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Reconnaissance Geology and Exploration Geochemistry of King Cove, Alaska Peninsula

by

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ABSTRACT

Volcanic sandstone and black coaly shale at Indian Head and northwest of Indian Head in Belkofski Bay, originally called (in part) the "arkose" unit and (in part) the Belkofski Tuff, and later assigned to the Belkofski Formation are herein reassigned to the Stepovak Formation. Volcanic and volcaniclastic sedimentary rocks on the west shore of Deer Island, previously designated as Tachilni(?) Formation are herein assigned to the Unga Formation.

The Belkofski Formation consists of the same volcanic and volcaniclastic sedimentary rock lithologies as the Unga Formation but is contact metamorphosed. As mapped the Belkofski Formation occurs near plutons whereas the Unga Formation tends to be distant from plutons. The Unga and Belkofski Formations are not known to be in contact, however both overlie the Stepovak Formation. We suggest that the Belkofski Formation may be contact-metamorphosed Unga Formation.

The quartz diorite pluton in the vicinity of King Cove has a greater areal extent than previously mapped. The roof of the pluton contacts the Belkofski Formation at the high tide line of King Cove. Volcanic intrusive centers shown on ridge crests in the vicinity of King Cove may be components of the Belkofski Formation or may be equivalent to Miocene volcanic rocks to the northeast.

Geochemical analyses show low level Pb and other metal anomalies at the contact of the King Cove pluton and the Belkofski Formation.

INTRODUCTION

Five days of field work in the King Cove vicinity was done in July of 1988 as part of the Regional Alaska Mineral Resource Assessment Program (RAMRAP) for the Alaska Peninsula. King Cove is located near the southwestern end of the Alaska Peninsula, approximately 1000 km southwest of Anchorage, Alaska (fig. 1). Field work was accomplished primarily by road work and foot traverses along ridges and beaches, with limited helicopter support. Previous geologic mapping in the area was by Kennedy and Waldron (1955), Waldron (1961), Burk (1965), and McLean and others (1978).

We suggest several revisions to the above referenced geologic maps in the King Cove vicinity; these revisions are shown on the accompanying geologic map (fig. 2). The position and correlation of the Belkofski Formation is one of the outstanding problems in the Tertiary stratigraphy of the Alaska Peninsula. Data collected as part of this project provide some evidence to clarify the relation of the Belkofski to other stratigraphic units on the Alaska Peninsula.

Seventy three rock samples were collected for semi-quantitative geochemical analysis and the analytical results are included in this report (table 1).

GEOLOGY and DISCUSSION

Stepovak Formation

Strata that outcrop at Indian Head and along the shore northwest of Indian Head on Belkofski Bay (fig. 2, locality A) consist of cross-bedded volcaniclastic sandstone with pebble conglomerate and olive-gray siltstone with plant fragments. The sandstone is tuffaceous, has blotchy green and white spots characteristic of laumontite, and is composed of low-angle tabular cross-bed sets with pebble conglomerate layers between bed sets. Some bed sets are bioturbated and some are interbedded with dark brown to black coaly siltstone with plant fragments and leaves. We interpret the environment of deposition as a beach fronting a swamp. These units were originally designated (in part) the "arkose" unit and (in part) the Belkofski Tuff by Kennedy and Waldron (1947, 1955); Burk (1965) and McLean and others (1979) later mapped these rocks as Belkofski Formation. We tentatively reassign these rocks to the Stepovak Formation on the basis of their distinct difference from other rocks assigned to the Belkofski Formation and their similarity to sandstone of the Stepovak Formation. These outcrops are approximately 50 kilometers southwest of the previously mapped limit of the Stepovak Formation.

Unga Formation

Rocks on the west shore of Deer Island, south of West Cape (fig. 2, locality B), consist of lahars, volcanic conglomerate, breccia, sandstone, and mudstone cut by basalt dikes. The lahars and conglomerate are composed of a volcanic mud matrix with well rounded volcanic clasts up to 25 centimeters in diameter. The volcanic mudstone varies in color from dark brown to green with some carbonaceous layers and sandy layers in cut and fill channels. The sandstone is volcanic, dark brown, with interbedded conglomerate and carbonaceous layers. These strata were mapped as Tertiary volcanic flows and breccias by Burk (1965) and as Tachilni(?) Formation by McLean and others (1978). The rocks are distinctly unlike those found at the type locality of the Tachilni Formation on Cape Tachilni. Below are descriptions of the Unga and Tachilni Formations from their type localities, adapted from Detterman and others (in press) for comparison.

The Unga Formation consists of volcaniclastic sedimentary rocks: sandstone, conglomerate, siltstone, mudstone, shale, carbonaceous shale, debris flows and coal seams. The sandstone varies from light olive brown to yellowish gray, is fine- to coarse-grained and contains some pebble clasts. It is locally interbedded with siltstone, shale and carbonaceous shale. The lahars are massive, with volcanic mud matrices and angular volcanic clasts varying from pebble to boulder size. Thin marine sediments intertongued with thick non-marine sediments locally contain abundant molluscan fauna of early middle Miocene age (Detterman and others, in press).

The Tachilni Formation consists mainly of fossil-rich, poorly consolidated, marine, subgreywacke sandstone, interbedded with volcanic pebble conglomerate and siltstone. The sandstone is gray to brown, fine- to medium-grained, cross-bedded with pebble layers, and is composed of 30-35 percent angular quartz, 10-15 percent feldspar, 5 percent pyroxene and amphibole, and 30 percent volcanic rock fragments. The pebble conglomerate is thick-bedded to massive with a sand matrix. Both the sandstone and conglomerate contain mollusks of late Miocene age (Detterman and others, in press).

The Deer Island volcaniclastic sedimentary rocks consist of volcanic sandstone, carbonaceous shale, lahars and conglomerates with large volcanic clasts. The Unga Formation is composed of virtually the same materials, whereas the Tachilni Formation is fossil-rich and consists of a poorly consolidated subgreywacke sandstone with interbedded pebble conglomerate. We suggest assignment of these rocks to the Unga Formation on the basis of their lithlogic similarity.

Belkofski Formation

Originally named the Belkofski Tuff by Kennedy and Waldron (1955), later called the Belkofski Formation by Burk (1965); this unit is characterized by beds of volcanic agglomerate, breccia, tuff, sandstone and conglomerate. It is commonly intensely silicified and sericitized where near intrusive contacts. Color ranges from gray to green and includes a distinctive purple. Rocks of the Belkofski Formation have been mapped from Cold Bay to Pavlof Bay (fig. 1). The age of the Belkofski Formation is uncertain. Fossils are rare and not age-diagnostic.

Detterman and others (in press) tentatively correlate the Belkofski Formation with either the Unga Formation or the Stepovak Formation on the basis of lithology. The rocks of the Belkofski Formation that Detterman and others (in press) tentatively correlate with the Stepovak Formation are the outcrops near Indian Head discussed above. The remaining rocks of the Belkofski Formation except for their alteration, have many lithologic similarities with the Unga Formation. We suggest in this report that the Belkofski Formation is hydrothermally altered and contact metamorphosed Unga Formation.

The Stepovak Formation underlies the Belkofski Formation (this report) and also unconformably underlies the Unga Formation. The Belkofski and Unga Formations are not seen in contact; however, the recognition of Unga Formation on Deer Island indicates that the Belkofski Formation lies entirely within the Unga depositional basin. The major outcrop areas of Belkofski Formation are all in near proximity to plutonic rocks and have been contact metamorphosed and hydrothermally altered, which is uncharacteristic of the Unga Formation. Contact metamorphism of the Unga Formation would yield rocks similar in character to the Belkofski Formation. Therefore, we suggest that the Belkofski Formation is altered Unga Formation.

Intrusive Rocks

A quartz diorite pluton intrudes the Belkofski Formation in the vicinity of King Cove and King Cove Lagoon. Its composition ranges from quartz diorite to hornblende quartz diorite, and it is locally hydrothermally altered. No age determinations are available from this pluton; however, the Moss Cape pluton to the east is a similar quartz diorite body intruding the Belkofski Formation; a potassium-argon age determination of 3.21 ± 0.14 Ma was obtained on biotite (DuBois and others, 1987) from this pluton. Another diorite body intruding the Belkofski Formation on Deer Island has a potassium-argon age of 6.00 ± 0.20 Ma on plagioclase (Hugh McLean, written commun., 1986). However, plagioclase is generally considered of marginal utility in dating of intrusive rocks, due to argon loss, hence the date on the Deer Island diorite may be considered a minimum age. The similar composition of these intrusive bodies and that they intrude the Belkofski Formation suggests a similar late Miocene or Pliocene age for the King Cove pluton. Plutons of similar age are well known on the Alaska Peninsula to the northeast (Wilson and others, 1983; F.H. Wilson and Nora Shew, unpublished data, 1989).

The King Cove pluton has greater areal extent than previously mapped. The contact of the quartz diorite pluton with the Belkofski Formation continues south of King Cove Lagoon along the high tide line of King Cove. Both the pluton and Belkofski Formation contain disseminated sulfides and minor sulfide-bearing quartz veins near their contact.

Mafic (andesitic?) dikes cut the Belkofski Formation but the exposures are not adequate to indicate whether the dikes cut the pluton. However, the mafic dikes are not mineralized as are the quartz diorite pluton and the Belkofski Formation, suggesting that the dikes are younger than the main intrusive phase.

Burk (1965) and McLean and others (1978) both show a number of volcanic intrusive centers within the Belkofski Formation on the ridges east and west of King Cove. Capping the ridge, east of King Cove is a volcanic unit mapped as a volcanic intrusive center by Burk (1965) and McLean and others (1978). However it does not appear to us to be an intrusive feature, but rather an eroded remnant of a volcanic flow. These volcanic rocks may be a part of the Belkofski Formation or equivalent to the Miocene volcanic rocks found to the east. Perhaps other volcanic intrusive centers in the King Cove area shown by Burk (1965) and McLean and others (1978) are this same type of volcanic unit. Other volcanic flows which occurred as valley fills but now, due to erosion and reversal of topography, form ridge crests, were mapped by Burk (1965) as volcanic intrusive centers elsewhere on the Alaska Peninsula (F.H. Wilson and others, unpublished data).

GEOCHEMICAL SAMPLING

Seventy-one rock samples from the King Cove vicinity were analyzed using 6-step semi-quantitative emission spectrography as described by Grimes and Marazino (1968), and by atomic absorption spectrophotometry (table 1). Sample data included coding for source, rock type, and other characteristics (table 2) to facilitate statistical analysis. The samples were analyzed for 35 elements (with lower level determination levels shown in table 3). No samples had detectable levels of gold (Au), antimony (Sb), germanium (Ge), thorium (Th), or tungsten (W) and these elements, though analyzed, are not shown in the table of analytical results (table 3).

Samples collected as part of this project were compared to thresholds calculated from data for 2708 samples from the adjacent Port Moller and Stepovak Bay quadrangles (Angeloni and others, 1985; Wilson and others, 1987). The ninetieth percentile for each metal for all rock types was used as the anomalous threshold for the rocks from King Cove. Sixteen samples had anomalous amounts of various metals (table 4). Eight of the anomalous samples are from near the contact between the pluton and the Belkofski Formation.

CONCLUSIONS

We have herein tentatively reassigned the bedrock exposures northwest of Indian Head to the Stepovak Formation of Burk (1965). This is the first recognition of rocks of this age and stratigraphic position in the Cold Bay quadrangle. The nearest other exposures of this formation occur 50 kilometers to the northwest.

The recognition herein of the Unga Formation on the west side of Deer Island indicates that the known outcrop area of the Belkofski Formation lies entirely within the Unga depositional basin. Nevertheless, we know of no place where the Belkofski and Unga are in contact. In all areas we have examined, the Belkofski Formation occurs in close proximity to large plutons, for example the King Cove pluton. Our preferred age for the Belkofski is the same as that for the Unga. We therefore suggest that the Belkofski Formation, though a distinct mappable unit, is hydrothermally altered and contact metmorphosed Unga Formation.

We have found the King Cove pluton to have a larger areal extent than has been previously shown. The nearly ubiquitous hydrothermal alteration, the development of sulfide veins, and occurrence of disseminated sulfides and low level Pb anomalies in its contact zone with the country rock indicates mineral potential.

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Table 1. Analytical results of rock geochemistry samples from King Cove, Alaska. Results are in ppm except for Fe, Mg, P, Ca, Ti, which are in percent. Analysts were R.T. Hopkins, Z.O. Brown and E.A. Bailey. Sample coding is shown in table 2, and the lower limits of determination for each element is shown in table 3. Elements analyzed by atomic absorption spectrophotometry methods are shown by adding -AA to the element symbols (i.e. Sb-AA, table 3).

Sample number	Lat. N	Long. W	Sample type	Sample source	Rock class	Quad	FC3	FC4	Form	Rock type
88Dg1	550431	1621315	A	A	D	A-1	A	B	E	Q
88Dg2a	550444	1621227	A	A	D	A-1	A	A	B	M
88Dg2b	550444	1621227	A	A	D	A-1	A	B	B	M
88Dg2c	550444	1621227	A	A	D	A-1	A	B	E	Z
88Dg3	550452	1621227	A	A	D	A-1	A	A	B	M
88Dg4	550513	1621835	A	A	D	A-1	A	D	D	Q
88Dg5	550510	1621838	A	D	D	A-1	A	D	D	Q
88Dg6	550339	1621813	A	A	D	A-1	A	A	A	L
88Dg7	550316	1621938	A	A	D	A-1	A	D	B	K
88Dg7a	550316	1621938	A	A	D	A-1	A	D	E	Q
88Dg8	550306	1621943	A	A	D	A-1	A	B	D	N
88Dg9	550259	1621946	A	A	D	A-1	A	B	E	Z
88Dg9a	550259	1621946	A	A	D	A-1	A	D	D	Q
88Dg10	550250	1621946	A	A	D	A-1	A	B	E	L
88Dg11	550337	1621807	A	A	D	A-1	A	A	F	L
88Dg12	550335	1621756	A	A	D	A-1	A	A	F	L
88Dg13	550332	1621750	A	D	D	A-1	A	D	F	L
88Dg14	550332	1621747	A	A	D	A-1	A	D	B	M
88Dg15	550337	1621744	A	A	D	A-1	A	A	B	Z
88Dg16	550325	1621749	A	A	D	A-1	A	A	B	Z
88Dg17	550316	1621756	A	A	Y	A-1	A	B	G	Z
88Dt1	550601	1621510	B	A	D	A-1	A	A	A	K
88Dt2	550558	1621531	A	A	D	A-1	A	A	A	K
88Dt3	550602	1621455	A	A	D	A-1	A	A	A	M
88Dt4	550606	1621430	A	A	D	A-1	A	A	A	M

Table 1 (cont.). Analytical results of rock geochemistry samples from King Cove, Alaska.

Sample number	Lat. N	Long. W	Sample type	Sample source	Rock class	Quad	FC3	FC4	Form	Rock type
88Dt5	550615	1621341	B	A	B	A-1	A	A	A	C
88Dt6	550603	1621331	B	A	B	A-1	A	A	A	A
88Dt7	550548	1621305	B	A	B	A-1	A	A	A	B
88Dt9a	550312	1621821	A	A	C	A-1	A	D	A	Z
88Dt9b	550312	1621821	A	A	D	A-1	A	B	D	Q
88Dt10c	550238	1621805	A	A	Y	A-1	A	D	G	Z
88Dt11	550238	1621805	A	A	D	A-1	A	A	D	Q
88Dt12	550221	1621800	A	A	D	A-1	A	D	D	Z
88Dt15	545506	1622515	A	A	D	D-2	A	A	A	Z
88Dt16	545448	1622530	A	A	B	D-2	A	A	A	K
88Dt17	545433	1622521	A	A	B	D-2	A	A	A	Z
88Dt19	545348	1622459	B	A	B	D-2	A	A	A	C
88Dt20	545828	1621645	A	A	D	D-1	A	A	A	K
88Dt21	545837	1621649	A	A	D	D-1	A	A	D	Q
88Ws1a	550423	1621335	A	A	C	A-1	A	A	A	M
88Ws1b	550423	1621335	A	A	D	A-1	A	B	E	Q
88Ws2a	550426	1621326	A	A	D	A-1	A	A	F	M
88Ws2b	550426	1621326	A	A	D	A-1	A	B	F	M
88Ws4a	550520	1621201	A	A	D	A-1	A	A	F	L
88Ws4b	550520	1621201	A	A	Y	A-1	A	C	G	Z
88Ws5a	550514	1621840	A	A	C	A-1	A	A	A	Z
88Ws5b	550514	1621840	A	A	D	A-1	A	D	D	Q
88Ws6a	550511	1621840	A	A	D	A-1	A	A	D	Q
88Ws6b	550511	1621840	A	A	D	A-1	A	D	D	Q
88Ws7	550654	1621739	A	A	D	A-1	A	A	F	M

Table 1 (cont.). Analytical results of rock geochemistry samples from King Cove, Alaska.

Sample number	Lat. N	Long. W	Sample type	Sample source	Rock class	Quad	FC3	FC4	Form	Rock type
88Ws8a	550654	1621730	A	A	C	A-1	A	B	A	Z
88Ws8b	550654	1621730	A	A	D	A-1	A	A	B	Q
88Ws8c	550654	1621730	A	A	D	A-1	A	B	F	L
88Ws9	550654	1621705	A	A	D	A-1	A	A	F	L
88Ws10a	550647	1621654	A	A	D	A-1	A	A	D	N
88Ws10b	550647	1621654	A	A	C	A-1	D	A	A	Z
88Ws10c	550647	1621654	A	A	C	A-1	A	C	A	Z
88Ws11	550640	1621708	A	A	D	A-1	A	A	A	K
88Ws11b	550640	1621708	A	A	D	A-1	A	A	A	K
88Ws12	550413	1621813	A	A	D	A-1	A	A	D	N
88Ws13	550402	1621937	A	A	D	A-1	A	D	E	L
88Ws14	550359	1621938	A	A	D	A-1	A	A	D	N
88Ws15	550353	1621939	A	A	D	A-1	A	A	D	N
88Ws16	550350	1621938	A	A	D	A-1	A	A	D	N
88Ws17	545522	1622519	A	A	D	D-2	A	A	B	L
88Ws18	545453	1622527	A	A	D	D-2	A	C	E	J
88Ws19	545712	1622510	A	A	D	D-2	A	A	B	J
88Ws20a	545509	1621529	A	A	D	D-1	A	B	B	L
88Ws20b	545509	1621529	A	A	D	D-1	A	B	F	L
88Ws21a	545436	1625040	A	A	D	D-1	A	A	F	K
88Ws21b	545436	1625040	A	A	Y	D-1	A	D	H	Z

Table 1 (cont.). Analytical results of rock geochemistry samples from King Cove, Alaska.

Sample number	Fe	Mg	Na	P	Ca	Ti	Ag	As	As-AA	B	Ba	Be	Bi
88Dg1a	2.00	0.70	2.00	N	1.00	0.30	N	N	60.00	<10.00	700.00	1.00	N
88Dg2a	3.00	1.50	2.00	N	1.00	0.50	N	N	10.00	<10.00	500.00	<1.00	N
88Dg2b	5.00	1.00	2.00	<0.20	0.70	0.50	N	N	10.00	N	500.00	1.00	N
88Dg2c	5.00	1.50	2.00	N	2.00	0.50	N	N	<10.00	N	500.00	<1.00	N
88Dg3	3.00	1.00	2.00	<0.20	1.50	0.50	N	N	<10.00	10.00	500.00	1.00	N
88Dg4	5.00	1.50	1.50	N	2.00	0.50	N	N	<10.00	50.00	500.00	<1.00	N
88Dg5	5.00	1.50	2.00	N	3.00	0.50	N	N	<10.00	20.00	700.00	<1.00	N
88Dg6	5.00	1.50	2.00	N	3.00	0.50	N	N	<10.00	N	150.00	<1.00	N
88Dg7	5.00	1.50	2.00	<0.20	2.00	0.50	N	N	<10.00	<10.00	200.00	<1.00	N
88Dg7a	5.00	1.50	1.50	N	3.00	0.50	N	N	<10.00	N	300.00	<1.00	N
88Dg8	3.00	1.50	1.50	N	3.00	0.50	N	N	<10.00	N	700.00	<1.00	N
88Dg9	3.00	1.50	2.00	N	3.00	0.50	N	N	<10.00	<10.00	700.00	<1.00	N
88Dg9a	5.00	2.00	1.50	N	5.00	0.50	N	N	<10.00	N	30.00	N	N
88Dg10	5.00	1.50	2.00	N	2.00	0.50	N	N	<10.00	N	500.00	N	N
88Dg11	3.00	1.50	2.00	N	2.00	0.30	N	N	<10.00	<10.00	300.00	<1.00	N
88Dg12	5.00	2.00	1.50	N	3.00	0.50	N	N	<10.00	<10.00	300.00	<1.00	N
88Dg13	3.00	1.50	2.00	N	1.50	0.30	N	N	<10.00	10.00	500.00	<1.00	N
88Dg14	5.00	1.50	2.00	N	2.00	0.50	N	N	<10.00	15.00	700.00	<1.00	N
88Dg15	3.00	1.50	2.00	N	2.00	0.30	N	N	<10.00	N	500.00	<1.00	N
88Dg16	5.00	1.50	2.00	N	3.00	0.50	N	N	<10.00	N	300.00	<1.00	N
88Dg17	3.00	0.70	1.50	N	3.00	0.50	N	N	<10.00	<10.00	300.00	<1.00	N
88Dt1	5.00	1.00	2.00	N	1.50	0.50	N	N	<10.00	N	200.00	<1.00	N
88Dt2	7.00	2.00	3.00	N	2.00	0.50	N	N	<10.00	N	150.00	N	N
88Dt3	5.00	1.00	1.50	N	3.00	0.70	N	N	<10.00	N	300.00	1.50	N
88Dt4	5.00	1.50	2.00	N	3.00	0.50	N	N	<10.00	<10.00	500.00	1.50	N

Table 1 (cont.). Analytical results of rock geochemistry samples from King Cove, Alaska.

Sample number	Fe	Mg	Na	P	Ca	Ti	Ag	As	As-AA	B	Ba	Be	Bi
88Dt5	7.00	2.00	3.00	N	3.00	1.00	N	N	<10.00	N	100.00	N	N
88Dt6	5.00	1.00	2.00	<0.20	1.50	0.50	N	N	<10.00	<10.00	500.00	1.00	N
88Dt7	5.00	1.50	2.00	N	1.00	0.30	N	N	<10.00	10.00	700.00	1.00	N
88Dt9a	5.00	2.00	1.50	N	1.50	0.5	N	N	<10.00	N	300.00	<1.00	N
88Dt9b	5.00	1.50	2.00	N	5.00	0.5	N	N	<10.00	<10.00	200.00	<1.00	N
88Dt10c	7.00	2.00	2.00	N	5.00	0.7	0.30	N	<10.00	10.00	300.00	<1.00	10.00
88Dt11	5.00	1.50	2.00	N	5.00	0.50	N	N	<10.00	N	300.00	<1.00	N
88Dt12	5.00	0.70	1.00	N	3.00	0.50	N	N	<10.00	20.00	150.00	1.50	N
88Dt15	5.00	2.00	2.00	N	3.00	0.50	N	N	<10.00	N	200.00	<1.00	N
88Dt16	7.00	10.00	2.00	N	3.00	0.50	N	N	<10.00	N	150.00	N	N
88Dt17	7.00	1.50	3.00	N	3.00	1.00	N	N	<10.00	10.00	150.00	<1.00	N
88Dt19	7.00	1.50	3.00	<0.20	3.00	0.70	N	N	<10.00	N	150.00	<1.00	N
88Dt20	3.00	1.00	2.00	<0.20	1.00	0.50	N	N	<10.00	N	200.00	1.50	N
88Dt21	7.00	2.00	1.50	N	7.00	0.30	N	N	<10.00	N	200.00	<1.00	N
88Ws1a	5.00	0.15	N	N	7.00	0.30	N	N	60.00	10.00	<20.00	2.00	N
88Ws1b	5.00	1.50	1.50	N	2.00	0.30	N	N	<10.00	N	500.00	N	N
88Ws2a	7.00	1.50	3.00	<0.20	2.00	1.00	N	N	<10.00	<10.00	500.00	<1.00	N
88Ws2b	3.00	0.50	1.00	N	3.00	0.30	N	N	<10.00	<10.00	70.00	1.00	N
88Ws4a	7.00	1.50	3.00	N	1.50	0.50	N	N	<10.00	10.00	500.00	<1.00	N
88Ws4b	0.70	0.30	<0.20	N	15.00	0.07	N	N	<10.00	10.00	300.00	<1.00	N
88Ws5a	5.00	2.00	1.00	N	7.00	0.07	N	N	20.00	<10.00	500.00	<1.00	N
88Ws5b	5.00	1.50	1.50	N	3.00	0.70	N	N	<10.00	10.00	500.00	<1.00	N
88Ws6a	5.00	1.50	2.00	N	3.00	0.70	N	N	<10.00	10.00	500.00	<1.00	N
88Ws6b	3.00	1.50	1.50	N	3.00	0.30	N	N	<10.00	<10.00	500.00	1.00	N
88Ws7	7.00	1.50	5.00	N	0.70	0.70	N	N	<10.00	<10.00	70.00	<1.00	N

Table 1 (cont.). Analytical results of rock geochemistry samples from King Cove, Alaska.

Sample number	Fe	Mg	Na	P	Ca	Ti	Ag	As	As-AA	B	Ba	Be	Bi
88Ws8a	7.00	0.70	1.50	N	1.50	1.00	N	N	<10.00	10.00	300.00	<1.00	N
88Ws8b	7.00	2.00	2.00	N	7.00	0.50	N	N	<10.00	<10.00	200.00	N	N
88Ws8c	5.00	2.00	1.50	N	7.00	0.50	N	N	<10.00	<10.00	200.00	N	N
88Ws9	5.00	2.00	2.00	N	7.00	0.50	N	N	<10.00	<10.00	300.00	N	N
88Ws10a	7.00	1.50	1.50	N	5.00	0.70	N	N	<10.00	<10.00	150.00	N	N
88Ws10b	2.00	0.70	1.50	N	0.50	0.70	N	N	<10.00	15.00	500.00	1.50	N
88Ws10c	5.00	0.70	1.50	<0.20	1.50	0.50	N	N	<10.00	<10.00	500.00	1.00	N
88Ws11	7.00	1.50	2.00	N	1.50	0.70	N	N	<10.00	20.00	70.00	<1.00	N
88Ws11b	7.00	1.50	2.00	N	0.30	0.70	N	N	40.00	10.00	50.00	<1.00	N
88Ws12	5.00	1.50	2.00	N	3.00	0.50	N	N	<10.00	10.00	700.00	<1.00	N
88Ws13	7.00	2.00	1.50	N	5.00	0.50	N	N	10.00	<10.00	200.00	<1.00	N
88Ws14	7.00	1.50	2.00	N	7.0	0.50	N	N	<10.00	N	300.00	<1.00	N
88Ws15	7.00	2.00	2.00	N	5.00	0.70	N	N	10.00	<10.00	300.00	N	N
88Ws16	5.00	2.00	2.00	N	5.00	0.50	N	N	<10.00	<10.00	300.00	N	N
88Ws17	5.00	1.50	3.00	N	2.00	0.70	N	N	<10.00	<10.00	300.00	<1.00	N
88Ws18	5.00	2.00	3.00	N	5.00	0.70	N	N	<10.00	N	500.00	<1.00	N
88Ws19	5.00	2.00	2.00	<0.20	5.00	0.70	N	N	<10.00	<10.00	300.00	<1.00	N
88Ws20a	5.00	1.50	2.00	<0.20	3.00	0.70	N	N	<10.00	<10.00	1000.00	<1.00	N
88Ws20b	5.00	3.00	2.00	<0.20	7.00	0.50	N	N	<10.00	N	150.00	<1.00	N
88Ws21a	5.00	1.50	2.00	<0.20	1.50	0.50	N	N	10.00	<10.00	500.00	<1.00	N
88Ws21b	3.00	0.30	2.00	<0.20	0.30	0.50	N	N	30.00	<10.00	300.00	1.50	N

Table 1 (cont.). Analytical results of rock geochemistry samples from King Cove, Alaska.

Sample number	Bi-AA	Cd	Cd-AA	Co	Cr	Cu	Ga	La	Mn	Mo	Nb	Ni
88Dg1a	1.00	N	1.00	<10.00	<10.00	20.00	20.00	<50.00	700.00	N	N	<5.00
88Dg2a	<1.00	N	<0.10	10.00	50.00	20.00	20.00	<50.00	1000.00	N	N	7.00
88Dg2b	<1.00	N	<0.10	15.00	70.00	20.00	20.00	<50.00	1000.00	N	N	7.00
88Dg2c	1.00	N	<0.10	20.00	50.00	30.00	30.00	<50.00	1000.00	N	N	<5.00
88Dg3	<1.00	N	0.10	20.00	50.00	50.00	30.00	<50.00	1000.00	N	N	15.00
88Dg4	<1.00	N	0.10	20.00	30.00	30.00	30.00	<50.00	1000.00	N	N	<5.00
88Dg5	1.00	N	0.10	15.00	15.00	30.00	30.00	<50.00	1000.00	N	N	<5.00
88Dg6	1.00	N	<0.10	20.00	20.00	30.00	30.00	<50.00	1500.00	N	N	<5.00
88Dg7	<1.00	N	<0.10	15.00	30.00	70.00	20.00	<50.00	1000.00	N	N	<5.00
88Dg7a	<1.00	N	<0.10	15.00	50.00	30.00	30.00	<50.00	1000.00	N	N	<5.00
88Dg8	<1.00	N	0.20	15.00	N	20.00	30.00	<50.00	1000.00	N	N	<5.00
88Dg9	<1.00	N	<0.10	20.00	50.00	20.00	30.00	<50.00	1000.00	N	N	7.00
88Dg9a	<1.00	N	<0.10	50.00	100.00	70.00	20.00	N	1000.00	N	N	20.00
88Dg10	<1.00	N	<0.10	20.00	10.00	30.00	30.00	<50.00	1000.00	N	N	<5.00
88Dg11	<1.00	N	<0.10	20.00	10.00	20.00	20.00	<50.00	1000.00	N	N	<5.00
88Dg12	1.00	N	<0.10	30.00	100.00	50.00	20.00	<50.00	1500.00	N	N	15.00
88Dg13	<1.00	N	<0.10	20.00	30.00	<5.00	20.00	<50.00	1000.00	N	N	5.00
88Dg14	<1.00	N	0.10	20.00	30.00	5.00	30.00	<50.00	1000.00	N	N	<5.00
88Dg15	1.00	N	0.10	15.00	10.00	20.00	30.00	<50.00	1000.00	N	N	<5.00
88Dg16	1.00	N	0.10	20.00	30.00	30.00	20.00	<50.00	1000.00	N	N	<5.00
88Dg17	1.00	N	<0.10	10.00	20.00	30.00	20.00	<50.00	500.00	N	N	<5.00
88Dt1	<1.00	N	<0.10	15.00	20.00	30.00	30.00	<50.00	1000.00	N	<20.00	<5.00
88Dt2	<1.00	N	<0.10	20.00	50.00	50.00	30.00	N	1000.00	N	N	5.00
88Dt3	<1.00	N	<0.10	10.00	50.00	20.00	30.00	<50.00	1000.00	N	<20.00	<5.00
88Dt4	<1.00	N	0.10	10.00	15.00	30.00	50.00	<50.00	1000.00	N	<20.00	<5.00

Table 1 (cont.). Analytical results of rock geochemistry samples from King Cove, Alaska.

Sample number	Bi-AA	Cd	Cd-AA	Co	Cr	Cu	Ga	La	Mn	Mo	Nb	Ni
88Dt5	<1.00	N	<0.10	30.00	<10.00	70.00	30.00	<50.00	1500.00	N	<20.00	5.00
88Dt6	<1.00	N	<0.10	15.00	50.00	15.00	30.00	<50.00	1000.00	N	<20.00	7.00
88Dt7	<1.00	N	<0.10	10.00	50.00	20.00	30.00	N	700.00	N	N	10.00
88Dt9a	<1.00	N	0.10	15.00	50.00	100.00	30.00	N	1500.00	N	N	10.00
88Dt9b	<1.00	N	0.10	20.00	30.00	30.00	50.00	N	1500.00	N	N	<5.00
88Dt10c	1.00	N	0.90	20.00	70.00	7.00	30.00	N	1000.00	N	N	20.00
88Dt11	<1.00	N	<0.10	15.00	<10.00	30.00	30.00	N	1500.00	N	N	<5.00
88Dt12	1.00	N	0.10	10.00	70.00	30.00	50.00	<50.00	300.00	N	<20.00	5.00
88Dt15	<1.00	N	<0.10	20.00	150.00	30.00	20.00	<50.00	1000.00	N	N	20.00
88Dt16	<1.00	N	<0.10	30.00	1000.00	50.00	20.00	N	1000.00	N	N	150.00
88Dt17	<1.00	N	0.20	20.00	30.00	50.00	30.00	N	1000.00	N	<20.00	15.00
88Dt19	<1.00	N	0.20	20.00	30.00	50.00	30.00	N	1000.00	N	<20.00	<5.00
88Dt20	<1.00	N	0.10	<10.00	20.00	20.00	30.00	<50.00	1000.00	N	<20.00	N
88Dt21	<1.00	N	<0.10	30.00	150.00	50.00	20.00	<50.00	1000.00	N	N	50.00
88Ws1a	3.00	N	1.80	N	<10.00	10.00	50.00	N	2000.00	<5.00	N	5.00
88Ws1b	2.00	N	0.20	30.00	70.00	50.00	30.00	N	700.00	N	N	20.00
88Ws2a	<1.00	N	0.20	30.00	15.00	30.00	50.00	N	1000.00	N	N	15.00
88Ws2b	1.00	N	2.10	10.00	30.00	50.00	20.00	<50.00	1500.00	15.00	N	7.00
88Ws4a	2.00	N	0.20	20.00	100.00	20.00	50.00	N	700.00	N	N	20.00
88Ws4b	<1.00	N	<0.10	N	15.00	20.00	N	<50.00	2000.00	N	N	<5.00
88Ws5a	1.00	N	0.40	30.00	70.00	50.00	20.00	<50.00	1000.00	N	N	20.00
88Ws5b	1.00	N	0.10	20.00	20.00	30.00	30.00	<50.00	1000.00	N	N	<5.00
88Ws6a	2.00	N	0.10	20.00	30.00	30.00	30.00	<50.00	1000.00	N	N	5.00
88Ws6b	<1.00	N	<0.10	15.00	30.00	30.00	30.00	<50.00	700.00	N	N	<5.00
88Ws7	3.00	N	0.30	30.00	50.00	50.00	50.00	<50.00	1000.00	N	N	15.00

Table 1 (cont.). Analytical results of rock geochemistry samples from King Cove, Alaska.

Sample number	Bi-AA	Cd	Cd-AA	Co	Cr	Cu	Ga	La	Mn	Mo	Nb	Ni
88Ws8a	2.00	N	0.20	30.00	100.00	70.00	30.00	<50.00	1000.00	N	N	20.00
88Ws8b	<1.00	N	0.10	30.00	20.00	30.00	50.00	N	1000.00	N	N	15.00
88Ws8c	2.00	N	<0.10	30.00	50.00	30.00	30.00	N	1000.00	N	N	15.00
88Ws9	2.00	N	<0.10	30.00	100.00	30.00	30.00	N	1000.00	N	N	20.00
88Ws10a	3.00	N	0.10	30.00	30.00	30.00	20.00	N	1000.00	N	N	7.00
88Ws10b	1.00	N	0.10	15.00	30.00	30.00	30.00	<50.00	700.00	N	N	7.00
88Ws10c	1.00	N	0.10	15.00	30.00	20.00	30.00	<50.00	1000.00	N	N	5.00
88Ws11	<1.00	N	0.10	20.00	50.00	30.00	30.00	N	1000.00	N	N	15.00
88Ws11b	<1.00	N	<0.10	30.00	70.00	50.00	30.00	N	1000.00	N	N	20.00
88Ws12	1.00	N	<0.10	20.00	15.00	30.00	30.00	<50.00	1000.00	N	N	<5.00
88Ws13	2.00	N	0.40	30.00	70.00	30.00	20.00	<50.00	1500.00	N	N	10.00
88Ws14	2.00	N	0.10	20.00	N	50.00	30.00	<50.00	700.00	N	N	<5.00
88Ws15	<1.00	N	0.10	30.00	70.00	50.00	30.00	N	1000.00	N	N	10.00
88Ws16	<1.00	N	<0.10	30.00	50.00	30.00	30.00	N	1000.00	N	N	7.00
88Ws17	1.00	N	0.10	20.00	<10.00	30.00	50.00	<50.00	700.00	N	N	N
88Ws18	<1.00	N	0.10	30.00	100.00	50.00	30.00	<50.00	1000.00	N	N	30.00
88Ws19	1.00	N	<0.10	30.00	100.00	30.00	30.00	<50.00	1000.00	N	N	50.00
88Ws20a	2.00	N	0.10	20.00	100.00	30.00	30.00	<50.00	700.00	N	N	10.00
88Ws20b	<1.00	N	0.10	30.00	150.00	50.00	50.00	<50.00	1000.00	N	N	30.00
88Ws21a	<1.00	N	0.10	20.00	30.00	20.00	30.00	<50.00	1000.00	N	N	5.00
88Ws21b	<1.00	N	0.20	<10.00	<10.00	7.00	30.00	<50.00	500.00	N	<20.00	N

Table 1 (cont.). Analytical results of rock geochemistry samples from King Cove, Alaska.

Sample number	Pb	Sb-AA	Sc	Sn	Sr	V	Y	Zn	Zn-AA	Zr
88Dg1a	20.00	<2.00	5.00	N	300.00	70.00	20.00	N	85.00	150.00
88Dg2a	30.00	<2.00	15.00	N	300.00	100.00	20.00	<200.00	95.00	150.00
88Dg2b	15.00	<2.00	20.00	N	300.00	150.00	20.00	<200.00	90.00	150.00
88Dg2c	20.00	<2.00	20.00	N	500.00	200.00	30.00	N	80.00	150.00
88Dg3	20.00	<2.00	20.00	N	300.00	150.00	30.00	<200.00	90.00	
88Dg4	20.00	<2.00	20.00	N	300.00	150.00	30.00	N	40.00	150.00
88Dg5	30.00	<2.00	20.00	N	300.00	150.00	30.00	<200.00	75.00	150.00
88Dg6	30.00	<2.00	20.00	N	300.00	150.00	30.00	<200.00	40.00	150.00
88Dg7	20.00	<2.00	20.00	N	300.00	150.00	30.00	<200.00	75.00	150.00
88Dg7a	20.00	<2.00	20.00	20.00	300.00	150.00	20.00	<200.00	45.00	100.00
88Dg8	20.00	<2.00	15.00	N	300.00	150.00	30.00	<200.00	50.00	100.00
88Dg9	20.00	<2.00	20.00	N	300.00	150.00	30.00	<200.00	35.00	150.00
88Dg9a	20.00	<2.00	20.00	N	500.00	200.00	30.00	<200.00	30.00	70.00
88Dg10	20.00	<2.00	20.00	N	700.00	200.00	30.00	N	55.00	100.00
88Dg11	20.00	<2.00	15.00	N	700.00	150.00	30.00	<200.00	30.00	100.00
88Dg12	15.00	<2.00	20.00	N	500.00	200.00	20.00	N	35.00	70.00
88Dg13	20.00	<2.00	15.00	50.00	300.00	150.00	20.00	<200.00	60.00	100.00
88Dg14	20.00	<2.00	15.00	N	300.00	150.00	30.00	N	80.00	150.00
88Dg15	30.00	<2.00	15.00	N	300.00	150.00	30.00	N	50.00	150.00
88Dg16	20.00	<2.00	20.00	N	300.00	150.00	30.00	N	25.00	150.00
88Dg17	20.00	<2.00	20.00	N	300.00	150.00	30.00	<200.00	35.00	150.00
88Dt1	15.00	<2.00	15.00	N	300.00	100.00	20.00	N	30.00	150.00
88Dt2	15.00	<2.00	20.00	N	500.00	200.00	20.00	N	80.00	70.00
88Dt3	20.00	<2.00	15.00	N	500.00	100.00	30.00	N	80.00	200.00
88Dt4	20.00	<2.00	15.00	N	500.00	100.00	30.00	N	20.00	200.00

Table 1 (cont.). Analytical results of rock geochemistry samples from King Cove, Alaska.

Sample number	Pb	Sb-AA	Sc	Sn	Sr	V	Y	Zn	Zn-AA	Zr
88Dt5	<10.00	<2.00	20.00	N	N	300.00	20.00	<200.00	85.00	100.00
88Dt6	20.00	<2.00	15.00	N	<100.00	150.00	20.00	N	80.00	100.00
88Dt7	20.00	<2.00	15.00	N	200.00	100.00	20.00	N	70.00	70.00
88Dt9a	15.00	<2.00	15.00	N	300.00	150.00	20.00	N	30.00	70.00
88Dt9b	15.00	<2.00	15.00	N	500.00	200.00	20.00	N	40.00	150.00
88Dt10c	200.00	<2.00	20.00	N	200.00	150.00	20.00	<200.00	110.00	100.00
88Dt11	50.00	<2.00	15.00	N	300.00	200.00	20.00	<200.00	65.00	100.00
88Dt12	10.00	<2.00	15.00	N	300.00	70.00	30.00	N	5.00	150.00
88Dt15	15.00	<2.00	20.00	N	500.00	150.00	20.00	N	60.00	100.00
88Dt16	10.00	<2.00	20.00	N	300.00	150.00	15.00	N	50.00	70.00
88Dt17	15.00	<2.00	20.00	N	500.00	200.00	30.00	N	75.00	100.00
88Dt19	15.00	<2.00	20.00	N	300.00	200.00	30.00	N	80.00	100.00
88Dt20	20.00	<2.00	15.00	N	300.00	100.00	30.00	N	70.00	150.00
88Dt21	20.00	<2.00	20.00	N	700.00	150.00	15.00	N	30.00	70.00
88Ws1a	200.00	2.00	15.00	N	700.00	500.00	15.00	<200.00	140.00	70.00
88Ws1b	20.00	<2.00	20.00	N	300.00	150.00	20.00	N	55.00	150.00
88Ws2a	20.00	2.00	20.00	N	500.00	150.00	30.00	N	90.00	150.00
88Ws2b	50.00	2.00	15.00	N	300.00	150.00	30.00	N	60.00	200.00
88Ws4a	30.00	<2.00	20.00	N	300.00	150.00	30.00	<200.00	110.00	200.00
88Ws4b	15.00	<2.00	<5.00	N	500.00	30.00	15.00	N	5.00	15.00
88Ws5a	30.00	2.00	30.00	N	700.00	200.00	20.00	<200.00	130.00	150.00
88Ws5b	30.00	<2.00	20.00	N	500.00	150.00	30.00	N	50.00	200.00
88Ws6a	20.00	2.00	20.00	N	500.00	200.00	30.00	N	30.00	200.00
88Ws6b	30.00	<2.00	20.00	N	300.00	150.00	20.00	N	30.00	150.00
88Ws7	20.00	<2.00	20.00	N	500.00	200.00	30.00	<200.00	95.00	150.00

Table 1 (cont.). Analytical results of rock geochemistry samples from King Cove, Alaska.

Sample number	Pb	Sb-AA	Sc	Sn	Sr	V	Y	Zn	Zn-AA	Zr
88Ws8a	20.00	<2.00	20.00	N	500.00	200.00	30.00	<200.00	50.00	150.00
88Ws8b	20.00	<2.00	20.00	N	300.00	150.00	20.00	N	55.00	70.00
88Ws8c	15.00	<2.00	30.00	N	300.00	200.00	30.00	N	45.00	100.00
88Ws9	20.00	<2.00	30.00	N	500.00	200.00	30.00	N	25.00	150.00
88Ws10a	15.00	<2.00	20.00	N	300.00	200.00	30.00	N	35.00	100.00
88Ws10b	30.00	<2.00	20.00	N	200.00	200.00	30.00	N	20.00	150.00
88Ws10c	20.00	<2.00	15.00	N	500.00	100.00	30.00	N	70.00	200.00
88Ws11	20.00	<2.00	20.00	N	300.00	150.00	30.00	N	70.00	100.00
88Ws11b	15.00	4.00	20.00	N	200.00	200.00	30.00	N	80.00	150.00
88Ws12	20.00	<2.00	20.00	N	500.00	200.00	30.00	N	25.00	150.00
88Ws13	30.00	<2.00	20.00	N	300.00	200.00	30.00	<200.00	90.00	100.00
88Ws14	20.00	<2.00	20.00	N	500.00	200.00	30.00	N	25.00	150.00
88Ws15	20.00	<2.00	30.00	N	500.00	300.00	30.00	N	55.00	70.00
88Ws16	20.00	<2.00	30.00	N	500.00	300.00	20.00	<200.00	40.00	70.00
88Ws17	15.00	<2.00	20.00	N	300.00	150.00	30.00	N	65.00	100.00
88Ws18	20.00	<2.00	30.00	N	500.00	200.00	30.00	N	70.00	150.00
88Ws19	10.00	<2.00	20.00	N	500.00	200.00	30.00	N	45.00	100.00
88Ws20a	20.00	<2.00	20.00	N	300.00	150.00	30.00	N	45.00	200.00
88Ws20b	15.00	<2.00	20.00	N	500.00	150.00	30.00	<200.00	75.00	150.00
88Ws21a	20.00	<2.00	15.00	N	200.00	150.00	30.00	N	75.00	200.00
88Ws21b	20.00	<2.00	15.00	N	300.00	50.00	30.00	N	30.00	200.00

Table 2 Sample coding for rock samples.

Sample type	Sample source	Rock class
A Grab sample B Composite	A Outcrop or rubble B Mine C Dump or prospect D Float G Other	B Sedimentary C Metamorphic D Igneous E Unconsolidated

Quad	FC3 (Type of collection)	FC4 (Class of sample):
A to D and 1 to 6 depending on 1:63,360 sheet.	A Primary sampling B Resampling C Replicate sample D Reanalysis	A Background (major) B Background (minor) C Atypical (very minor) D Atypical (mineralized)

Form	Rock type	
A Bed B Mass C Foliated D Pluton E Dike or sill F Extrusive G Vein H Fault I Other	A Feldspathic sandstone B Lithic sandstone C Sandstone D Shale or mudstone E Siltstone F Conglomerate G Chert H Argillite I Limestone	J basalt K Volcanic breccia L Andesite M Tuff N Quartz diorite O Granodiorte P Quartz monzonite Q Diorite Z Other

Table 3 Lower limit of determination for respective elements (All analyses are by emission spectrography unless otherwise noted; AA indicates atomic absorption spectrophotometry)

Element	Limit	Element	Limit	Element	Limit	Element	Limit
Fe	0.05	B	10	Ga	5	Sc	5
Mg	0.02	Ba	20	Ge	10	Sn	10
Na	0.2	Be	1	La	50	Sr	100
P	0.02	Bi	10	Mn	10	Th	100
Ca	0.05	Bi-AA	1	Mo	5	V	10
Ti	0.002	Cd	20	Nb	20	W	20
Ag	0.5	Cd-AA	0.1	Ni	5	Y	10
As	200	Co	10	Pb	10	Zn	200
As-AA	10	Cr	10	Sb	100	Zn-AA	5
Au	10	Cu	5	Sb-AA	2	Zr	10

Table 4. Samples that equal or exceed threshold values in ppm for lead (Pb), copper (Cu), zinc (Zn), or molybdenum (Mo). Threshold values for the anomalous metals are: Pb = 30 ppm, Cu = 100 ppm, Zn = 100 ppm, Mo = 5 ppm.

88ADg 2a	Pb	88AWs 1a	Pb,Zn
88ADg 5	Pb	88AWs 2b	Pb,Mo
88ADg 6	Pb	88AWs 4a	Pb,Zn
88ADg 15	Pb	88AWs 5a	Pb,Zn
88ADt 9a	Cu	88AWs 5b	Pb
88ADt 10	Pb	88AWs 6b	Pb
88ADt 10c	Pb,Zn	88AWs 10b	Pb
88ADt 11	Pb	88AWs 13	Pb

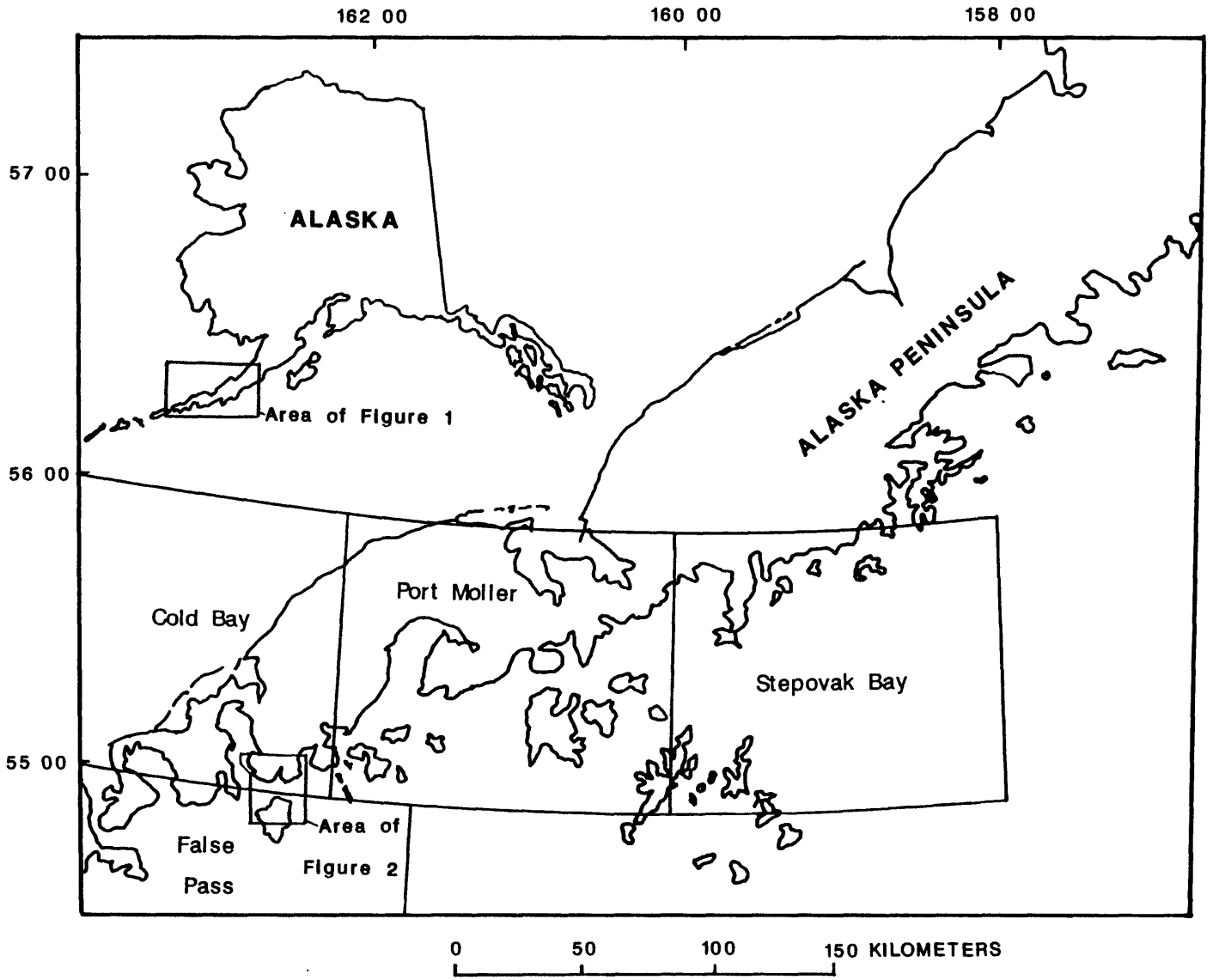
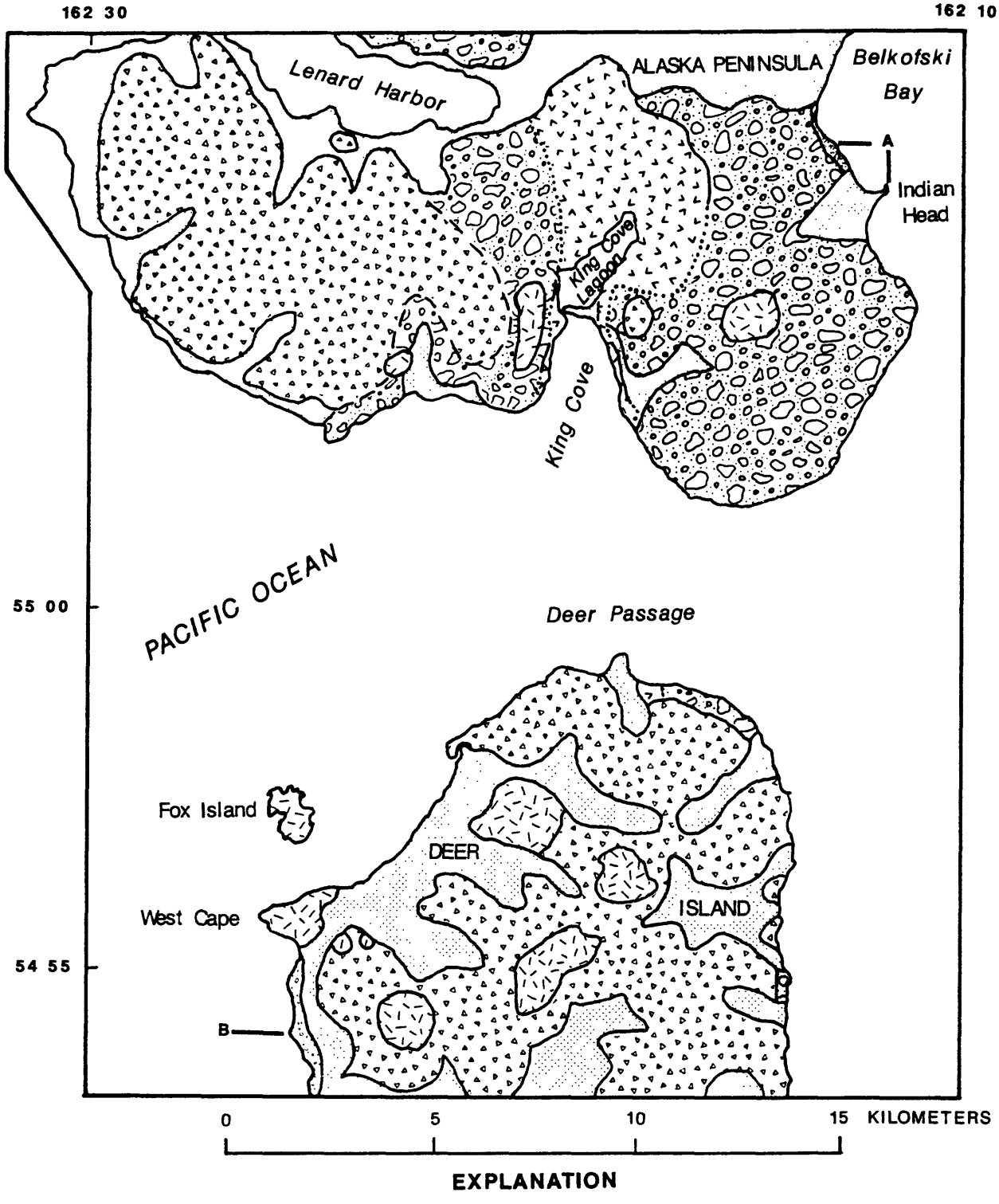


Figure 1. Index map of study area.



EXPLANATION

- Alluvium (Quaternary)
- Quartz diorite (Pliocene to late Miocene)
- Belkofski(?) Formation (middle Miocene to late Oligocene)
- Volcanic intrusive centers
- Volcanic rocks, undivided
- Belkofski Formation (middle Miocene to late Oligocene)
- Unga Formation (middle Miocene to late Oligocene)
- Stepovak Formation of Burk (1965) (Oligocene and Eocene)

Contact
Dashed where approximately located
dotted where concealed

Figure 2. Geologic Map of King Cove area. Geology revised from McLean and others, 1978.

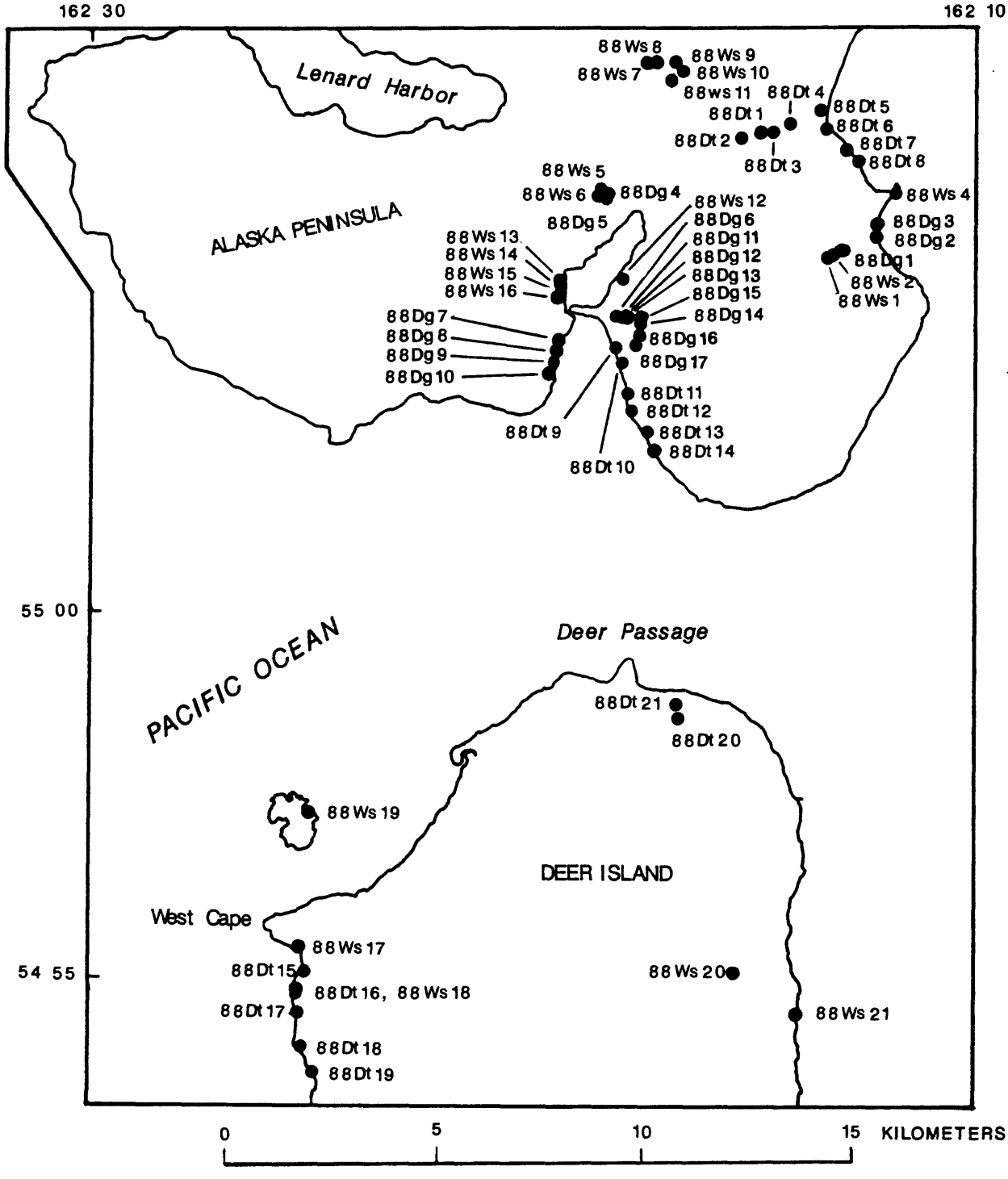


Figure 3. Station location map.