

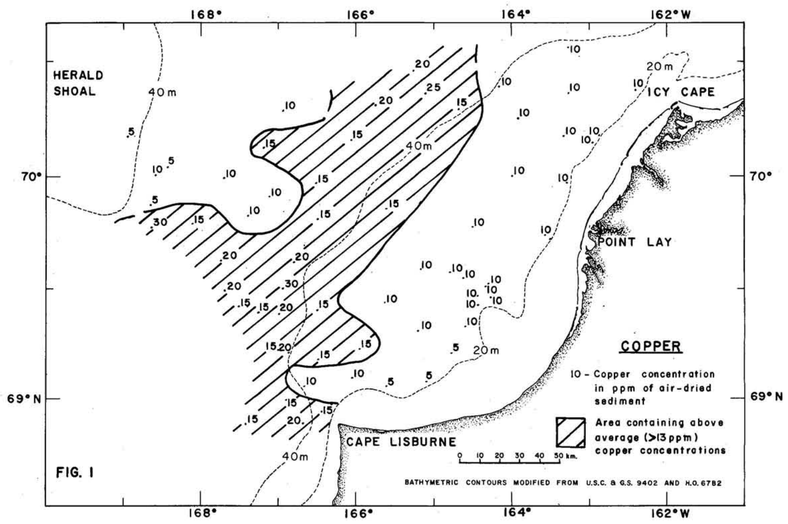


FIG. 1

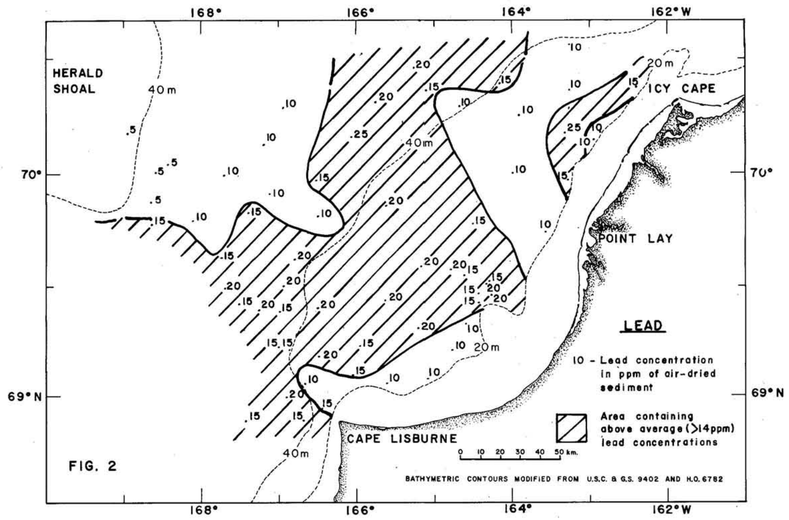


FIG. 2

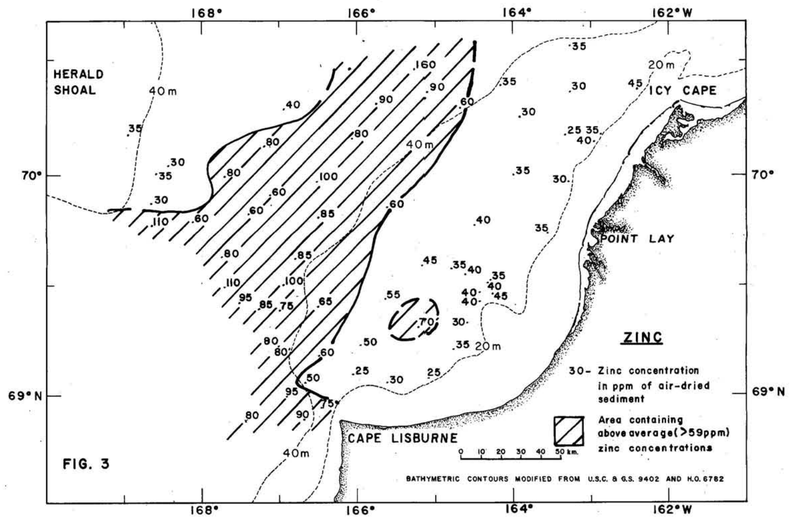


FIG. 3

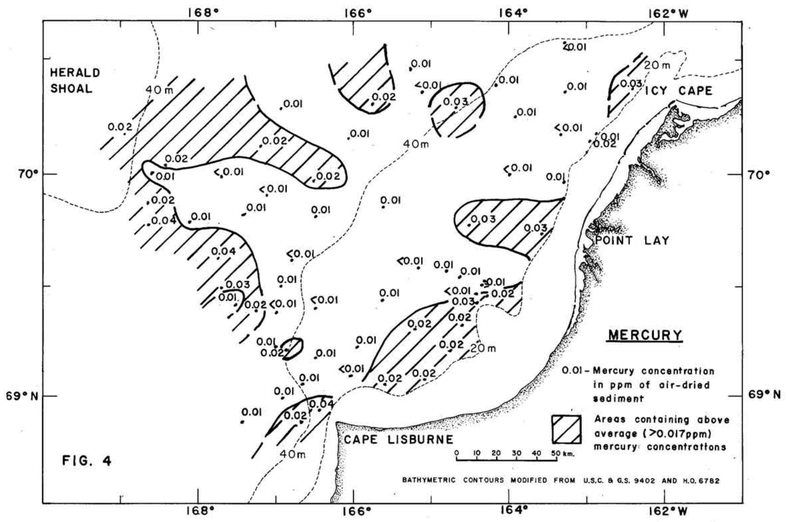


FIG. 4

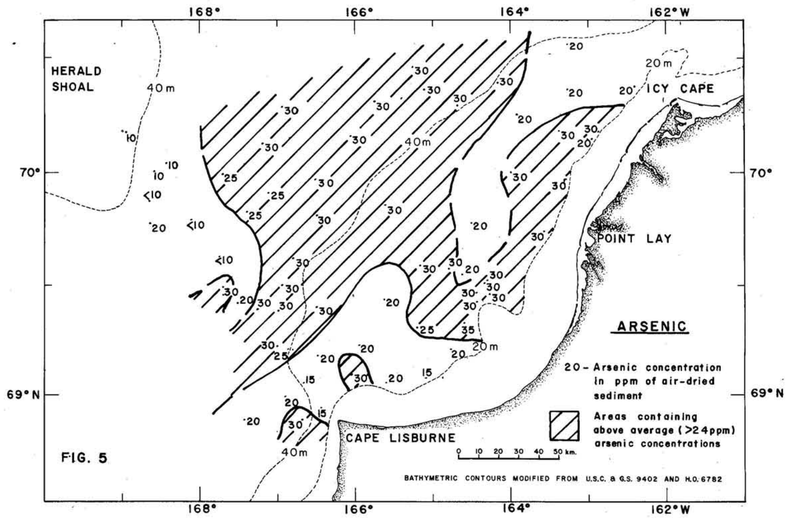


FIG. 5

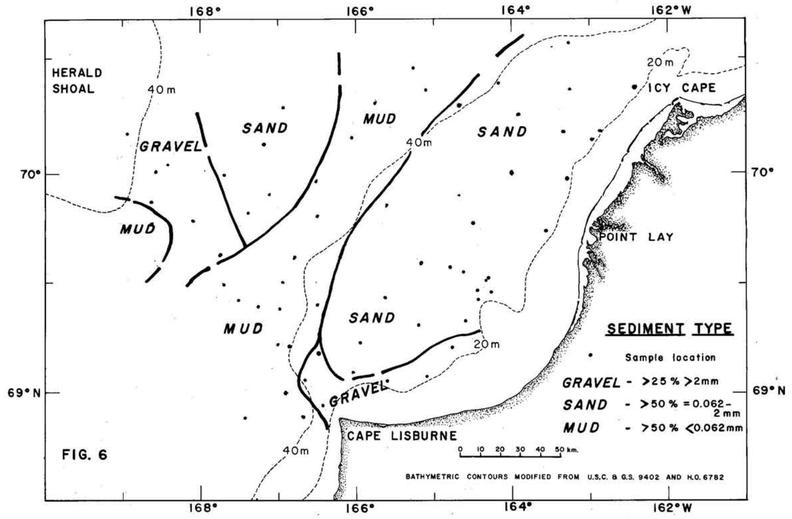
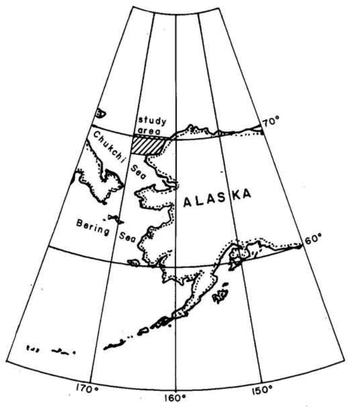


FIG. 6



DISTRIBUTION OF COPPER, LEAD, ZINC, MERCURY, AND ARSENIC IN THE SURFACE SEDIMENTS OFF THE COAST OF NORTHWESTERN ALASKA

by

Peter Barnes and Kam Leong

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