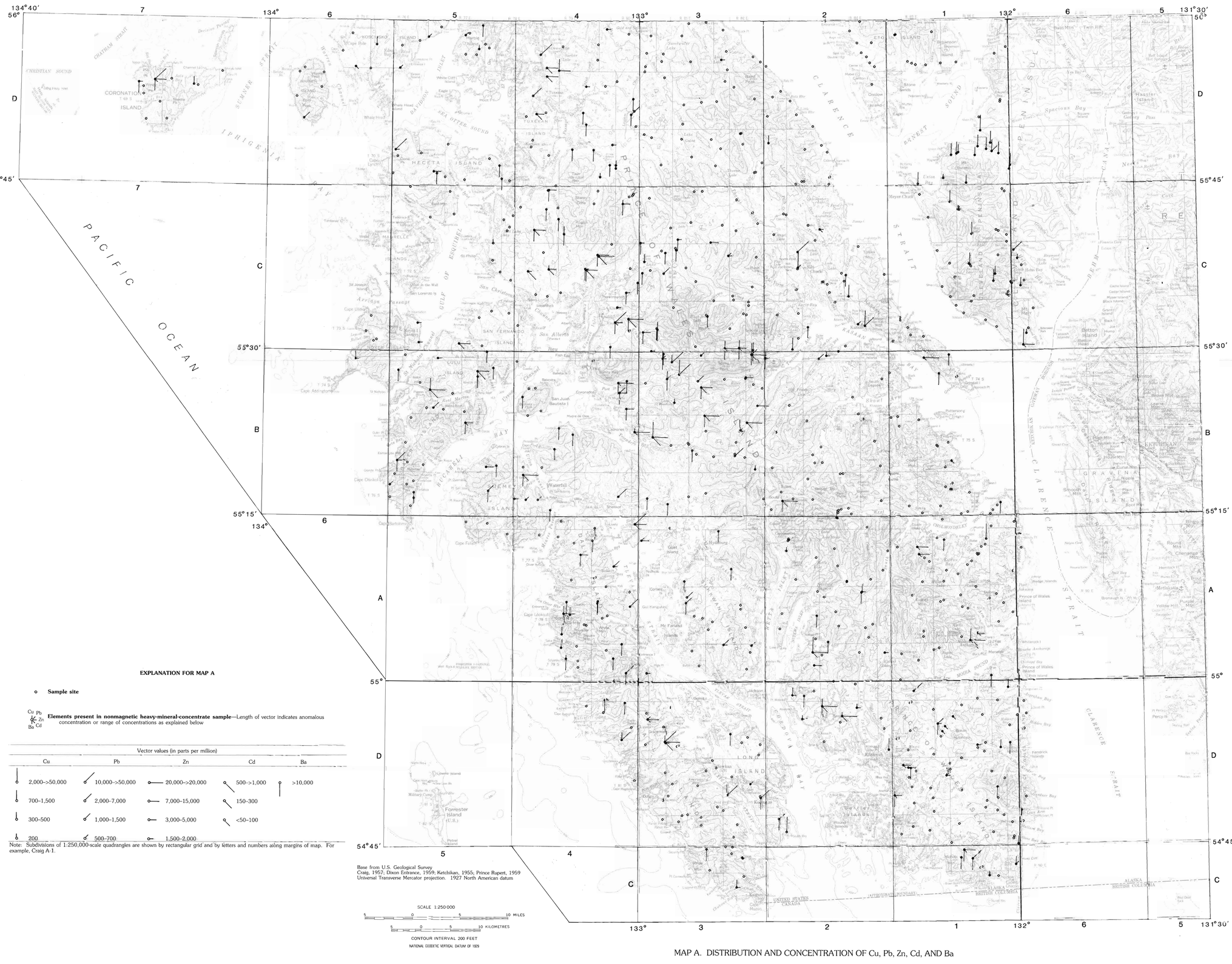
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

MISCELLANEOUS FIELD STUDIES
MAP MF–2217–B (SHEET 1 OF 2)



MAP A. DISTRIBUTION AND CONCENTRATION OF Cu, Pb, Zn, Cd, AND Ba

EXPLANATION FOR MAP A

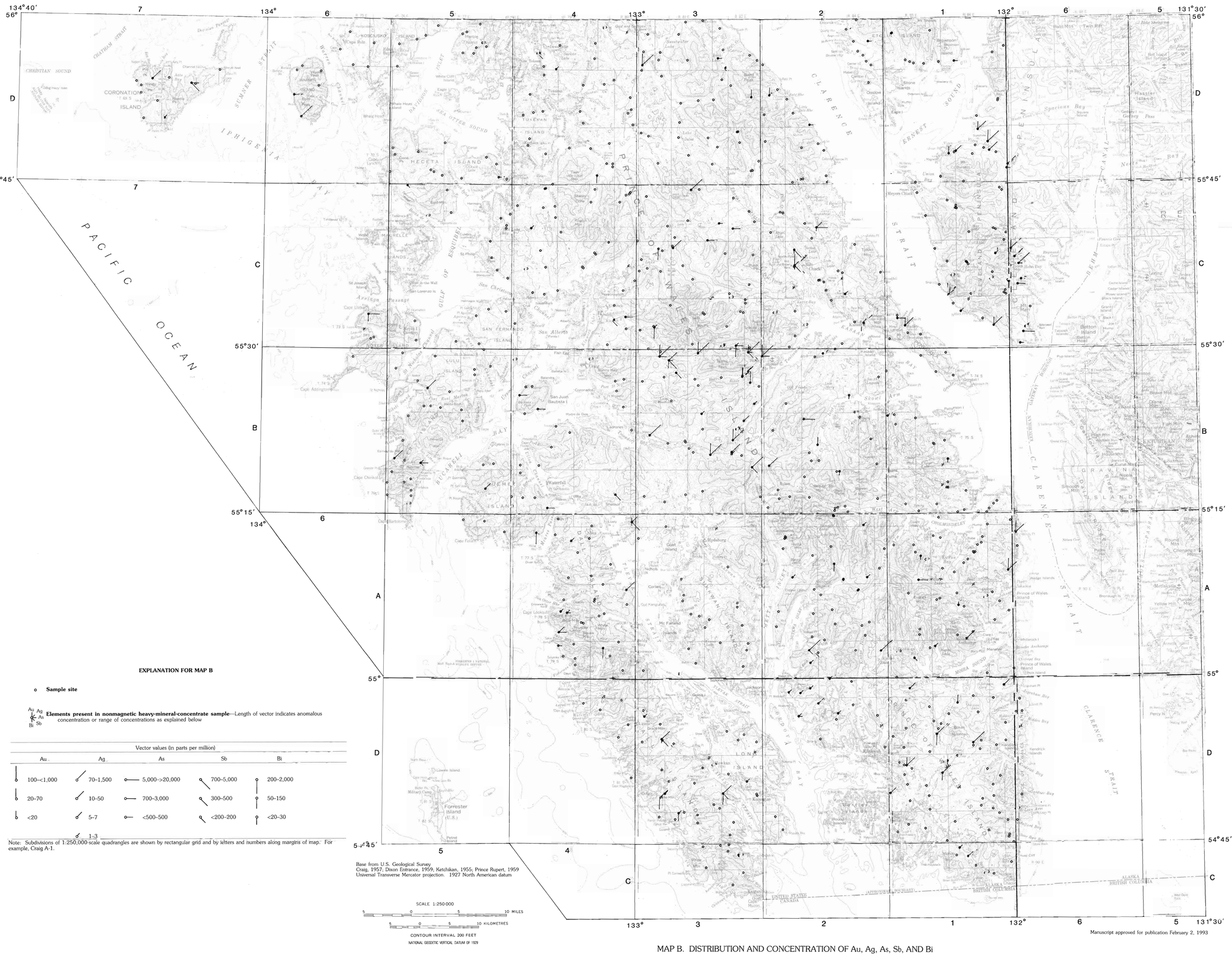
Sample site

Elements present in nonmagnetic heavy-mineral-concentrate sample—Length of vector indicates anomalous concentration or range of concentrations as explained below

Vector values (in parts per million)

Cu	Pb	Zn	Cd	Ba
2,000–>50,000	10,000–>50,000	20,000–>20,000	500–>1,000	>10,000
700–1,500	2,000–7,000	7,000–15,000	150–300	
300–500	1,000–1,500	3,000–5,000	<50–100	
200	500–700	1,500–2,000		

Note: Subdivisions of 1:250,000-scale quadrangles are shown by rectangular grid and by letters and numbers along margins of map. For example, Craig A-1.



MAP B. DISTRIBUTION AND CONCENTRATION OF Au, Ag, As, Sb, AND Bi

EXPLANATION FOR MAP B

Sample site

Elements present in nonmagnetic heavy-mineral-concentrate sample—Length of vector indicates anomalous concentration or range of concentrations as explained below

Vector values (in parts per million)

Au	Ag	As	Sb	Bi
100–<1,000	70–1,500	5,000–>20,000	700–5,000	200–2,000
20–70	10–50	700–3,000	300–500	50–150
<20	5–7	<500–500	<200–200	<20–30
	1–3			

Note: Subdivisions of 1:250,000-scale quadrangles are shown by rectangular grid and by letters and numbers along margins of map. For example, Craig A-1.

GEOCHEMICAL MAPS SHOWING THE DISTRIBUTION AND CONCENTRATION OF SELECTED ELEMENTS IN NONMAGNETIC HEAVY-MINERAL-CONCENTRATE SAMPLES FROM STREAM SEDIMENT FROM THE CRAIG, DIXON ENTRANCE, AND WESTERN EDGES OF THE KETCHIKAN AND PRINCE RUPERT QUADRANGLES, SOUTHEAST ALASKA

By
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1993

INTRODUCTION

The USGS (U.S. Geological Survey) is required by ANILCA (Alaska National Interest Lands Conservation Act, Public Law 96-487, 1980) to survey certain Federal lands in Alaska to determine their mineral resource potential. Results from AMRAP (Alaska Mineral Resource Assessment Program) must be made available to the public and be submitted to the President and Congress. This report presents the results of a geochemical survey of the Craig, Dixon Entrance, and western edges of the Ketchikan and Prince Rupert quadrangles, southeast Alaska. For simplicity, the area shall be referred to herein as the Craig study area.

During the summers of 1983-85 and 1989, the USGS conducted a reconnaissance geochemical survey of the Craig study area. Both stream-sediment samples and heavy-mineral-concentrate samples panned from stream sediments were collected. Stream sediments are generally indicative of upstream bedrock geology and may also reveal extensive areas of exposed mineralized rock. The nonmagnetic heavy-mineral-concentrate fraction panned from stream sediments contains ore-related minerals, and its geochemistry may be useful in delineating areas of poorly exposed or buried mineralized rock. This report presents geochemical maps showing the distribution and concentration of 16 elements in the nonmagnetic heavy-mineral-concentrate fraction panned from stream sediments. The 16 elements of this report are the same group of elements shown on the stream-sediment geochemical maps (Cathrall and others, 1993), except for mercury, which was not analyzed in the nonmagnetic heavy-mineral-concentrate fraction.

The study area encompasses an area of about 1,400 mi^2 (3,600 km^2) between latitudes 54°40′ N. and 56° N. and longitudes 131°30′ W. and 134°40′ W. in the southernmost part of southeastern Alaska, about 15 mi (24 km) east of Ketchikan and 170 mi (274 km) south of Juneau. The project area is entirely in the Tongass National Forest.

The largest part of the land area is on the Prince of Wales Island, the southernmost major island of the Alexander Archipelago. The island is separated from the Cleveland Peninsula and Etolin Island by the Clarence Strait, and from the many large and small islands seaward by generally narrow irregular-shaped channels and straits.

From west to east the study area includes parts of the Prince of Wales Mountains, Kupreanof Lowland, and Coastal Foothills physiographic divisions of Wahrhaftig (1965) (fig. 1).

The Prince of Wales Mountains physiographic division consists of moderately rugged glaciated mountains having rounded hummocky summits 2,000-3,500 ft (610-1,068 m) in altitude and some spirelike aretes as much as 3,800 ft (1,159 m) in altitude. The mountains are dissected by steep-walled U-shaped valleys and by fiords 600-1,000 ft (183-305 m) deep.

The Kupreanof Lowland physiographic division consists of islands and channels. Islands of rolling, heavily glaciated terrane have a local relief of 300-500 ft (91-152 m) and a maximum relief of 1,000-1,500 ft (305-457 m) and are separated by an intricate network of waterways. Scattered blocklike mountains having rounded hummocky summits 2,000-3,000 ft (610-915 m) in altitude rise above the general level of the lowland. Parts of some islands are plains that are a few feet above sea level.

The Coastal Foothills physiographic division consists of blocks of high mountains 3-30 mi (4.8-48.3 km) across separated by flat-floored valleys and straits 1/2-10 mi (0.8-16 km) wide; they include closely spaced mountain islands and peninsulas 1,000-4,500 ft (305-1,372 m) in altitude. Mountains less than 3,500 ft (1,068 m) in altitude were overridden by glaciers and have rounded hummocky summits.

Transportation into the study area is limited to private, commercial, and public boats and aircraft. Most of the shorelines are easily accessible to small boats and many deep-water channels and anchorages exist for larger vessels. Two towns, Craig and Klawock, and two villages, Hollis and Hydaburg, are located on Prince of Wales Island. Public roads connect Craig, Klawock, and Hollis. Hollis can be reached by a ferry boat from Ketchikan. Numerous logging roads crisscross Prince of Wales Island. Most of the inland area is accessible only by helicopter.

The climate of the region is mild; the mean annual rainfall is 100-150 in. (254-381 cm). The density of forest cover and undergrowth is typical of the rain forest of cold temperate regions.

GEOLOGIC SETTING

The Craig study area contains parts of three northwest-trending tectonostratigraphic terranes (Berg and others, 1972, 1978; Monger and Berg, 1987) (fig. 1). From southwest to northeast, they are the Alexander terrane, the Gravina-Nutzotin overlap assemblage, and the Taku terrane (Brew and Ford, 1984).

The Alexander terrane consists of Proterozoic(?) to Paleozoic (Pennsylvanian) sedimentary and volcanic rocks that have been intruded by Paleozoic and Mesozoic plutonic rocks on Prince of Wales and Dall Islands southwest of Clarence Strait. Unmetamorphosed rocks of Ordovician and younger age appear to stratigraphically overlie generally low-grade metamorphosed rocks of the pre-Middle Ordovician Wales Group (Eberlein and Churkin, 1970, 1973). The Wales Group is a structurally complex assemblage of predominantly andesitic to basaltic marine fragmental volcanic rocks and flows interbedded with graywacke, mudstone, shale, and, locally, marble. The Wales Group is regionally deformed and metamorphosed to greenschist and, in places, amphibolite facies. The southern part of the Alexander terrane includes an Ordovician to Silurian volcanoplutonic complex of diorite, trondhjemite, and cogenetic volcanic and volcaniclastic rocks that is in fault contact with the Wales Group (Eberlein and others, 1983; Gehrels and others, 1983a, b).

The rocks northeast of Clarence Strait have been assigned to the Gravina-Nutzotin overlap assemblage and the Taku terrane (Berg and others, 1978; Monger and Berg, 1987; Brew and Ford, 1984). The Gravina-Nutzotin overlap assemblage underlies part of the south end of the Cleveland Peninsula and Orsilow Island. The overlap assemblage consists of marine flysch, argillite, graywacke, and interbedded andesitic to basaltic volcanic and volcaniclastic rocks intruded by plutons that range in composition from quartz diorite to dunite and peridotite. In the Craig study area, the contact between the rocks of the Gravina-Nutzotin overlap assemblage and the Alexander terrane is the Clarence Strait fault (Brew and Ford, 1984).

In the extreme northeastern part of the study area, the Taku terrane underlies Bronson Island, Etolin Island, and part of the Cleveland Peninsula. The terrane consists of upper Paleozoic to Mesozoic bedded rocks (phyllitic mudstone, siltstone, sandstone, conglomerate, and minor limestone). Southeast of these bedded rocks the terrane consists of complexly deformed and metamorphosed upper Paleozoic or Mesozoic pelitic sedimentary rocks and subordinate felsic to mafic volcanic rocks intruded by intermediate and felsic plutons of Mesozoic and Cenozoic age (Silberling and others, 1982).

Regional structures in the Craig study area include northwest-trending and east-west-trending high-angle lateral and extensional faults, and some moderate-angle contractional faults. Regional metamorphism generally ranges from zeolite to greenschist facies, but locally reaches amphibolite facies, particularly in the southern and northeastern parts of the project area (Eberlein and others, 1983).

SAMPLE COLLECTION, PREPARATION, AND ANALYSIS

Nonmagnetic heavy-mineral-concentrate samples were collected from active alluvium, primarily from first-order (unbranched) and second-order (below junction of two first-order streams) streams, as shown on USGS topographic maps (scale 1:63,360). A total of 793 panned-concentrate samples were collected. The areas of the drainage basins sampled ranged from about 2 to 10 mi^2 (5-26 km^2). At each site the sample was collected by wet sieving through a 10-mesh (2.0 mm) stainless steel screen, to remove the coarse material, into a 35-cm (14-in.) gold pan. The less-than-2.0-mm fraction was panned at the site until most of the quartz, feldspar, organic material, and clay-sized material was removed. The samples were air dried and then shipped to the laboratory where they were sieved with a minus 20-mesh (0.83 mm) stainless steel screen. Following the removal of the light-density-mineral fraction by flotation in bromoform (specific gravity about 2.8), the heavy-mineral fraction was separated into three magnetic fractions using a Frantz isodynamic separator. The first fraction (containing the most magnetic material, mostly magnetite) and the second fraction (largely ferromagnesium silicates and iron oxides) were not analyzed. The third fraction (the least-magnetic material), referred to as the nonmagnetic heavy-mineral concentrate, contains high-specific-gravity rock-forming minerals as well as minerals that might indicate mineralization. This fraction was then split. One portion was saved for further studies and the other portion was ground for spectrographic analyses. The analyses were done by a six-step semiquantitative direct-current-arc emission spectrographic method (Grimes and Marranzino, 1968). The results are reported in McDanal and others (1991).

A statistical summary of the geochemical data for 16 elements from 793 nonmagnetic heavy-mineral-concentrate fractions is given in table 1. The 16 elements selected for this report are Cu, Pb, Zn, Cd, Ba, Au, Ag, As, Sb, Bi, Mo, La, Nb, Y, Be, and Th. The selection of these elements is based on descriptions of approximately 268 mineral deposits (mines, prospects, claims, and mineral occurrences) and their major metals or commodities that occur in the study area (Berg, 1984; Nokleberg and others, 1987). Some of the mineral deposit types/occurrences that occur in the study area are (1) base-metal- or precious-metal-bearing vein deposits, (2) massive sulfide deposits, (3) disseminated sulfide deposits, (4) porphyry deposits, (5) skarn deposits, (6) magmatic Li-Ta or REE (rare-earth element) deposits, (7) REE-bearing vein deposits, and (8) bedded barite deposits. In addition, Cu, Pb, Zn, and Ba are elements of economic significance that are present in concentrations that are well above the lower detection limits. The elements Cd, Au, Ag, As, Sb, Bi, and Mo are commonly associated with mineral deposits, but levels of analytical determinations are so high that nearly all values suggest mineralization. The elements La, Nb, Y, Be, and Th are associated with known REE-bearing vein deposits locally accompanied by base or precious metals within the study area (Denny, 1962; MacKevett, 1963).

Anomalous element values are those that deviate from the norm or stand out above some geochemical background. Commonly the 95th percentile for a given geochemical distribution is chosen as a geochemical threshold, with all values greater than that threshold being considered anomalous (Levinson, 1974). The 95th-percentile values for the 16 elements are listed in table 1. However, for some or all of the elements the reader may wish to adjust geochemical thresholds upward or downward from the 95th percentile to accommodate breaks in the percentile distribution of the data. Therefore, additional percentiles and their corresponding values are listed in table 1.

Element concentrations are shown on the three geochemical maps by vectors that radiate from each sample locality. The resulting vector diagram not only shows the presence of concentrations of suites of elements, but also can be used to indicate geochemical signatures of particular types of mineral deposits. Clusters of similar vectors may represent one or more potential deposits having large areal exposure. The vectors are subdivided into as many as four lengths that represent concentration ranges/concentration.

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Table 1. *Statistical summary of the geochemical data for 16 selected elements from the nonmagnetic heavy-mineral concentrates from the Craig study area, southeast Alaska*

[Analyses by semiquantitative emission spectography. Values in parts per million; >, greater than; <, less than; N, not detected at value shown]

Element	DR[1]	N[2]	L[3]	G[4]	No. of values[5]	Minimum value	Median value	Maximum value[5]
Cu	0.726	68	146	3	576	10	70	50,000
Pb	.579	201	129	4	459	20	<20	50,000
Zn	.179	574	54	9	146	500	500N	20,000
Cd	.052	743	8	1	41	50	50N	1,000
Ba	.798	13	35	112	633	50	700	10,000
Au	.029	763	4	3	23	20	20N	500
Ag	.121	666	31	0	96	1	1N	1,500
As	.034	758	7	1	27	500	500N	15,000
Sb	.018	774	5	0	14	200	200N	5,000
Bi	.024	766	8	0	19	20	20N	2,000
Mo	.111	657	47	0	88	10	10N	1,000
La	.393	214	266	7	312	100	<100	2,000
Nb	.334	341	187	0	265	50	<50	700
Y	.958	20	11	2	760	20	200	3,000
Be	.066	532	208	1	52	2	2N	700
Th	.038	758	5	0	30	200	200N	2,000

Element	Percentile values									
	60th	70th	75th	80th	85th	90th	92nd	95th	97.5th	98th	99th
Cu	50	50	70	100	100	200	300	300	1,000	1,000	2,000
Pb	50	70	70	100	150	200	300	700	1,500	2,000	10,000
Zn	500N	500N	<500	500	700	1,500	2,000	5,000	15,000	20,000	>20,000
Cd	50N	50N	50N	50N	50N	50N	50N	50	200	300	700
Ba	1,500	3,000	5,000	7,000	10,000	>10,000	10,000	>10,000	>10,000	>10,000	>10,000
Au	20N	20N	20N	20N	20N	20N	20N	20N	20	30	150
Ag	1N	1N	1N	1N	<1	1.5	3	7	50	70	200
As	500N	500N	500N	500N	500N	500N	500N	500N	500	700	1,500
Sb	200N	200N	200N	200N	200N	200N	200N	200N	200N	<200	300
Bi	20N	20N	20N	20N	20N	20N	20N	20N	<20	20	150
Mo	10N	10N	10N	10N	<10	10	10	30	100	150	200
La	100	150	200	200	300	500	500	700	700	1,000	>2,000
Nb	<50	50	50	70	70	100	100	100	200	200	200
Y	200	300	300	500	500	700	700	700	1,000	1,000	2,000
Be	2N	<2	<2	<2	<2	<2	<2	5	5	5	15
Th	200N	200N	200N	200N	200N	200N	200N	200N	200N	<200	200

[1]Detection ratio (DR), number of uncensored values that is true without N, L, and G divided by total number of samples analyzed.
[2]N, number of samples in which concentration could not be detected at lower determination limit.
[3]L, number of samples in which element was observed, but concentration was less than lower determination limit.
[4]G, number of samples in which element was observed, but concentration was greater than upper determination limit.
[5]Value based on uncensored values.

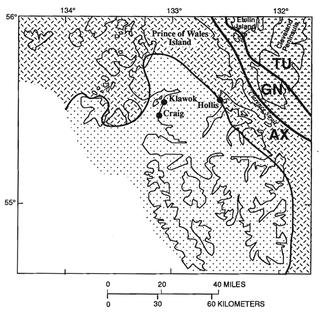

Figure 1. Physiographic divisions (Wahrhaftig, 1965) and tectonostratigraphic terranes (Berg and others, 1972, 1978; Monger and Berg, 1987) of the Craig study area, southeast Alaska.

INDEX MAP SHOWING LOCATIONS OF THE CRAIG, DIXON ENTRANCE, AND WESTERN EDGES OF THE KETCHIKAN AND PRINCE RUPERT QUADRANGLES

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