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GEOLOGY AND GEOCHEMISTRY OF THE SKAGWAY B-2 QUADRANGLE, SOUTHEASTERN ALASKA

By

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GEOLOGY AND GEOCHEMISTRY OF THE SKAGWAY B-2 QUADRANGLE, SOUTHEASTERN ALASKA

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SUMMARY

The Skagway B-2 Quadrangle is located at the northern end of a large batholith that underlies the mountains of the southeastern Alaska mainland for much of its length. Most rocks of the quadrangle are of intrusive igneous origin, although metamorphosed remnants of volcanic and sedimentary country rocks occur locally. Three large plutons of intermediate-to-felsic composition, called herein the Burro Creek, Ferebee, and Mt. Kashagnak plutons, have been recognized. Meta-andesite and metabasalt occur in the southwest part of the quadrangle, and remnants of an old gneissic complex occur as roof pendants and irregular inclusions in the younger plutonic rocks of the northeast part of the quadrangle.

The early Tertiary Burro Creek pluton is composed of two phases: euhedral biotite granodiorite and biotite quartz monzonite. The Burro Creek pluton intrudes both the Ferebee pluton and a highly deformed gneiss and migmatite unit derived from a thick sequence of Paleozoic(?) shelf sediments that underwent intense Barrovian regional metamorphism. The Late Cretaceous and early Tertiary Ferebee pluton is composed of moderately foliated hornblende biotite granodiorite. It intruded the rocks of the gneiss and migmatitite unit near the end of the latest regional metamorphic event. The Burro Creek pluton was intruded after the metamorphic episode and is largely unfoliated.

The Cretaceous Mt. Kashagnak pluton has three phases: prophyritic hornblende granodiorite, porphyritic hornblende-biotite quartz monzonite, and hornblende diorite. Remnants of the Cretaceous metabasalt country rock intruded by the Mt. Kashgnak pluton occur on its flanks and as inclusions. The pluton also intrudes a Cretaceous pyroxenite unit of problematic origin, and small Tertiary felsic intrusions cut the rocks of the pluton and the metabasalt unit.

Southwest of the Chilkat River, in the southwestern corner of the quadrangle, intermediate intrusive rocks with cataclastic textures contain large pendants or inclusions of andesitic volcanic rocks. The intrusive rocks are of Tertiary age and consist of granodiorite and hornblende-biotite quartz monzonite.

The Burro Creek and Ferebee plutons, together with the gneiss and migmatite they intrude, belong in the Tracy Arm tectonostratigraphic terrane described by Berg and others (1978); they assigned the basalts intruded by the Kashagnak pluton to the Taku terrane, although the pluton itself appears to be closely related to the other two intrusives of the quadrangle. The rocks south of the Chilkat River are assigned to the Alexander terrane of Berg and others (1972).

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The linear valleys and inlets of the quadrangle are controlled by four major faults or fault systems: the Chilkat fault, the Lutak Inlet fault and its subsidiary splays, the Ferebee fault, and the Taiya fault. All four are splays of the Lynn Canal - Chatham Strait fault, which is in turn a part of the Denali fault system. Bedding and foliation in much of the quadrangle trend about 140°.

Occurrences of iron, copper, gold, and radioactive elements have been noted in the quadrangle. Several small iron deposits near Haines received some attention in the early 1900s, but there is now little mineral activity in the quadrangle. An extensive stream-sediment-sampling program revealed geochemical anomalies that fall into specific geographic areas. Although many of the anomalous areas are underlain by rock types that commonly have high backgrounds in the anomalous elements, others are unexplained or are associated with structural features. However, the analytical values from the sampling are low compared with those from known mineralized areas, although some of the anomalies from the latter group may merit attention.

INTRODUCTION

In early 1983, DGGS contracted C.C. Hawley and Associates, Inc., to geologically map and geochemically sample the Skagway B-2 Quadrangle at a scale of 1:63,360. Fieldwork was conducted during July and August of 1983.

The Skagway B-2 Quadrangle lies north of Haines and east of Skagway at the upper end of Lynn Canal (fig. 1). The region is very steep, with elevations reaching 6,282 ft in the northern part of the quadrangle. In the central part of the quadrangle are the Takshanuk Mountains, named by the Tlingit Indians for the many waterfalls that occur there. The long, linear river valleys and inlets of the region divide the quadrangle into four topographic blocks. For discussion in this report these blocks are called, from northeast to southwest: the Ferebee, Chilkoot, Chilkat, and Takhin blocks (pl. 1).

Small glaciers are common on the higher peaks of the quadrangle, and glacial processes have been important in its recent history. Peaks below 4,000 ft show distinctively rounded summits and ridges that are indicative of burial by glacial ice, and rocks along the shore of Taiya Inlet have been well carved, scalloped, and polished by ice movement. Chilkoot Lake and Taiyassank Harbor both formed behind terminal moraines (March, 1982).

Precipitation varies radically across the quadrangle. Haines and the Chilkoot and Ferebee Valleys receive about 140 cm of precipitation a year. Skagway and Klukwan, however, only 25 and 32 km away, respectively, receive but one-third of that amount.

PREVIOUS INVESTIGATIONS

Previous geologic investigations in the Skagway B-2 Quadrangle were limited, probably by a lack of known economic mineral deposits. Most early geological studies in the region concentrated on the Porcupine gold placer district (Wright, 1904; Eakin, 1919) and the Klukwan iron-ore deposit (Knopf,

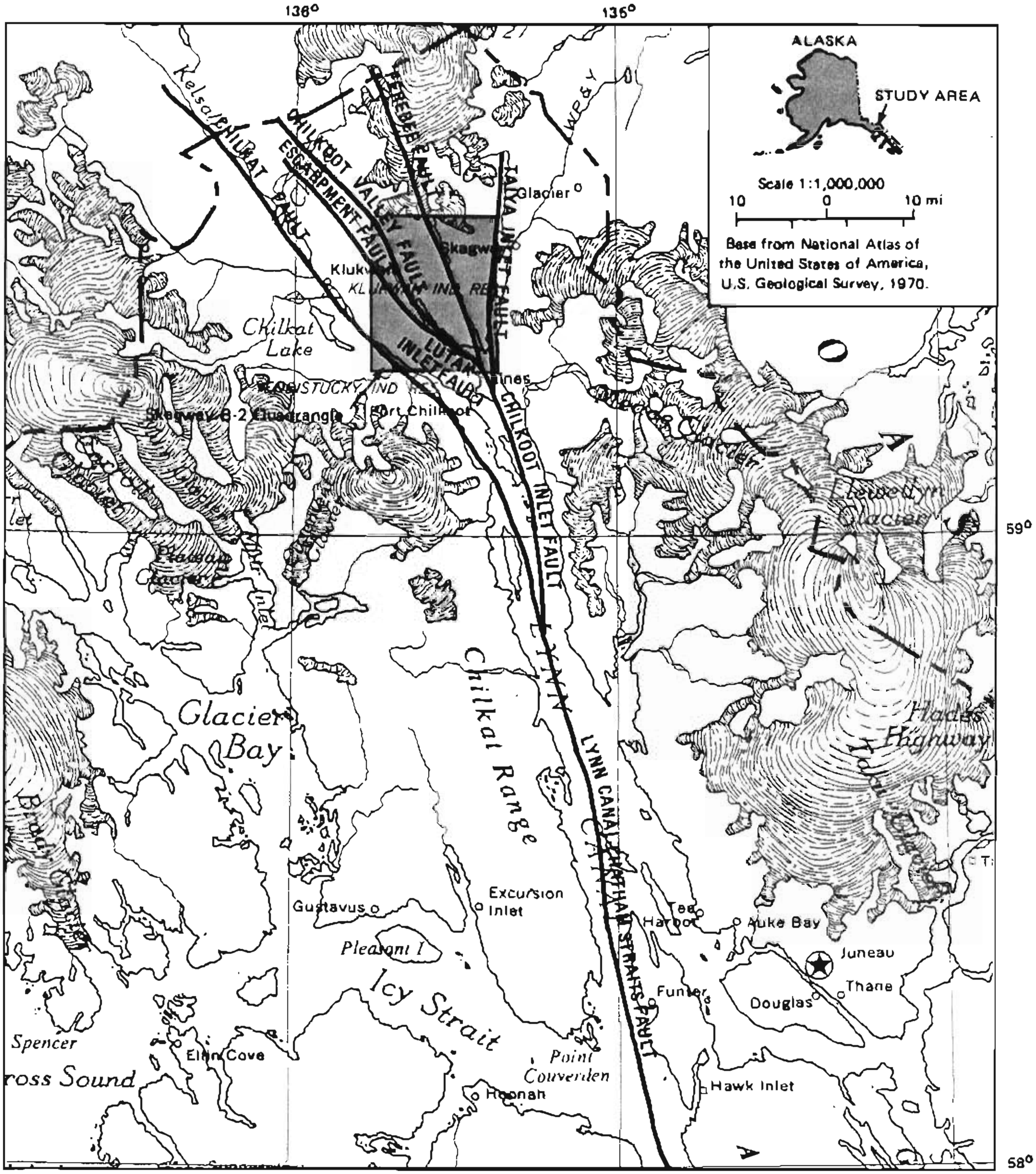

Figure 1. Map showing location of the Skagway B-2 Quadrangle and regional faults.

1910). Buddington and Chapin (1929) made the first geological investigation of the study area, mapping coastal portions of the quadrangle.

In the early 1950s, Robertson (1956) studied the magnetite-bearing ultramafic deposits at Klukwan and Haines and mapped the Takshanuk Mountains near the prospects. Results of mapping and sampling by the U.S. Geological Survey in the adjacent B-3 and B-4 quadrangles between 1969 and 1971 were compiled by MacKevett and others (1974) and Winkler and MacKevett (1970). Stream-sediment and water samples from the Skagway 1:250,000-scale Quadrangle were collected and analyzed in the early 1970s for the National Uranium Resource Evaluation Program in an effort to identify possible uranium occurrences (Union Carbide, 1981).

REGIONAL GEOLOGIC SETTING

Most of the Skagway-Haines area is underlain by rocks of the Coast plutonic complex (fig. 2), a granitic plutonic complex that extends the length of the southeastern Alaska panhandle. These batholithic rocks form the core of the Coast Mountains and have been termed the 'Coast plutonic complex' (Brew, 1983; Brew and Ford, 1984). As defined, the Coast plutonic complex includes the granitic, migmatitic, and gneissic rocks of the Coast Mountains and the adjacent metamorphic belts. The rocks of the Coast plutonic complex are assigned to the Tracy Arm tectonostratigraphic terrane (Berg and others, 1978). Metabasalts north of the Chilkat River have been assigned to the Taku terrane (Berg and others, 1978), and rocks south of the Chilkat River are assigned to the Alexander terrane of Berg and others (1972).

The linear river valleys and marine inlets of the region are controlled by major faults that are splays of the Lynn Canal - Chatham Strait fault, a major structural feature that connects the Fairweather - Queen Charlotte Islands fault with the Denali fault (fig. 1). Just south of the map area, the Lynn Canal - Chatham Strait fault splits into two splays. The western splay, the Chilkat fault, cuts the southwest corner of the map area and follows the Chilkat River. The second splay, the Chilkoot Inlet fault, divides again into three splays near the southeastern corner of the Skagway B-2 Quadrangle. The first of these, the Lutak Inlet fault and its subsequent splays, occupies the Lutak Inlet and Chilkoot River valleys. The Ferebee fault, the second splay of the Chilkoot fault, follows the valley of the Ferebee River. The Taiya fault (third splay) controls Taiya Inlet, along the eastern margin of the quadrangle.

QUADRANGLE GEOLOGY

Rock units of the Skagway B-2 Quadrangle (pl. 1) can be divided into three groups based on spatial and geologic relationships. The largest of these groups underlies the Ferebee and Chilkoot topographic blocks, to the northeast of Lutak Inlet and the Chilkoot Valley. The second group of rocks underlies the Chilkat topographic block, between the Chilkoot and Chilkat Valleys. The third group of rocks underlies the Takhin block, in the southwestern corner of the quadrangle. Rocks of the first two blocks belong to the Coast plutonic complex and the Tracy Arm terrane (Brew and Ford, 1981);

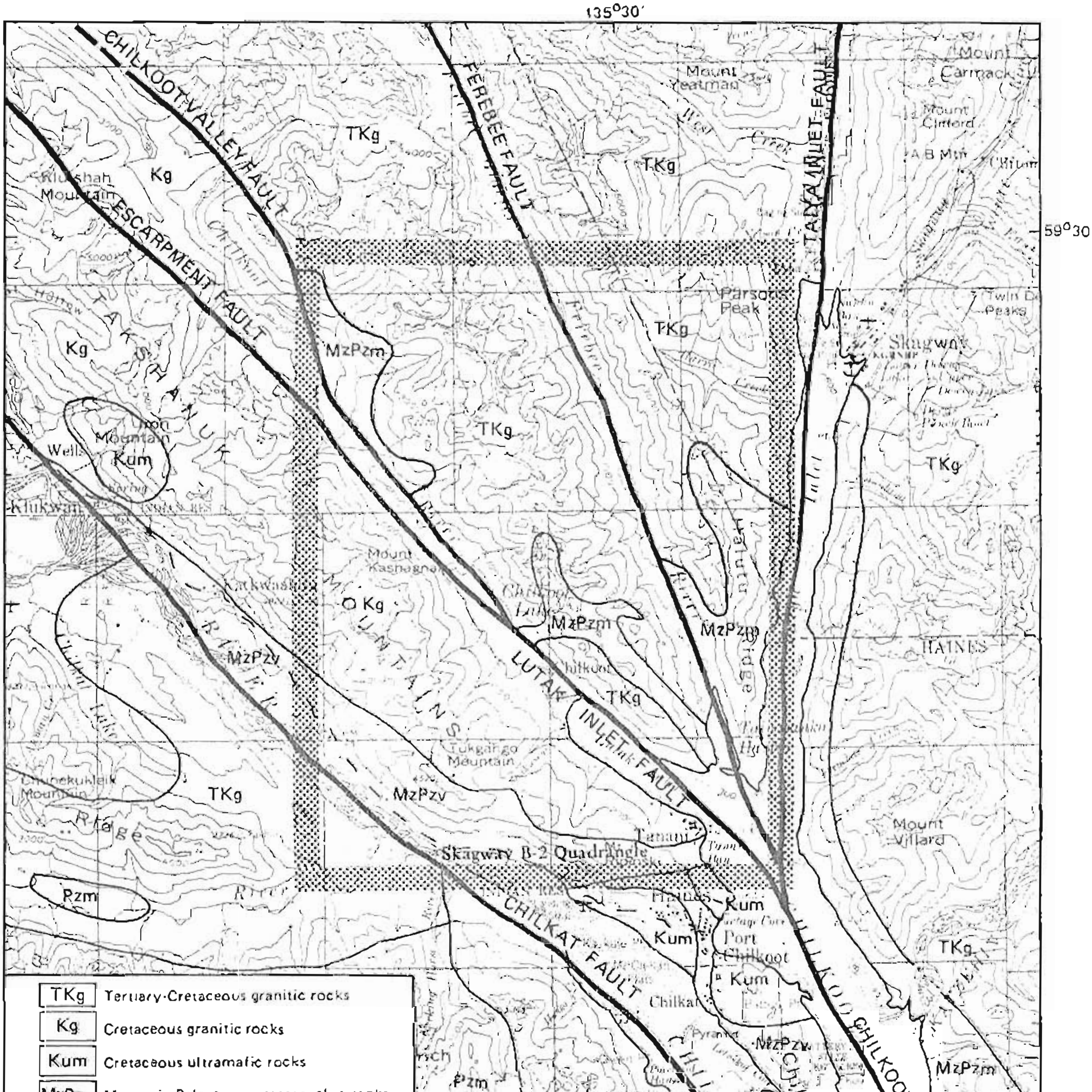

Figure 2. Map of the regional geology of the Skagway B-2 Quadrangle.

rocks of the Takhin block belong to the Alexander terrane (Berg and others, 1972).

Lithologic Units

Classification of igneous rocks in this report is based on mineralogy observed in 52 thin sections and in 150 sawed rock slabs stained with sodium colbaltinitrite to distinguish feldspars. The classification used is that of Travis (1955).

Rocks of the Ferebee and Chilkoot Blocks

The Ferebee and Chilkoot topographic blocks occupy the region north and east of the Chilkoot Valley, which comprises the northeastern two-thirds of the quadrangle. Rocks of the two blocks consist of the Burro Creek and Ferebee plutons and the gneiss and migmatite unit they intrude.

Gneiss and Migmatite

The gneiss and migmatite unit is a complex group of very high grade metamorphic rocks. It is composed of three distinguishable rock types---paragneiss, orthogneiss, and migmatite---that are too complexly intermixed to be shown as separate units at the map scale.

The paragneiss subunit of the gneiss and migmatite unit consists of quartzo-feldspathic gneiss with intercalated marble, quartzite, amphibolite, and biotite schist. Amphibolite and biotite schist are not common but are locally present as agmatites, which are brecciated mafic rocks with a matrix of swirled gneiss (Winkler, 1965). The paragneiss is readily identifiable as a metamorphic rock because of its conspicuous banding and schistosity, which is parallel to its compositional intercalations.

Quartz, plagioclase, and biotite are the most common minerals in the paragneiss, but potassium feldspar and hornblende are present where the parent rocks had a different composition. Diopside and garnet are common in the marbles, and diopside is also present in some of the quartzites. Mineral grains in the paragneiss unit are commonly 2 to 5 mm in diameter, although smaller grain sizes are not uncommon, particularly in thicker sequences of the paragneissic rocks.

Boudinage is common in the paragneiss subunit, and the rocks are locally strongly deformed. Rare, large-amplitude isoclinal folds occur, but most observed folds have amplitudes between 0.5 cm and 1 m. Some areas are so strongly deformed that it is impossible to determine average attitudes of the foliation on an outcrop scale.

The rocks of the orthogneiss subunit are widespread in the gneiss and migmatite unit. They consist of gneiss of granitic composition, which shows a strong foliation. The orthogneiss is compositionally similar to the rocks of the Ferebee pluton. It has a stronger foliation, however, than most rocks of the pluton, probably as a result of temperature and stress gradients associated with the contacts. Mafic dikes that cut the orthogneisses show a stair-step offset with throughgoing foliation, probably from regional shearing.

The migmatite subunit of the gneiss and migmatite unit consists of an intimate mixture of orthogneiss and highly deformed and sheared paragneiss. Orthogneiss, which predominates in most of the migmatite exposures, has been injected into the paragneiss along foliation and shear planes. Rocks best described as lit-par-lit injection gneisses are widespread in migmatite zones. Individual paragneiss layers rarely exceed 60 m in length before being cut off by shearing, and many paragneissic exposures resemble a string of large boudins within a matrix of orthogneiss. Both Halutu Ridge and the east flank of Mt. Harding have well-exposed migmatite zones.

Contacts between the gneiss and migmatite unit and the Ferebee pluton are gradational zones up to 300 m wide, and the widespread orthogneiss subunit and the rocks of the pluton have similar compositions. The contacts shown on plate 1 are therefore somewhat subjective. Because of the importance of showing the margins of the pluton and the distribution of the gneiss and migmatite pendants and inclusions, intermixtures of metamorphic rocks and rocks of the pluton were preferentially mapped as gneiss and migmatite. In some cases, rocks with as little as 25 percent unequivocal paragneiss were included in the gneiss and migmatite map unit.

The gneiss and migmatite unit was probably once a thick sequence of shale, sandstone, and limestone with a few volcanic layers that was deposited on a stable continental shelf during the early Mesozoic - late Paleozoic Eras (Beikman, 1975). The sediments were subject to one or more episodes of regional metamorphism, the most recent being a Barrovian (high-temperature, high-pressure metamorphism characteristic of deeply buried environments) metamorphic event that probably occurred during the Late Cretaceous - early Tertiary periods. This event resulted in a mineral assemblage in the sillimanite, almandine, orthoclase subfacies of almandine-amphibolite facies metamorphism (Winkler, 1965). Near the end of the event, the Ferebee pluton was intruded and the metamorphic rocks were injected with granitic orthogneiss. Wet granitization and partial melting probably also took place.

Ferebee Pluton

Foliated hornblende-biotite granodiorite of the Ferebee pluton underlies most of the Chilkoot and Ferebee blocks. This rock varies in composition from hornblende diorite to biotite quartz monzonite, but the most common rock type is hornblende-biotite granodiorite. Grain sizes are in the 2 to 4 mm range, and the rock exhibits a good to poor foliation. The rock has a subhedral seriate texture and contains 15 to 20 percent combined biotite and hornblende. Biotite is by far the dominant mafic mineral, but hornblende predominates locally. Quartz forms approximately 15 to 20 percent of the rock, and the potassium-feldspar content varies between 5 and 15 percent, averaging about 10 percent. Magnetite is moderately common. The part of the Ferebee pluton in the Chilkoot block commonly contains at least a trace of sphene; however, sphene is extremely rare in that part of the pluton in the Ferebee block. Sphene appears to be most abundant in the less foliated portions of the pluton, forming up to 3 percent of the rock (in crystals as long as 6 mm) in the area of Peak 6282. Zircon is common locally, particularly in the Chilkoot block east of Chilkoot Lake and Lake 2270. Pan concentrates from this area contained abundant clear zircon crystals.

In general, the Ferebee pluton is well foliated in areas near its contacts with paragneissic rocks and less foliated in the center of large areas of granodiorite. Areas with strong foliation also tend to exhibit some recrystallization of the quartz and feldspar grains. Compaction textures, where feldspar or quartz grains have been forced into and deformed biotite crystals, are also present in well-foliated areas. The northern part of the Chilkoot block above the upper end of Chilkoot Lake tends to be massive, poorly foliated, and unrecrystallized. The foliated granodiorite also occurs as injections within the gneissic areas and appears to grade into the paragneissic sections.

There are areas within the Ferebee pluton that are distinctly porphyritic and poorly foliated. These rocks are probably separate intrusions, but they were not mapped as discrete units. They are basically similar to the rest of the Ferebee pluton in overall composition, although they have fewer mafic minerals (10 to 15 percent compared to 15 to 20 percent). Their most distinctive feature is the presence of potassium feldspar phenocrysts up to 1.5 cm long.

The Ferebee pluton is in fault contact with the Mt. Kashagnak pluton. It intrudes the gneiss and migmatite unit and is in turn intruded by the Burro Creek pluton.

D.A. Brew (personal commun., 1983) correlates the Ferebee pluton with the 'tonalite sill' that he and others have mapped from Prince Rupert to at least as far north as Berners Bay. This sill is composed of a nearly continuous series of narrow, sheetlike orthogneiss plutons that range from 3 to 25 km wide (Brew and Ford, 1981). Much of the tonalite sill to the south of the B-2 Quadrangle was emplaced during the last stages of the regional Barrovian metamorphic event.

U-Pb zircon ages of tonalite-sill rocks in the Juneau area range between 69 and 62 m.y. (Gehrels and others, 1983; Gehrels and others, 1984). Wilson and others (1979) report a K-Ar age of 30 m.y. from biotite in quartz diorite on the shore of Lutak Inlet. Rocks in that area are intruded by up to six different stages of dikes, and it is not known whether the date came from dike rock or from a part of the Ferebee pluton that gives anomalous ages due to resetting by heat from the dikes or their parent magma. The Ferebee pluton is probably correlative with the tonalite sill and is of Late Cretaceous to early Paleocene age.

Burro Creek Pluton

The Burro Creek pluton, which underlies the Burro Creek, Parsons Peak, and Face Mountain area, is composed of two closely related phases: euhedral biotite granodiorite and biotite quartz monzonite. The two rock types generally have gradational contacts, but they also intrude each other locally. The rocks are generally nonfoliated. The Burro Creek pluton has not undergone the metamorphic events that have affected older units.

Brew (personal commun., 1983) has mapped rocks similar to the euhedral-biotite granodiorite near Berners Bay and Skagway. The rocks have been dated at about 50 m.y. in the Juneau Icefield area (Forbes and Engels, 1970; Brew and Ford, 1981; 1984).

Euhedral biotite granodiorite. The hornblende-biotite granodiorite phase of the Burro Creek pluton crops out in Burro Creek and on Face Mountain. This rock has a subhedral seriate texture with a grain size of 2 to 5 mm. The granodiorite is relatively light colored and has a color index of about 15. Large hexagonal books of biotite are characteristic of this rock, and euhedral hornblende crystals are common. The relative proportions of biotite to hornblende vary considerably, but probably average about 2:1. Quartz forms 15 to 20 percent of the rock, but sphene and magnetite are not common. The potassium-feldspar content varies from about 3 to 10 percent, and the average content is just high enough for the rocks to be classified as granodiorite.

At its contact with the Ferebee pluton and the gneiss and migmatite unit, the euhedral biotite granodiorite exhibits a distinct chill margin where grain size decreases to about 1 mm. Locally---particularly where biotite is dominant---the marginal zone can have a well-developed flow foliation.

Biotite quartz monzonite. A fine-grained, subhedral, granular biotite quartz monzonite also occurs in the Burro Creek area. This rock has a grain size of 0.5 to 2 mm and contains 10 to 15 percent biotite and 15 to 20 percent quartz. Potassium feldspar can form up to about 30 percent of the rock or as little as 10 percent. Actual composition ranges from diorite to quartz monzonite, with the latter being the most common. Distinctive, large (up to 1.5 cm) poikilitic plagioclase feldspars are characteristic of the rock.

The biotite quartz monzonite distinctively intrudes the gneiss and migmatite unit and the Ferebee pluton. On the east flank of Mt. Harding the quartz-monzonite contact with the gneiss and migmatite unit is well exposed. Large dikes and apophyses of quartz monzonite intrude the metamorphic rocks. A contact breccia zone of varying width (30 to 150 m wide) borders the plutonic margin and contains up to 75 percent gneiss and migmatite fragments in a chaotic swarm of large and small angular inclusions. The contact itself is abrupt, and the metamorphic rocks beyond are cut by only a few dikes.

Emplacement of the biotite quartz monzonite was apparently nearly contemporaneous with that of the euhedral biotite granodiorite. The two phases mixed locally along their common borders, but generally remained separate. Fragments of the granodiorite have been found within the quartz monzonite, quartz monzonite dikes cut the granodiorite, and dikes of granodiorite cut the quartz monzonite. The two rocks have also been seen to grade into each other locally, as evinced by a decrease in grain size and hornblende content and an increase in potassium feldspar. This gradational contact is well displayed on the ridge north of Peak 5005.

Rocks of the Chilkat Block

The Chilkat topographic block lies between the Chilkoot and Chilkat Valleys in the south-central and west-central parts of the quadrangle. The rocks of the block consist of the Kashagnak pluton, the metabasalt unit it intrudes, and a later felsic intrusive unit that cuts both.

Metabasalt

A sequence of metamorphosed, massive, basaltic marine volcanic flows with rare phyllitic interbeds is exposed in a band along the west flank and southern end of the Takshanuk Mountains. The band varies in width from 0.7 km at its northwest end to 3.4 km below Tukgahgo Mountain. Attitudes of volcanic rocks conform to the general regional trend of 140° and dip steeply southwest.

The metabasalt tends to be dark green to black and ranges from massive to well flow-banded or highly amygdaloidal. Most units are dense and aphanitic to prophyritic, but fine-grained dioritic zones occur in the center of thicker flows. A few flattened structures that may be deformed pillows have been seen in roadcuts. Epidote is widespread in replacement zones, pods, and veins, and traces of malachite are not uncommon. Magnetite is a common accessory mineral and can be abundant enough to affect a compass. The phyllites, some of which may contain talc, are probably intercalated metamorphosed sediments and tuffaceous units.

Thin sections of typical metabasalt showed subequal amounts of hornblende and plagioclase with small to insignificant amounts of chlorite and epidote. Because the plagioclase is andesine (MacKevett and others, 1974), the rock might be called andesite. However, because the textures, colors, geologic relationships, and whole-rock analyses (table 1) are more like those of basalts, the rocks are interpreted to be basalts that have had their mineralogy altered by metamorphism. The petrographic specimens examined were mostly unaltered, but one thin section of metabasalt at the contact with the intruding diorite showed strong alteration to chloritized hornblende, clinozoisite, epidote, and sericite.

The metabasalt is intruded by hornblende diorite along a steeply southwest-dipping contact. The contact zone is marked by the development of a phyllitic or schistose foliation caused by orientation of hornblende or biotite. Although the macroscopic effects of thermal metamorphism are obvious for only 30 to 80 m from the contact, most or all of the basalt sequence appears to have undergone Abukuma-type metamorphism (high-temperature, low-pressure metamorphism characteristic of shallow burial) during intrusion of the Mt. Kashagnak pluton. Under these conditions, the augite and labradorite characteristic of normal basalt would be converted to hornblende and andesine plagioclase, both of which are stable in the quartz, andalusite, plagioclase, and chlorite subfacies of Abukuma-type greenschist facies metamorphism (Winkler, 1965). The mineralogical change is difficult to observe in hand specimen or outcrop because of the fine-grained textures of the unit. Rocks along the Haines Highway, however, are unusually dense and brittle for basalts, probably as a result of the metamorphism.

In his early work, Winkler (1965) equated Abukuma metamorphism with hornfelsing or thermal-contact metamorphism, such as would probably have accompanied intrusion of a pluton as large as the Mt. Kashagnak body. More recently, Winkler (1979) also stated that low-pressure regional metamorphism

Table 1. Whole-rock geochemistry (%).[a]

Map no.	Field no.	SiO_2	Al_2O_3	Fe_2O_3	FeO	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5	MnO	H_2O	LOI[b]	Total
Pyroxenite															
W018	SHH138	38.18	10.15	9.48	8.95	11.71	14.56	1.13	0.71	2.17	0.07	0.17	0.10	0.93	98.3
Metabasalt															
W014	SHR008	53.00	14.20	3.32	4.82	9.28	8.24	2.89	1.34	0.95	0.22	0.14	0.13	1.40	99.93
W016	SHE041	47.35	13.88	4.52	8.75	6.71	10.57	2.18	0.35	3.01	0.37	0.23	0.07	0.89	98.88
Hornblende diorite															
W012	SHR038	57.31	20.11	2.79	2.59	1.62	6.49	4.45	1.97	0.63	0.40	0.21	0.17	1.36	100.01
Prophyritic granodiorite															
W013	SHR053	65.06	17.66	1.54	1.64	0.85	4.22	5.03	2.80	0.45	0.19	0.13	0.13	0.35	100.05
W006	SHE164	60.25	20.94	1.96	1.21	0.75	4.93	6.68	1.99	0.41	0.22	0.14	0.05	0.30	99.83
Quartz monzonite porphyry															
W010	SHR127	64.25	18.57	1.70	1.59	0.92	4.16	5.47	2.34	0.41	0.23	0.14	0.08	0.12	100.45
W011	SHE167	57.35	21.51	2.51	2.56	1.57	6.35	6.71	0.49	0.60	0.36	0.17	0.04	0.21	100.43
Leucocratic quartz monzonite															
W015	SHE015	73.04	15.82	0.46	0.18	0.00	0.51	7.36	2.02	0.06	0.06	0.02	0.08	0.12	99.73
W017	SHE042	71.98	15.67	0.74	0.34	0.14	0.59	6.88	2.47	0.11	0.06	0.04	0.09	0.36	99.47
Ferebee foliated granodiorite															
W001	SHE082	68.84	16.11	0.52	2.58	1.05	3.41	3.28	3.40	0.46	0.18	0.05	0.05	0.29	100.22
W008	SHE177	68.63	16.07	0.45	2.77	1.16	3.52	3.74	2.80	0.61	0.25	0.06	0.02	0.16	100.34
Hexagonal-biotite granodiorite															
W005	SHC007	68.81	16.01	0.57	2.67	0.95	3.63	3.94	2.51	0.44	0.23	0.08	0.13	0.32	100.29
W002	SHE180	66.82	16.64	0.63	3.44	1.35	4.34	3.57	2.21	0.57	0.24	0.09	0.00	0.25	100.15
Biotite quartz monzonite															
W004	SHE048	69.75	15.42	0.81	2.38	0.87	3.14	3.55	2.78	0.46	0.20	0.07	0.05	0.48	99.96
W009	SHE126	68.00	16.73	0.66	2.54	0.80	3.82	4.05	2.08	0.47	0.19	0.06	0.04	0.31	99.75
Dikes															
W007	SHE066	64.82	16.81	0.82	3.81	1.64	4.82	3.31	2.31	0.68	0.30	0.10	0.07	0.64	100.13
W003	SHE070	67.76	16.48	0.64	3.06	1.17	3.94	3.49	2.44	0.54	0.25	0.08	0.06	0.33	100.24

Average elemental compositions of typical igneous rocks (Cox and others, 1979)

Rock type	SiO_2	Al_2O_3	Fe_2O_3	FeO	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5	MnO	H_2O	LOI	Total
Basalt	49.20	15.74	3.79	7.13	6.73	9.47	2.91	1.10	1.84	0.35	0.20			99.95
Andesite	57.94	17.02	3.27	4.04	3.33	6.79	3.48	1.62	0.87	0.21	0.14			99.93
Diorite	57.48	16.67	2.50	4.92	3.71	6.58	3.54	1.76	0.95	0.29	0.12			99.98
Tonalite	61.52	16.48	1.83	3.82	2.80	5.42	3.63	2.07	0.73	0.25	0.08			100.01
Granodiorite	66.09	15.73	1.38	2.73	1.74	3.83	3.75	2.73	0.54	0.18	0.08			99.90
Quartz monz.	68.65	14.55	1.23	2.70	1.14	2.68	3.47	4.00	0.54	0.19	0.08			100.05
Granite	71.30	14.32	1.21	1.64	0.71	1.84	3.68	4.07	0.31	0.12	0.05			100.07

[a] Analysis performed by DGGS assay lab.
[b] LOI - Loss on ignition.

can also cause the mineralogical associations seen in the metabasalt.

The metabasalts are thought to be Cretaceous. MacKevett and others (1974) report a K-Ar age on hornblende of 109 m.y. on 'mafic rocks' (assumed to be metabasalts) near Haines; they also report hornblende ages of 109 to 96 m.y. on ultramafic rocks from Klukwan and Haines. Because the Klukwan body intrudes the Mt. Kashagnak pluton, which in turn intrudes the metabasalt, a mid-Cretaceous or older age is indicated.

Pyroxenite

A coarse-grained, altered pyroxenite crops out along Lutak Road, in Johnson Creek, and along the Haines Highway. The rock consists of a cumulate mass of large, subhedral crystals of hornblende and augite that average about 1 cm in length but are locally up to 10 cm long. Most of the unit is composed of hornblende, but pyroxenite is retained as a unit designation to conform with both previous usage and the original composition of the unit. In the Haines area, Abukuma high-temperature, low-pressure metamorphism has partially altered the pyroxenite to hornblende. Magnetite is an abundant accessory mineral in the pyroxenite, forming up to 10 percent of the rock (Robertson, 1956). Traces of malachite are not uncommon. The pyroxenite has been well fractured, and all fractures are healed by pegmatite that contains hornblende, plagioclase, and thulite (a pink, manganese-bearing zoisite created by alteration of plagioclase). Contacts between the pegmatite and the pyroxenite may be either sharp or gradational.

The pyroxenite has been intruded by hornblende diorite of the Kashagnak pluton in and near Johnson Creek. Contacts between the pyroxenite and metabasalt are all along faults; therefore, the relationship between the rocks is uncertain. Brew (personal commun., 1983) thought that the two rocks were gradational in the Battery Point area south of Haines, but this could not be substantiated (or refuted) in the Skagway B-2 Quadrangle.

The intrusive relationship shown by diorite cutting pyroxenite is the reverse of that found in the Klukwan area to the north. Robertson (1956) and Still (1984) noted that the Klukwan ultramafic pluton distinctly intruded the surrounding diorite and gabbro. The diorite in the Klukwan area is probably part of the hornblende diorite portion of the Mt. Kashagnak pluton; also, the fact that the untramafic rocks and the diorite intrude each other indicates a close age relationship.

Thulite-bearing pegmatites, very similar to those within the pyroxenite, are present in the diorite bordering the pyroxenite, another fact that suggests a close relationship between the pyroxenite and diorite. Because the diorite is considered part of the Mt. Kashagnak pluton, the pyroxenite may also be related to the intrusive complex.

According to Taylor and Noble (1969), the ultramafic bodies in southeastern Alaska are multiphase and derived from ultramafic magmas, not the gabbroic or dioritic rocks they are now associated with. It may be that the Mount Kashagnak pluton is semicontemporaneous with, but unrelated to, the ultramafic bodies and the Mt. Kashagnak pluton.

Ultramafic rocks in the Skagway B-2 area, like ultramafic rocks throughout southeastern Alaska, are considered to be of mid-Cretaceous age. MacKevett and others (1974) reported K-Ar ages on hornblende of 99 and 96 m.y. on drill cores from Klukwan and 108 m.y. (biotite) and 109 m.y. (hornblende) from outcrops south of Haines. The Klukwan ages are considered to be too young because of alteration effects, but MacKevett and others (1974) believe the 108- and 109-m.y. ages are reliable.

Mount Kashagnak Pluton

The Mt. Kashagnak pluton is a concentrically zoned, three-phase body that underlies most of the Takshanuk Mountains and consists of: 1) an extensive, hornblende diorite outer component, 2) a porphyritic hornblende granodiorite middle zone, and 3) a biotite-quartz monzonite porphyry core. The diorite and granodiorite are very similar in appearance except that the inner granodiorite is more leucocratic and contains large potassium feldspar phenocrysts, a feature it has in common with the core quartz monzonite porphyry. The two phenocryst-bearing phases appear to be related because of the distinctive, large potassium feldspar phenocrysts, whereas the outer two phases are thought to be related because of appearance and composition. Although no contacts were seen in outcrop between the three units, the abruptness of the change from one unit to another and the presence of a few inclusions of the granodiorite in the quartz monzonite indicate intrusive contacts.

All three units of the Mt. Kashagnak pluton show some microscopic recrystallization---particularly of quartz grains---between feldspar crystals.

The outer hornblende-diorite phase intrudes the metabasalt and pyroxenite. Many diorite dikes cut the matabasalt, and metabasalt fragments are included in the diorite along the contact. Obvious thermal metamorphic effects can be traced for less than 100 m out into the metabasalt.

The Mt. Kashagnak pluton is probably mid-Cretaceous. The hornblende-diorite border phase of the pluton has been intruded by the Klukwan untramafic body in the B-3 Quadrangle, but intrudes the Haines ultramafic near Johnson Creek, which suggests possible age and genetic relationships. MacKevett and others (1974) believe that the Klukwan ultramafic body is approximately 108 m.y. old, which would give a minimum age for the Mt. Kashagnak pluton.

Hornblende diorite. The hornblende diorite subunit of the Mt. Kashagnak pluton occurs mostly in the Chilkat block. The rock has a subhedral, seriate texture and an average grain size that varies from 2 to 6 mm. Hornblende is the dominant dark mineral of this phase, although rare augite does occur, sometimes as individual crystals and sometimes as cores to hornblende. Epidote alteration is widespread and pervasive. This alteration can range from nonexistent to well developed and is probably of deuteric origin. A little secondary biotite is locally present as an alteration product from the hornblende. Quartz, if present, forms 5 to 10 percent of the rock. About 5 percent potassium feldspar is usually present, but amounts vary from a trace to 30 percent. Color index is low for a diorite, usually about 15, but sometimes up to 20.

Sphene and magnetite are common accessory minerals. Amber-colored sphene is conspicuous as 0.05- to 2-mm euhedral grains that form from 1 to 3 percent of the diorite. Magnetite grains are scattered throughout the diorite, but are distinctly concentrated within the hornblende crystals, which causes them to readily attract a magnet.

Hornblende grains throughout the pluton show a distinct lineation that trends about 140° and plunges most commonly to the northwest but locally to the southeast. The plunge in much of the unit is between 50 to 70°, although angles less than 50° are not uncommon.

The diorite commonly has concentrations of hornblende that vary from concordant bands and pods within foliation to occasional larger masses that may be 25 m across. Contacts between the concentrations and the normal diorite are abrupt, but do not appear to be intrusive. The concordant bands and pods tend to be small (a few centimeters thick and a few meters long) and undulatory. The small masses contain up to 80 percent hornblende. The larger masses of hornblende in the diorite are usually poorly foliated and contain almost no plagioclase, although sphene is common. Hornblende crystals within the mafic bands and pods tend to be slightly coarser (4 to 6 mm) than grains in the main mass of diorite.

Concentrically banded orbicules occur near the summit of Peak 4412, 1.6 km north of Tukgahgo Peak. The significance of the orbicles is uncertain, as is the method of their formation. The orbicules are found within 100 m of the basalt contact and form discrete zones 1 to 4 m wide by 10 to 15 m long. The elongate axes of the orbicle zones form at an angle of approximately 60° to the basalt contact and appear to be roughly parallel to each other. The orbicules form 10- to 40-cm-long ovoid bodies set in a matrix of hornblende diorite, which forms 20 to 40 percent of the zones. Each orbicule has a core of either normal diorite or hornblendite that is about one-third of the outer dimension of the orbicle. The cores have alternating light and dark layers composed of plagioclase and hornblende, respectively. The hornblende grains commonly have their long axes perpendicular to the layers.

The epidote-bearing part of the diorite appears to be the epidote diorite of Robertson (1956) and may be correlative with the gabbro and diorite unit of MacKevett and others (1974), although no gabbroic rocks were identified within the B-2 Quadrangle.

Porphyritic hornblende granodiorite. A large body of porphyritic hornblende granodiorite underlies the highest peaks in the Mount Kashagnak area. This leucocratic rock contains 5 to 10 percent hornblende along with about 10 percent quartz and up to 20 percent potassium feldspar. The rock has a subhedral seriate texture, with grain sizes of 3 to 6 mm. Epidote is locally associated with the hornblende, and very minor amounts of magnetite are present. Sphene is common.

Large, pink, zoned megacrysts of potassium feldspar are the most conspicuous feature of this subunit. These pink megacrysts vary in size from 1 to 6 cm and usually have a core of granodiorite. Larger megacrysts have small (1 mm), elongate plagioclase grains that parallel crystal zoning. The crystals are fresh and have relatively sharp borders. The megacrysts commonly make up from 2 to 20 percent of the rock, but the average content is about 10 percent.

The megacrysts are primarily minerals that formed from the original magma and not secondary, postcrystallization replacement features. They are large, distinctly euhedral, and commonly nonpoikilitic. The grains that are included within the megacrysts can probably be explained by concurrent crystallization.

The textures of the megacrysts show a crystallization history of the granodiorite. First, precipitation of the original magma apparently formed a fine-grained quartz diorite (smaller grain size is indicated by the smaller crystals now contained in the core of the megacrysts). At some point, precipitation of potassium feldspar began to concentrate potassium from the system so that little was available for crystallization of the matrix. Larger mineral grains began to form, either because the overall rate of solidification slowed or because the fluidity increased. Early diorite grain sizes (as seen in the megacryst cores) ranged from 1 to 3 mm, whereas later grain sizes averaged about 6 mm.

The granodiorite subunit lacks the epidote alteration common in the diorite, and the diorite occurs in a roughly concentric zone around the granodiorite. The granodiorite therefore probably intrudes the diorite. Diorite and granodiorite outcrops were found within 75 m of each other, but no contacts were exposed.

Hornblende-biotite quartz monzonite porphyry. Underlying the immediate Mount Kashagnak area is the moderately foliated, medium-grained, subhedral, seriate, hornblende-biotite quartz monzonite porphyry subunit of the Mt. Kashagnak pluton. Grain sizes vary from 2 to 4 mm. The rock contains 10 to 15 percent biotite and 5 percent hornblende with 10 to 15 percent quartz. Potassium feldspar makes up 20 to 30 percent of the rock as a whole, although 85 percent occurs in megacrysts. The matrix of the rock contains less than 10 percent potassium feldspar. Sphene and magnetite are present, but are not common.

As in the porphyritic granodiorite, the most notable feature of the biotite quartz monzonite is the presence of potassium-feldspar megacrysts up to 7 cm long. The crystals make up from 5 to 25 percent of the rock, with local concentrations up to 70 percent. They are zoned and have small cores of quartz monzonite. Whereas megacrysts in the granodiorite consist of a rock core surrounded by pink potassium feldspar, megacrysts in the quartz monzinite have a rock core, a middle zoned section of pink potassium feldspar, and an outer zone of white or translucent potassium feldspar with included biotite grains. The biotite grains are parallel to crystal boundaries. The largest megacrysts include small grains of plagioclase and biotite in the outermost layer; sphene has also been noted within the megacrysts. Grain boundaries of the potassium feldspars are relatively sharp, but show signs of some corroding.

The quartz monzonite intrusion is surrounded by a roughly concentric zone of granodiorite, a few fragments of which have been found in the quartz monzonite, thereby establishing the quartz monzonite as the younger rock. No actual contacts were observed in the field, but outcrops of the two rocks were separated by as little as 15 m. Because of their uniquely similar phenocrysts, the two potassium feldspar-bearing rocks are probably very closely related. The presence of the poikilitic zone surrounding the pink potassium feldspar in the megacrysts of the quartz monzonite suggests that conditions must have been similar in both rocks until precipitation of the outer potassium feldspar zone began in the quartz monzonite.

Leucocratic Quartz Monzonite

Two small bodies of leucocratic quartz monzonite crop out in upper Shakuseyi Creek and near lower Chilkoot Lake in the Chilkat block. A large swarm of dikes with similar composition occurs in the same area and extends along the northwest flank of Mt. Ripinski. Megascopically, the quartz monzonite is granular with an average grain size of about 3 mm, while grain size in the dikes is 0.5 mm. Microscopically, all examined samples of both types exhibit a bimodal grain-size distribution. Both types contained about 35 percent fine-grained (0.03 mm) feldspar grains. These grains are scattered throughout the rock, but tend to be concentrated between the larger grains and along cleavage planes within the larger grains.

The two quartz-monzonite bodies are almost free of mafic minerals, but up to 3 percent chloritized biotite occurs locally. Their rocks contain nearly equal amounts of plagioclase and potassium feldspar and about 20 percent quartz. Scattered miarolitic cavities occur and no foliation is present.

The felsic dikes are very leucocratic, containing virtually no mafic minerals. Typical composition is about 25 percent quartz, 30 percent potassium feldspar, and 45 percent plagioclase. Small red garnets are present locally in the cores of the dikes. The dikes can vary in width from a few centimeters to several meters and are strongly aligned parallel to the regional foliation and structure of the area (about 130°).

At contacts with the hornblende diorite (which it intrudes), the quartz monzonite becomes distinctly porphyritic, with potassium feldspar and quartz phenocrysts. The matrix grain size averages 0.5 to 1 mm; the potassium-feldspar phenocrysts can be as large as 2 cm. The quartz phenocrysts are the doubly terminated, high-temperature beta form. This indicates near-surface emplacement because the high-temperature beta form usually converts to alpha quartz at lower temperatures; also, very rapid cooling, which occurs under near-surface conditions, is required to preserve the high-temperature form.

The leucocratic quartz monzonite unit has not been dated radiometrically, and the only units it intrudes are the hornblende diorite and metabasalt. The quartz monzonite is probably no older than the Burro Creek pluton (because both lack foliation) and may be younger. On the basis of similarity with dated plutons, Brew (personal commun., 1983) believes the bodies could be 25 to 20 m.y. old, although they are also similar to the 30- to 27-m.y.-old suite of felsic plutons that includes the Quartz Hill stock near Ketchikan.

Diorite and Volcanic Rocks of the Takhin Block

The Takhin topographic block occupies the region southwest of the Chilkat River, in the southwestern corner of the quadrangle. The rocks of the block consist of hornblende quartz diorite with inclusions and pendants of andesitic volcanic rocks.

A small part of a diorite pluton and remnants of a sequence of andesitic volcanic rocks occur in the southwest corner of the quadrangle, separated from the rest of the map area by the Chilkat fault. The pluton is composed of fine- to medium-grained hornblende biotite diorite or granodiorite with a strong, cataclastic foliation caused by proximity to the Chilkat fault zone. The cataclastic texture diminishes away from the fault. Average grain size is 2 to 3 mm, and the rock has a subhedral, granular texture. Biotite is the dominant dark mineral and forms 15 to 20 percent of the rock. A minor amount of hornblende is also present. About 10 percent of the rock is quartz.

A 180-m-thick section of locally amygdaloidal andesitic volcanic rocks with phenocrysts of hornblende and plagioclase was found above the Takhin River. This unit was not mapped as a separate rock type. The diorite body extends into the Skagway B-3 Quadrangle, where it has been described and dated by MacKevett and others (1974). Although they show inclusions of undivided metamorphic rocks within the diorite, they do not show a rock unit that appears to be correlative with the andesites. MacKevett and others (1974) have dated four samples from the diorite, with ages of 33 to 22.7 m.y. Three of the ages are clustered about 30 m.y. The youngest date is from the cataclastic part of the diorite and is probably inaccurate because of argon loss during deformation (MacKevett and others, 1974).

Structure

Faults

The Skagway B-2 Quadrangle is divided into four topographic blocks by strands of the Lynn Canal - Chatham Strait fault (figs. 1 and 2). South of the Skagway B-2 area, the Lynn Canal structure splits into the Chilkat fault, which cuts the southwest corner of the map area, and the Chilkoot Inlet fault. Near Haines, the Chilkoot Inlet fault splits into three strands that form the Taiya Inlet fault, the Ferebee fault, and the Lutak fault and its subsequent splays, the Chilkoot Valley and Escarpment faults. Of possible significance is the fact that the Chilkoot Inlet fault splays at about the same point at which the Chilkat fault (which eventually connects with the Denali fault) makes an abrupt 20° bend to the west.

Within the Skagway B-2 Quadrangle, all major valleys are controlled by large faults (pl. 1). The Chilkat fault is the largest structure in the region, with a postulated right-lateral offset of about 170 km (Ovenshine and Brew, 1972). The Chilkat River follows the Chilkat fault and has completely covered the feature with fluvial deposits, but shearing in the rocks on either side of the valley is evidence for the presence of the feature. MacKevett and others (1974) have noted strong cataclastic textures and numerous subsidiary faults along the fault trace in the B-3 Quadrangle.

The Lutak Inlet fault, which breaks into the Chilkoot Valley and Escarpment faults north of Lutak Inlet, appears to be the largest of the Chilkoot Inlet strands in the B-2 Quadrangle. The Lutak Inlet fault is actually a fault zone and not a single, discrete fracture. One major component parallels the south side of the inlet and has caused extensive shearing and cataclasis of rocks exposed along Lutak Road and at Tanani Point.

Beyond Chilkoot Lake, the Lutak Inlet fault splits into the Chilkoot Valley and Escarpment faults. The Chilkoot Valley strand appears to be the older, more fundamental fracture because it juxtaposes the Ferebee pluton to the east (thought to be about 65 m.y. old) and rocks of the Mount Kashagnak pluton on the west (possibly 110 m.y. old). Its trace is not well documented, but the fault seems to have been deformed in the upper Chilkoot valley. Magnitude of offset along the fault is unknown.

The Escarpement fault forms a striking linear feature that splits from the Chilkoot Valley fault beneath Chilkoot Lake and trends up the west side of the valley. It juxtaposes different phases of the Mount Kashagnak pluton, but the type or size of displacement is not known.

The Ferebee fault forms the most conspicuous linear feature in the quadrangle. Its trace is now occupied by the Ferebee Glacier and Ferebee River, which completely cover the fault. Striking as this structure appears, offset is probably only a few kilometers. There is little evidence of fault-related shearing along the valley walls, and similar foliated granodiorite with gneiss and migmatite occur on both sides of the structure. Bodies of gneiss and migmatite are found on both sides of the fault, and it may be possible to determine fault offset by matching gneiss and migmatite sections across the fault. The most probable correlation, based on present mapping of gneiss and migmatite sections, gives a right-lateral offset of less that 5 km.

Several smaller but significant faults have also been mapped within the quadrangle. These include the Johnson Creek, Tukgahgo Mountain, Halutu, and Burro Creek faults. The east-west trending Johnson Creek fault controls the course of Johnson Creek and separates metabasalt on the north from pyroxenite and diorite on the south. The fault dips about 75° to the north and is probably a normal fault with at least a few hundred meters of displacement. The fault zone contains abundant serpentine and epidote due to proximity of the pyroxenite.

Near the summit of Tukgahgo Mountain, the Tukgahgo Mountain fault truncates the hornblende diorite and juxtaposes it against metabasalt. The fault trends 140° and probably has at least 450 m of movement, the north side has moved down relative to the south side.

The Halutu fault forms a prominent north- to north-northeast-trending linear reaching from the Ferebee River to the quadrangle boundary. There is right-lateral separation of between 200 and 350 m on gneiss and migmatite sections that cross the fault, but it is uncertain whether movement has been horizontal or vertical. The fault, which dips vertically in some areas and steeply east in others, is composed of a breccia zone about 15 m wide, with a 1-m-wide, green siliceous core.

The Burro Creek fault parallels the Halutu fault and also forms an obvious lineament. The fault dips steeply east and exhibits about 300 m of left-lateral separation on the south side of Burro Creek, where gneiss and migmatite have been brought into contact with the euhedral biotite granodiorite. Sulfide-bearing quartz veins are associated with the Burro Creek fault north of Burro Creek.

While estimates of actual magnitude and direction of offset along the major structures in the B-2 Quadrangle are very difficult to achieve because of the lack of units that can be correlated from one block to the next, it is possible to speculate on the relative vertical positions of the blocks in relation to each other. The Ferebee and Chilkoot blocks have probably been uplifted relative to the Chilkat block. The high-grade metamorphic rocks of the gneiss and migmatite unit in the easterly blocks must have been raised structurally to be adjacent to the metabasalt of the Chilkat block, which has a much lower grade of metamorphism. The rocks west of the Chilkat fault have probably also been uplifted compared to the Chilkat block, because they consist primarily of Paleozoic sediments that are now against rocks no older than Cretaceous. Uplift of the blocks west of the Chilkat fault and east of the Lutak Inlet fault leaves the Chilkat block as a structural trough.

Folding and Foliation

One of the most conspicuous features of the Skagway B-2 Quadrangle is the pervasive nature of the 130 to 150° foliation. It is found in all rocks older than the Burro Creek pluton, and therefore represents a major period of regional deformation and metamorphism that ended between 70 and 50 m.y. ago (unfoliated Burro Creek pluton rocks are 50 m.y. old, and the foliated granodiorite is 70 to 65 m.y. old). Brew (1983) and Gehrels and others (1983) believe that the tonalite sill (thought to be correlative with the Ferebee pluton) was emplaced during the final metamorphic stage of a major deformational event that occurred about 70 m.y. ago. This event, which produced the Wrangell-Revillagigedo Barrovian regional metamorphic belt during latest Cretaceous and earliest Tertiary time (Brew, 1983), also produced the pervasive foliation that characterizes most of the rock units in the Skagway B-2 Quadrangle.

Whole-rock Analyses

Results of eighteen whole-rock analyses (by the Alaska DGGS assay laboratory in Fairbanks) of igneous rocks from the quadrangle are shown in table 1. The average major elemental compositions of typical igneous rocks (Cox and others, 1979) are also given. Comparisons with world-wide averages reveal several interesting points. The pyroxenite sample from Johnson Creek is notably low in silica and magnesia, but contains twice the normal amount of ferric iron, possibly because of the high magnetite content of the Haines pyroxenite. The high combined iron-oxide content of one metabasalt sample (SHE041) probably also reflects a high magnetite content, because hand specimens were distinctly magnetic.

Figure 3 shows the relationship between silica (SiO_2) and the combined alkali oxides ($Na_2O + K_2O$) for the felsic plutonic rocks. Three clusters can

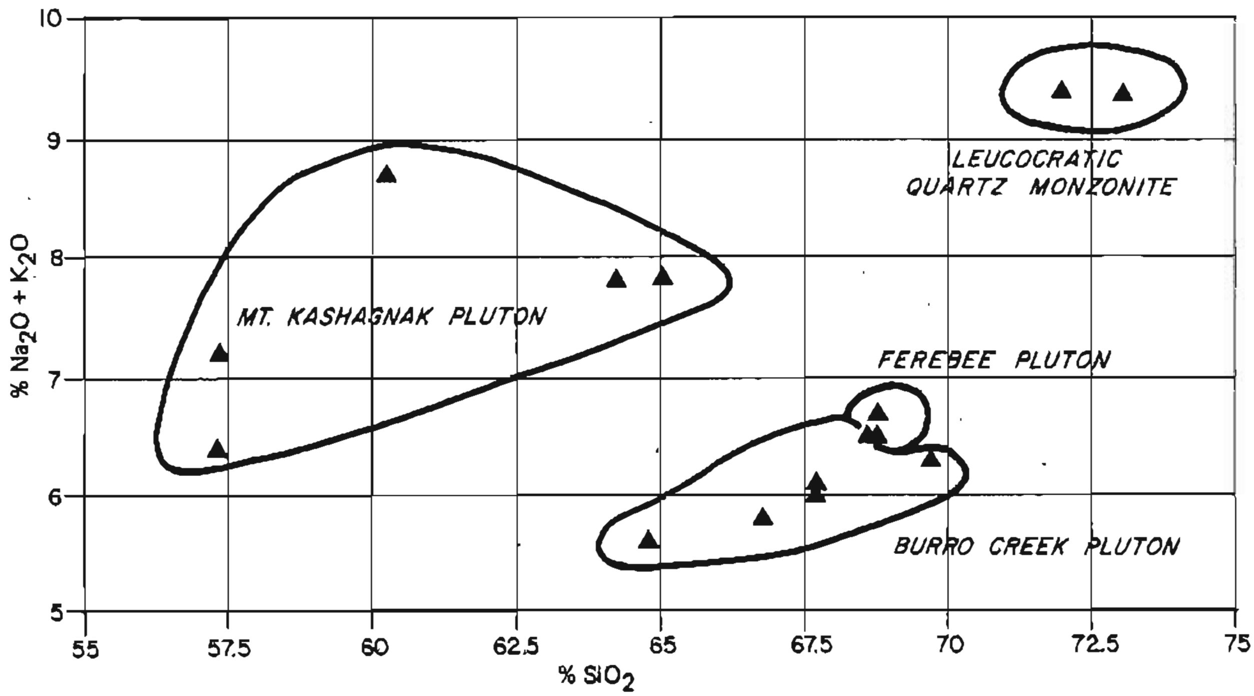

Figure 3. Silica-alkali plots of felsic plutonic rocks, Skagway B-2 Quadrangle.

be seen, representing the Mt. Kashagnak pluton, the leucocratic quartz-monzonite plugs, and the combined Burro Creek and Ferebee plutons. Other plots (SiO_2-Na_2O, SiO_2-K_2O, SiO_2-Al_2O_3, Na_2O+K_2O-CaO) show the same clustering.

The Mt. Kashagnak pluton grouping exhibits the widest divergence. The disparity between silica and alkali content between samples within the two porphyritic units may be partly caused by the presence or absence of potassium feldspar phenocrysts in the analyzed sample.

Oxide contents of leucocratic quartz-monzonite samples from two different plugs confirm the genetic relationship indicated by visual examination. Although the mineralogical composition is that of quartz monzonite, the plugs have the chemical composition of a high-potassium granite.

Compositions of the Ferebee pluton and the two phases of the Burro Creek pluton are very similar. Both plutons have the general composition of a typical quartz monzonite but also have low potassium and ferric-iron content, as well as higher than normal alumina and calcium. This may be coincidental, because an age difference is apparent (the Ferebee pluton has been subjected to metamorphism and the Burro Creek rocks have not). It may also suggest a common parent magma.

Two samples of the Ferebee pluton are chemically very similar to each other, even though one sample was taken from the Ferebee block (along Burro Creek) and is well foliated and the other was taken from the Peak 6282 area on the Chilkoot block and is poorly foliated.

The granodiorite and quartz monzonite of the Burro Creek pluton have very similar chemical compositions (as would be expected of rocks that grade into each other, as these do).

The two dike-rock samples listed in table 1 cut the Ferebee granodiorite and are probably related to the Burro Creek pluton. They show the same low potassium and ferric iron with elevated alumina and calcium as the Burro Creek rocks, and similar dikes are very common along the margins of the pluton. Chemically, the two sampled dikes have the composition of rhyodacite.

Age Dates

Thirteen samples were submitted for K-Ar dating, but results are not yet available.

Geologic History

Each of the three geologic provinces of the quadrangle---which occupy the Ferebee and Chilkoot, the Chilkat, and the Takhin blocks---have different geologic histories, at least until Tertiary time. Evidence suggests that after middle to late Tertiary time events began to affect all blocks as a whole.

The oldest rocks in the quadrangle are the metamorphic gneiss and migmatite unit, which lies within the Ferebee and Chilkoot blocks. Deposition of the shallow-marine shales, sandstones, limestones, and minor volcanic rocks that originally made up this unit probably occurred during late Paleozoic or early Mesozoic time (Beikman, 1975).

During latest Cretaceous time, the Ferebee-Chilkoot block was included in the intense deformation and recrystallization of a regional Barrovian metamorphic event. This event affected the whole length of the Coast Range in southeastern Alaska and altered the pelagic sediments of the Ferebee and Chilkoot blocks to very high grade gneisses and migmatite. Near the end of the Barrovian metamorphism, during latest Cretaceous - earliest Tertiary time, the Ferebee pluton was intruded into the metamorphosed sediments. Samples of tonalite-sill rocks near Juneau have been dated between 69 and 62 m.y. (Gehrels and others, 1983; 1984). Plutonic activity continued in the Ferebee and Chilkoot blocks during early Tertiary time, with intrusion of the Burro Creek pluton into the Ferebee pluton and the gneiss unit. Similar intrusives near Juneau have been dated at about 50 m.y. (Forbes and Engles, 1970; Brew and Ford, 1984).

To the west, in the Chilkat block, the geologic history is unknown until mid-Cretaceous time, when several events occurred during a relatively short period. The first event was deposition of basalt flows and associated sediments on the ocean floor (109-96 m.y. ago, according to MacKevett and others, 1974). The second event, which may have been semicontemporaneous with the first, was the intrusion of a small pluton of pyroxenite (109-108 m.y. ago, MacKevett and others, 1974). After the pyroxenite had been emplaced, intrusion of the Mt. Kashagnak pluton began. The first phase of the three-component pluton consisted of hornblende diorite that intruded both the basalt and the pyroxenite. The second phase of the pluton, porphyritic granodiorite, was intruded into the center of the diorite mass and was in turn intruded by the last phase, a quartz monzonite porphyry. The high-temperature, low-pressure environment that accompanied intrusion of the Mt. Kashagnak pluton subjected the older rocks to Abukuma-type metamorphism.

During Late Cretaceous-early Tertiary time, the Chilkat block was near enough to the Ferebee-Chilkoot block so that both areas were affected by the final stages of the Barrovian metamorphic event. These final stages produced the pervasive 130 to 150° foliation that is present in both the Ferebee pluton and the Mt. Kashagnak pluton.

The Takhin block includes rocks classified as part of the Craig subunit of the Alexander terrane (Berg and others, 1978). The rocks of this terrane in the Skagway B-2 Quadrangle are limited to Tertiary intrusive rocks (K-Ar dates from diorite northwest of the quadrangle boundary cluster around 30 m.y., according to MacKevett and others, 1974) and remnants of the volcanic terrane they intruded.

Middle to late Tertiary time was a period of convergence and similar activity within the three different geologic terrains. At the same time that the Takhin block was intruded by the granodiorite stock, small plugs and dikes of leucocratic quartz monzonite were emplaced on the Chilkat block. Regional strike-slip or vertical faulting (or both) brought the three areas into juxtaposition by late Tertiary time. Since that time, compression and uplift have probably continued to affect all blocks, not necessarily equally. Quaternary glaciations have sculpted the terrain heavily and exposed it to a series of isostatic and enstatic adjustments.

ECONOMIC GEOLOGY AND GEOCHEMISTRY

Occurrences of iron, copper, gold, and radioactive elements have been found within the Skagway B-2 Quadrangle. Several small iron deposits near Haines received some attention in the early 1900s, but there is now little mineral activity in the quadrangle. A regional stream-sediment-sampling program was conducted as a part of this project to aid evaluation of the economic potential of the region.

The 13 known mineral occurrences are shown on plate 1. Analytical data from the stream-sediment-sampling program are given in the appendix, sample sites are shown on plate 2, and anomalies are shown on plate 3.

Mineral Occurrences

Iron deposits associated with the pyroxenite near Haines have been known since 1879. Between 1906 and 1916, the best known deposit was staked and restaked several times, but the only development work reported was a 30-m adit. The deposits have an average iron content of 2 to 10 percent, and there are probably several billion tons of the material (Robertson, 1956). None of the four iron occurrences reported in literature were found in the field. Occurrence 1 is the probable site of the above tunnel, and occurrences 2 through 4 appear to be associated with areas of known magnetite-rich metabasalt.

Several chalcopyrite-bearing quartz veins occur in the quadrangle. Two of these small deposits, occurrences 5 and 6, have been reported by Berg and others (1981). Occurrences 7 through 9, found during this project, are similar and consist of clots of chalcopyrite and pyrite or pyrrhotite in white quartz.

Occurrence 5 is located near the summit of Peak 4920 and consists of malachite-stained quartz veins that cut diorite and carry chalcopyrite and bornite. The veins trend 25° and dip 55° east. They can be traced for at least 100 m and occupy a zone about 25 m wide. A sample of mineralized vein material contained 5.73 percent copper and 21 ppm silver.

Occurrence 6, located in the mountains above Chilkoot Lake, was not found. It is described by Berg and others (1981) as "lode claims on ridge between Chilkoot Lake and Ferebee River" and is said to contain copper. The U.S. Bureau of Mines Skagway Quadrangle claim map is the only reference given.

Occurrence 7, located at about 460 m on the west flank of Tukgahgo Mountain, consists of a series of chalcopyrite-bearing quartz veins that cut a diorite dike in the metabasalts. These veins were 2 to 25 cm thick and at least 10 m long. A representative sample carried 520 ppm copper and 0.3 ppm silver.

Occurrence 8 consists of mineralized quartz-vein float from the Burro Creek fault zone, where it cuts biotite quartz monzonite at the head of Burro Creek. A sample contained 1,580 ppm copper, 50.5 ppm silver, 170 ppm lead, and 128 ppm molybdenum. These veins contained a little chalcopyrite and pyrite in quartz. They were found only in float along the fault trace.

At occurrence 9, near the top of Mt. Harding, small (to 6 cm long) but massive pods of pyrrhotite with traces of chalcopyrite in quartz are associated with a fault zone that cuts paragneisses. A sample of the pyrrhotite yielded 555 ppm copper and 3.1 ppm silver.

At occurrence 10, the presence of a reported deposit of radioactive elements (Berg and others, 1981) was not confirmed by field examinations during this project. Test lines flown up and down Halutu Ridge over the reported occurrence using a gamma-ray spectrometer in a helicopter failed to detect any anomalous radiation.

Placer gold was reportedly found at occurrence 11 in a tributary to the Chilkoot River that flows from Lake 2270 and in the Chilkat River at occurrence 12 (Berg and others, 1981). However, no gold was found in any pan concentrates from these creeks or other nearby creeks.

At occurrence 13, below Mt. Kashagnak, a few rare, thin quartz veins containing small amounts of molybdenum were found. The veinlets are only 1 to 4 mm wide but can be traced for at least several meters. One sample of a single vein with attached wallrock contained 137 ppm molybdenum, 2.3 ppm silver, and 0.7 ppm gold.

Geochemistry

During the fieldwork, 265 stream-sediment, 26 pan-concentrate, and 54 rock samples were taken for geochemical analysis. Samples were analyzed by DGGS in Fairbanks by ICP (inductively coupled plasma). Results of the geochemical analyses are presented in the appendix; sample locations, anomalous elements, and areas of related anomalies are shown on plates 2 and 3.

Determination of Anomaly Thresholds

Anomaly threshold values for stream-sediment analyses differed in different parts of the map area. As shown in table 2, most of the Chilkat block has a much higher background in cobalt, chromium, copper, and nickel than the rest of the quadrangle. These are elements with mafic igneous affinities, and their high backgrounds are caused by the presence of the basalt and pyroxenite in the area. The Ferebee and Chilkoot blocks, composed primarily of felsic rocks, have higher threshold values for molybdenum, lead, antimony, and zinc, which have felsic igneous affinities. The stream-sediment anomaly threshold values in table 2 were determined graphically from histograms and verified statistically. Samples that exceeded these values are indicated on plate 3.

There were too few pan-concentrate samples for statistical evaluation, and the values were generally lower than those for stream-sediment samples, which indicates a lack of metallic minerals in the drainages. Anomaly thresholds for pan concentrates were determined by inspection. There were no silver, arsenic, gold, cadmium, molybdenum, lead, antimony, or tin anomalies; threshold values for the remaining elements are shown on table 3.

Table 2. Anomaly threshold values for stream-sediment samples.

Element	Chilkat block (ppm)	Chilkoot and Ferebee blocks (ppm)
Ag	0.15	0.15
As	10	10
Au	0.1	0.1
Cd	1	1
Co	20	13
Cr	70	50
Cu	300	70
Mo	4	6
Ni	40	30
Pb	9	20
Sb	1	4
Sn	3	3
W	2	2
Zn	75	120

Table 3. Anomaly threshold values for pan concentrate samples.

Element	ppm
Co	30
Cr	120
Cu	110
Hg	125
Ni	55
W	8
Zn	175

Two types of rock samples were analyzed: 1) samples of altered, mineralized or vein material, and 2) samples typical of the various rock units for general background determination. The rock samples, therefore, tend to be either obviously anomalous, with high geochemical values, or at background level. Anomaly thresholds were therefore chosen by inspection. There were too few soil samples for statistical treatment, and the reported values were so low that no threshold values were calculated.

Discussion of Anomalous Areas

Areas with anomalous geochemistry are outlined on plate 3. The most significant is the region associated with the Burro Creek pluton, which contains tungsten and molybdenum anomalies. Tungsten anomalies occur in a large area east of the Ferebee River, whereas molybdenum anomalies are concentrated in the area drained by upper Burro Creek. The anomalies are probably related to the granitic rocks of the pluton.

Two anomalous areas are associated with parts of the gneiss and migmatite unit. The source for these anomalies is uncertain. The first area, the southern end of Halutu Ridge, contains lead and silver anomalies. The second area includes the lower parts of the ridge west of the Ferebee River and Taiyasanka Harbor. The area as a whole is anomalous in molybdenum, but cobalt is also anomalous in the northern half of the area; nickel anomalies occur in the southern part.

The southern end of the Halutu fault appears to be anomalous in nickel and zinc. The area is underlain by both the gneiss and migmatite unit and the Ferebee pluton, but the source for the anomalies is not known.

The cluster of copper anomalies near the head of the Chilkoot River is derived from the silicified rocks cut by the Chilkoot Valley fault. Iron-stained rocks and disseminated pyrite are abundant in this area, and chalcopyrite is probably also present.

The Shakuseyi Creek drainage is anomalous in arsenic and silver. The area is underlain by metabasalt, hornblende diorite, and leucocratic quartz monzonite. The source of the anomalies is unknown but quartz monzonite is the rock most likely to have associated mineral occurrences of these metals.

The cobalt, chrome, copper, and nickel anomalies in the Johnson Creek area are probably due to the pyroxenite in the area.

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APPENDIX - GEOCHEMICAL RESULTS

STREAM SEDIMENT GEOCHEMISTRY (in ppm)

Map No.	Field No.	Ag	As	Au	Cd	Co	Cr	Cu	Fe%	Hg	Mn	Mo	Ni	Pb	Pt	Sb	Sn	W	Zn
S001	SSC002	<.1	<10	<.1	<1	<10	11	33	7.28		799	<1	11	5		<1	1	1	64
S002	SSE061	<.1	<10	<.1	<1	<10	<10	157	2.93		466	2	<10	4		<1	1	1	33
S003	SSH024	0.1	<10	<.1	<1	13	26	165	3.63		691	<1	19	<1		<1	1	1	51
S004	SSC003	<.1	<10	<.1	<1	<10	36	39	2.35		462	2	15	7		<1	2	1	55
S005	SSE015	<.1	<10	<.1	<1	<10	19	23	2.85		451	3	13	2		<1	2	1	68
S006	SSR053	<.1	<10	<.1	<1	<10	<10	22	1.98		270	2	<10	1		<1	2	1	37
S007	SSH105	0.1	<10	<.1	<1	<10	<10	25	1.16		274	1	<10	<1		<1			23
S008	SSE062	<.1	<10	<.1	<1	<10	<10	34	2.15		311	1	<10	3		<1	1	1	42
S009	SSH060	<.1	<10	<.1	<1	<10	<10	4	1.22		160	1	<10	2		<1	1	1	36
S010	SSR050	<.1	<10	<.1	<1	<10	<10	88	2.84		571	1	<10	1		<1	1	1	48
S011	SSH061	<.1	<10	<.1	<1	<10	<10	4	1.22		160	1	<10	2		<1	1	1	36
S012	SSR051	<.1	<10	<.1	<1	<10	<10	8	1.20		186	1	<10	1		<1	1	1	31
S013	SSR008	0.1	<10	<.1	<1	<10	17	5	1.18		188	<1	12	1		<1	1	1	38
S014	SSE017	<.1	<10	<.1	<1	<10	12	6	2.22		323	1	12	3		<1	1	1	56

Map No.	Field No.	Ag	As	Au	Cd	Co	Cr	Cu	Fe%	Hg	Mn	Mo	Ni	Pb	Pt	Sb	Sn	W	Zn
8015	8SR052	<.1	<10	<.1	<1	<10	<10	3	1.77		237	1	<10	2		<1	1	1	54
8016	8SE016	<.1	<10	<.1	<1	<10	11	6	2.29		343	1	12	2		<1	1	1	61
8017	8SH025	<.1	<10	<.1	<1	<10	18	3	2.19		309	<1	15	9		<1	1	1	78
8018	8SH059	<.1	<10	<.1	<1	<10	<10	5	1.11		154	2	<10	2		<1	1	1	29
8019	8SR060	0.1	14	<.1	<1	14	<10	134	3.61		676	2	13	1		<1			51
8020	8SR056	<.1	<10	<.1	<1	<10	<10	22	2.10		171	2	<10	1		<1	1	1	24
8021	8SR061	0.1	<10	<.1	<1	21	<10	399	3.70		291	1	15	1		<1			28
8022	8SR062	0.1	<10	<.1	<1	<10	<10	61	3.11		771	1	<10	1		<1			53
8023	8SR063	0.1	<10	<.1	<1	<10	<10	60	2.07		531	1	<10	1		<1			44
8024	8SR064	<.1	<10	<.1	<1	<10	<10	71	2.46		647	1	<10	1		<1			52
8025	8SR065	0.1	<10	<.1	<1	<10	<10	69	2.20		587	2	<10	2		<1			47
8026	8SE063	<.1	<10	<.1	<1	<10	<10	99	2.00		656	1	<10	4		<1	1	1	41
8027	8SC001	<.1	<10	<.1	<1	<10	11	33	7.28		799	<1	11	5		<1	1	1	64
8028	8SH104	<.1	<10	<.1	<1	<10	<10	14	2.12		247	1	<10	<1		<1			20
8029	8SH086	<.1	<10	<.1	<1	<10	<10	28	6.24		500	1	<10	2		1	1	1	46
8030	8SR070	<.1	<10	<.1	<1	12	<10	95	3.53		733	2	<10	1		<1			75
8031	8SR069	<.1	<10	<.1	<1	<10	<10	18	1.21		390	2	<10	<1		<1			35
8032	8SR068	0.1	<10	<.1	<1	<10	<10	44	2.65		797	3	<10	1		<1			58
8033	8SH053	<.1	<10	<.1	<1	<10	<10	41	3.28		798	1	<10	2		<1	1	1	60
8034	8SR067	0.1	<10	<.1	<1	<10	<10	45	2.41		899	2	<10	1		<1			60
8035	8SH026	<.1	<10	<.1	<1	<10	31	52	2.84		615	1	24	<1		<1	1	1	63
8036	8SE018	<.1	<10	<.1	<1	11	22	94	2.84		527	2	21	3		<1	1	1	54
8037	8SR049	<.1	<10	<.1	<1	<10	<10	48	2.42		494	1	11	3		<1	1	1	51
8038	8SH071	<.1	<10	<.1	<1	<10	<10	3	4.16		473	2	<10	3		2	1	1	152
8039	8SR030	<.1	<10	<.1	<1	<10	<10	2	1.22		143	1	<10	2		<1	1	2	45
8040	8SH019	0.1	<10	<.1	<1	<10	14	8	1.65		262	<1	13	<1		<1	1	1	51
8041	8SH020	<.1	<10	<.1	<1	<10	16	5	1.91		279	2	15	2		<1	2	1	58
8042	8SR005	0.1	<10	<.1	<1	<10	14	3	1.59		246	1	12	<1		<1	1	1	49
8043	8SH036	<.1	<10	<.1	<1	<10	14	5	3.77		527	1	23	10		<1	1	1	155
8044	8SR031	<.1	<10	<.1	<1	<10	<10	<5	2.99		370	2	<10	3		<1	1	1	75
8045	8SH072	<.1	<10	<.1	<1	<10	<10	3	2.82		492	2	<10	5		<1	1	15	80
8046	8SH021	<.1	<10	<.1	<1	<10	14	3	1.48		266	<1	14	3		<1	1	1	50
8047	8SR043	<.1	<10	<.1	<1	<10	<10	42	2.94		473	1	<10	4		<1	1	1	35
8048	8SR042	<.1	<10	<.1	<1	<10	<10	16	2.17		515	1	<10	3		<1	1	1	38
8049	8SE076	<.1	<10	<.1	<1	<10	<10	15	1.74		500	2	<10	2		<1			33
8050	8SE075	<.1	<10	<.1	<1	<10	<10	17	2.29		497	1	<10	2		<1			35
8051	8SH084	<.1	<10	<.1	<1	<10	<10	12	2.07		407	1	<10	2		4	1	1	32
8052	8SE074	<.1	<10	<.1	<1	<10	<10	17	2.27		519	2	<10	2		<1			36
8053	8SH083	<.1	<10	<.1	<1	<10	<10	28	7.87		627	1	<10	4		1	1	1	53
8054	8SR041	<.1	<10	<.1	<1	<10	<10	21	1.95		261	1	<10	2		<1	1	1	23
8055	8SE073	0.1	<10	<.1	<1	<10	<10	56	2.08		578	1	<10	3		<1			42
8056	8SH054	<.1	<10	<.1	<1	<10	<10	27	6.31		516	1	<10	4		<1	1	1	43
8057	8SR059	0.1	<10	<.1	<1	<10	<10	46	3.99		1110	2	14	1		<1			122
8058	8SE060	0.2	<10	<.1	<1	29	23	78	4.81		1900	2	29	5		<1	1	1	145
8059	8SH090	0.1	<10	<.1	<1	<10	<10	11	1.51		213	1	<10	1		3	1	1	24
8060	8SR007	0.1	<10	<.1	<1	<10	30	5	4.86		253	<1	17	<1		<1	1	1	25
8061	8SR055	<.1	<10	<.1	<1	<10	<10	9	1.32		130	<1	<10	1		<1	1	1	15
8062	8SR054	<.1	<10	<.1	<1	<10	<10	13	1.23		320	<1	<10	<1		<1	1	1	37
8063	8SH088	<.1	<10	<.1	<1	<10	<10	25	2.27		473	2	<10	3		1	1	1	36
8064	8SH055	<.1	<10	<.1	<1	<10	<10	18	1.96		458	1	<10	3		<1	1	1	35
8065	8SH085	<.1	<10	<.1	<1	<10	<10	11	1.40		388	1	<10	2		5	1	1	30

Map No.	Field No.	Ag	As	Au	Cd	Co	Cr	Cu	Fe%	Hg	Mn	Mo	Ni	Pb	Pt	Sb	Sn	W	Zn
S066	SSR074	<.1	<10	<.1	<1	<10	<10	23	2.53		921	2	<10	5		<1			69
S067	SSE077	<.1	<10	<.1	<1	<10	10	20	3.63		767	2	<10	2		<1			46
S068	SSH087	<.1	<10	<.1	<1	<10	<10	16	1.42		341	1	<10	2		4	1	1	30
S069	SSR040	<.1	<10	<.1	<1	<10	<10	22	1.68		363	1	<10	<1		<1	1	1	31
S070	SSH056	<.1	<10	<.1	<1	<10	<10	17	6.42		450	2	<10	5		<1	1	1	40
S071	SSH057	<.1	<10	<.1	<1	<10	<10	20	1.91		255	2	<10	2		<1	1	1	31
S072	SSE033	<.1	<10	<.1	<1	<10	<10	18	1.57		390	1	11	1		1			39
S073	SSE034	<.1	<10	<.1	<1	<10	<10	15	1.25		311	1	<10	<1		1			32
S074	SSE035	<.1	<10	<.1	<1	18	<10	27	2.57		1550	<1	12	3		<1			48
S075	SSH027	<.1	<10	<.1	<1	<10	23	18	1.69		385	<1	19	3		<1	1	1	43
S076	SSE036	<.1	<10	<.1	<1	<10	<10	22	2.18		476	<1	11	2		3			45
S077	SSH038	0.1	<10	<.1	<1	<10	22	17	2.18		343	2	19	<1		<1	1	1	34
S078	SSH076	<.1	<10	<.1	<1	<10	<10	26	2.60		399	<1	11	2		<1	1	1	36
S079	SSR034	<.1	<10	<.1	<1	<10	<10	20	2.14		330	1	13	2		<1	1	1	38
S080	SSH037	<.1	<10	<.1	<1	<10	20	12	1.26		245	<1	16	2		<1	1	1	33
S081	SSH075	<.1	<10	<.1	<1	<10	<10	21	2.66		349	<1	<10	2		<1	1	1	34
S082	SSR032	<.1	<10	<.1	<1	<10	<10	27	1.87		227	2	13	2		<1	1	1	30
S083	SSH073	0.1	<10	<.1	<1	<10	<10	2	3.14		430	3	<10	6		<1	1	1	79
S084	SSH074	<.1	<10	<.1	<1	<10	<10	2	3.08		406	2	<10	5		<1	1	1	63
S085	SSH029	<.1	<10	<.1	<1	<10	19	5	3.03		545	2	18	6		<1	1	1	91
S086	SSE038			<.1	<1	<10	<10	3	2.18		408	2	<10						78
S087	SSE039	<.1	<10	<.1	<1	<10	<10	6	2.23		409	2	<10	6		<1			79
S088	SSR016	<.1	<10	<.1	<1	<10	15	3	2.53		556	1	14	11		<1	1	9	79
S089	SSH035	0.1	<10	<.1	<1	<10	19	2	1.12		196	<1	17	6		<1	1	1	37
S090	SSE040	<.1	<10	<.1	<1	<10	<10	3	3.00		379	<1	<10	6		<1			58
S091	SSR006	<.1	<10	<.1	<1	<10	13	2	2.02		321	<1	12	<1		<1	2	1	62
S092	SSE044	<.1	<10	<.1	<1	<10	<10	8	3.26		612	6	<10	14		<1	2	3	120
S093	SSH029	<.1	<10	<.1	<1	<10	19	5	3.03		545	2	18	6		<1	1	1	91
S094	SSE043	0.1	<10	<.1	<1	<10	<10	3	2.53		461	2	11	6		<1			79
S095	SSE046	0.2	<10	<.1	<1	<10	<10	16	3.15		565	11	<10	20		<1	2	15	124
S096	SSR013	0.2	<10	<.1	<1	<10	20	10	2.70		529	6	15	13		<1	2	7	105
S097	SSR009	0.1	<10	0.1	<1	<10	21	4	3.01		482	3	16	12		<1	1	1	88
S098	SSR010	<.1	<10	<.1	<1	<10	21	3	2.78		404	1	15	62		<1	1	1	72
S099	SSE045	<.1	<10	<.1	<1	<10	<10	5	2.50		334	2	<10	3		<1	1	1	59
S100	SSR033	<.1	<10	<.1	<1	<10	<10	2	2.21		300	2	6	4		<1	1	2	55
S101	SSR036	<.1	<10	<.1	<1	<10	<10	21	1.72		371	1	<10	1		<1	1	1	39
S102	SSR035	0.1	<10	<.1	<1	<10	<10	4	3.80		528	2	<10	9		<1	1	1	107
S103	SSR011	<.1	<10	<.1	<1	<10	17	2	1.99		263	6	15	3		<1	1	1	60
S104	SSR012	0.1	<10	<.1	<1	<10	14	3	1.38		620	17	13	8		<1	1	3	43
S105	SSH022	0.1	<10	<.1	<1	<10	20	5	3.10		629	9	19	15		<1	1	3	109
S106	SSH023	0.1	<10	<.1	<1	<10	18	5	3.05		684	6	19	15		<1	2	1	107
S107	SSE078	0.7	<10	<.1	<1	<10	<10	2	2.20		768	7	<10	25		<1			86
S108	SSH030	0.1	<10	<.1	<1	10	17	4	2.31		512	3	17	18		<1	1	1	93
S109	SSH031	<.1	<10	<.1	<1	<10	20	5	2.22		358	4	19	4		<1	1	6	77
S110	SSR014	0.1	<10	<.1	<1	<10	51	17	3.28		462	1	31	4		<1	1	1	93
S111	SSH033	<.1	<10	<.1	<1	<10	30	6	2.13		311	2	24	4		<1	2	1	63
S112	SSH032	<.1	<10	<.1	<1	<10	21	3	1.42		286	1	23	<1		<1	1	1	52
S113	SSE042	<.1	<10	<.1	<1	<10	20	17	3.34		435	2	21	5		<1			90
S114	SSR015	0.1	<10	<.1	<1	20	34	18	3.34		622	3	86	7		<1	1	1	85
S115	SSH034	<.1	<10	<.1	<1	<10	28	8	2.13		317	2	23	7		<1	2	1	72
S116	SSE041	<.1	<10	<.1	<1	<10	<10	4	2.54		424	3	<10	10		<1			90
S117	SSE047	<.1	<10	<.1	<1	<10	16	14	2.40		314	3	15	6		<1	1	1	61

Map No.	Field No.	Ag	As	Au	Cd	Co	Cr	Cu	Fe%	Hg	Mn	Mo	Ni	Pb	Pt	Sb	Sn	W	Zn
S118	SSE048	0.1	<10	<.1	<1	<10	21	22	2.47		277	2	15	5		<1	2	1	53
S119	SSH077	<.1	<10	<.1	<1	<10	<10	3	3.53		395	1	<10	5		7	1	1	104
S120	SSR037	<.1	<10	<.1	<1	<10	<10	5	2.41		290	6	<10	6		<1	1	1	77
S121	SSH078	<.1	<10	<.1	<1	<10	24	39	4.04		842	3	24	8		3	1	1	111
S122	SSE056	<.1	<10	<.1	<1	<10	18	157	3.58		707	4	15	4		<1	1	1	66
S123	SSE053	<.1	<10	<.1	<1	<10	12	8	3.29		332	3	21	6		<1	1	1	87
S124	SSH079	<.1	<10	<.1	<1	<10	17	13	3.25		351	4	23	11		6	1	1	107
S125	SSH080	<.1	<10	<.1	<1	<10	<10	8	2.96		402	2	<10	6		1	1	1	91
S126	SSE055	<.1	<10	<.1	<1	<10	<10	20	2.25		404	1	<10	2		<1	1	1	38
S127	SSR048	<.1	<10	<.1	<1	<10	13	46	2.91		488	4	<10	5		<1	1	1	154
S128	SSE057	0.1	<10	<.1	<1	<10	<10	104	2.89		604	1	13	5		<1	1	1	57
S129	SSR047	<.1	<10	<.1	<1	<10	12	13	1.90		403	1	10	1		<1	1	1	49
S130	SSR046	<.1	<10	<.1	<1	<10	<10	47	1.97		385	2	<10	2		<1	1	1	44
S131	SSR045	<.1	<10	<.1	<1	<10	10	43	1.77		335	2	<10	1		<1	1	1	35
S132	SSH081	<.1	<10	<.1	<1	<10	<10	24	2.79		336	2	<10	2		4	1	1	30
S133	SSR029	<.1	<10	<.1	<1	<10	<10	11	1.37		191	1	10	<1		<1	1	1	29
S134	SSH070	<.1	<10	<.1	<1	<10	<10	3	1.79		146	1	<10	2		5	2	1	33
S135	SSH051	<.1	<10	<.1	<1	<10	33	18	3.21		422	2	31	9		<1	1	1	84
S136	SSH052	<.1	<10	<.1	<1	<10	27	11	3.07		431	2	25	11		<1	1	1	86
S137	SSE054	<.1	<10	<.1	<1	<10	12	17	2.47		434	2	13	2		<1	1	1	55
S138	SSR044	<.1	<10	<.1	<1	<10	<10	15	1.79		283	2	<10	<1		<1	1	1	40
S139	SSH089	<.1	<10	<.1	<1	<10	<10	97	2.24		303	5	10	2		5	1	1	28
S140	SSH058	<.1	<10	<.1	<1	17	166	56	17.9		1050	2	132	12		<1	1	1	154
S141	SSR071	<.1	<10	<.1	<1	<10	<10	10	1.41		396	<1	<10	1		<1			29
S142	SSH082	<.1	<10	<.1	<1	<10	<10	9	1.44		347	<1	<10	2		<1	1	1	27
S143	SSR072	<.1	<10	<.1	<1	<10	<10	13	1.56		570	<1	<10	1		<1			40
S144	SSE032	<.1	<10	<.1	<1	<10	<10	15	1.76		700	1	<10	3		2			47
S145	SSE031	<.1	<10	<.1	<1	<10	<10	13	1.39		530	1	<10	3		<1			36
S146	SSH069	<.1	<10	<.1	<1	<10	<10	58	2.15		424	3	<10	2		9	1	1	28
S147	SSE030	<.1	<10	<.1	<1	<10	<10	10	1.49		461	<1	<10	2		2			33
S148	SSH068	<.1	<10	<.1	<1	<10	13	48	2.31		525	1	12	2		<1	1	1	41
S149	SSE059	0.2	<10	<.1	<1	12	35	83	5.36		1070	6	23	4		1	1	1	111
S150	SSE029	<.1	<10	<.1	<1	<10	<10	9	1.98		496	1	<10	2		3			32
S151	SSR028	<.1	<10	<.1	<1	11	20	48	3.58		570	2	18	3		<1	1	1	80
S152	SSR021	<.1	<10	<.1	<1	<10	19	17	1.58		873	<1	26	17		<1	1	1	50
S153	SSR020	<.1	<10	<.1	<1	<10	21	23	1.67		616	1	29	7		<1	1	1	36
S154	SSR019	<.1	12	<.1	<1	<10	34	30	1.93		738	1	30	5		<1	1	1	42
S155	SSR018	<.1	<10	<.1	<1	<10	22	15	2.42		618	<1	29	4		<1	1	1	43
S156	SSR017	<.1	<10	<.1	<1	<10	25	20	2.20		704	<1	31	4		<1	1	1	43
S157	SSR003	0.2	<10	<.1	<1	14	39	204	3.56		566	1	28	<1		<1	1	1	46
S158	SSE065	0.1	<10	<.1	<1	<10	<10	88	2.27		523	1	<10	5		<1	1	1	36
S159	SSH108	<.1	<10	<.1	<1	12	16	228	4.72		505	2	14	2		<1			44
S160	SSH092	<.1	<10	<.1	<1	<10	10	242	1.98		664	1	10	2		<1	1	1	43
S161	SSH015	0.1	<10	<.1	<1	11	38	396	3.38		638	3	26	4		<1	2	1	52
S162	SSE023	<.1	<10	<.1	<1	<10	14	23	1.22		565	<1	32	5		<1	1	1	37
S163	SSE022	<.1	<10	<.1	<1	<10	20	48	2.23		546	<1	30	5		<1	1	1	31
S164	SSE021	<.1	<10	<.1	<1	<10	35	90	1.81		510	<1	35	3		<1	1	1	35
S165	SSE020	<.1	<10	<.1	<1	<10	69	107	2.26		519	<1	36	2		<1	1	1	51
S166	SSE019	<.1	<10	<.1	2	<10	29	89	1.86		472	<1	33	4		<1	1	1	86
S167	SSH040	<.1	<10	<.1	<1	<10	44	115	2.42		352	<1	35	3		<1	1	1	27
S168	SSH041	<.1	<10	<.1	<1	<10	34	91	2.10		222	<1	31	3		<1	1	1	18
S169	SSH067	<.1	<10	<.1	<1	<10	<10	48	1.91		316	<1	<10	1		<1	1	1	37

Map No.	Field No.	Ag	As	Au	Cd	Co	Cr	Cu	Fe%	Hg	Mn	Mo	Ni	Pb	Pt	Sb	Sn	W	Zn
S170	SSR027	<.1	<10	<.1	<1	<10	<10	16	1.56		454	1	<10	2		<1	1	1	36
S171	SSH066	<.1	<10	<.1	<1	<10	<10	26	2.10		420	1	<10	2		<1	1	1	50
S172	SSR026	<.1	<10	<.1	<1	<10	<10	14	1.79		413	1	<10	2		<1	2	1	38
S173	SSH094	<.1	<10	<.1	<1	<10	12	32	2.67		535	1	13	2		<1	1	1	66
S174	SSH048	0.1	<10	<.1	<1	<10	25	9	1.66		389	3	23	5		<1	1	1	40
S175	SSH047	<.1	<10	<.1	<1	<10	29	17	2.29		497	2	26	5		<1	1	1	64
S176	SSH049	<.1	<10	<.1	<1	<10	26	18	2.21		471	1	27	3		<1	1	1	62
S177	SSH050	<.1	<10	<.1	<1	<10	20	13	1.51		294	<1	21	4		<1	1	1	37
S178	SSH103	0.1	<10	<.1	<1	<10	<10	14	2.62		462	8	<10	10		<1			50
S179	SSE051	<.1	<10	<.1	<1	37	<10	36	2.61		1450	8	19	31		<1	2	1	80
S180	SSR038	0.1	<10	<.1	<1	15	25	18	2.98		793	6	21	9		<1	1	1	52
S181	SSR039	<.1	<10	<.1	<1	<10	<10	4	1.10		157	2	<10	<1		<1	1	1	29
S182	SSE052	<.1	<10	<.1	<1	<10	17	27	3.24		547	3	16	8		<1	2	1	79
S183	SSE026	<.1	<10	<.1	<1	<10	31	11	4.27		589	4	35	15		<1	1	1	130
S184	SSE025	<.1	<10	<.1	<1	<10	19	5	3.83		526	3	31	14		<1	1	1	132
S185	SSE024	<.1	<10	<.1	<1	<10	18	6	3.33		441	1	32	9		<1	1	1	111
S186	SSE049	0.1	<10	<.1	<1	<10	16	12	2.93		365	2	20	7		<1	2	1	82
S187	SSH101	<.1	<10	<.1	<1	<10	<10	8	2.10		322	1	<10	16		2			70
S188	SSE050	<.1	<10	<.1	<1	<10	15	11	2.34		289	2	17	6		<1	2	1	71
S189	SSH100	<.1	<10	<.1	<1	<10	11	10	2.75		356	2	15	10		3			82
S190	SSH098	0.1	<10	<.1	<1	<10	<10	10	1.93		357	2	<10	62		<1			89
S191	SSH099	<.1	<10	<.1	<1	<10	18	14	1.83		233	4	16	12		<1			40
S192	SSH097	<.1	<10	<.1	<1	<10	19	24	2.77		347	28	18	11		<1			73
S193	SSH096	<.1	<10	<.1	<1	<10	<10	7	3.20		463	2	<10	14		<1			111
S194	SHH095	<.1	<10	<.1	<1	<10	27	17	3.58		512	6	17	13		<1			96
S195	SSR025	0.1	<10	<.1	<1	<10	52	9	1.57		192	1	28	3		1	1	1	48
S196	SSR024	<.1	<10	<.1	<1	<10	36	8	1.41		236	2	25	5		<1	2	1	42
S197	SSR023	<.1	<10	<.1	<1	<10	28	9	1.66		285	2	26	4		<1	1	1	36
S198	SSR022	<.1	<10	<.1	<1	<10	26	9	2.07		362	2	25	5		<1	1	1	56
S199	SST003	<.1	<10	<.1	<1	<10	<10	9	2.27	80	465	4	<10	5		<1	1	1	60
S200	SST002	<.1	<10	<.1	<1	<10	<10	8	2.26	60	367	7	<10	3		<1	2	1	38
S201	SSH064	<.1	<10	<.1	<1	<10	<10	~~10~~	2.02		522	2	<10	29		<1	1	1	98
S202	SSE037	0.3	<10	<.1	<1	<10	<10	<10	1.91		462	2	<10	52		3			110
S203	SSR004	0.1	<10	<.1	<1	<10	14	8	1.74		347	4	17	4		<1	1	1	39
S204	SSH017	0.1	<10	<.1	<1	10	28	8	2.11		609	3	19	3		<1	1	1	46
S205	SSH063	0.2	<10	<.1	<1	<10	<10	9	2.24		263	3	<10	9		<1	1	1	52
S206	SSH062	<.1	<10	<.1	<1	<10	10	15	1.93		379	2	16	24		<1	1	1	110
S207	SSH016	<.1	<10	<.1	<1	<10	200	19	3.51		387	1	84	2		<1	1	1	93
S208	SSR066	0.1	<10	<.1	<1	11	62	14	2.65		715	9	35	4		<1			62
S209	SST001	0.2	<10	<.1	<1	11	<10	24	2.52	120	466	4	11	16		<1	1	1	77
S210	SSH102	<.1	<10	<.1	<1	<10	69	12	3.26		549	7	37	3		2			77
S212	SSH006	0.1	<10	<.1	<1	<10	28	29	2.49		611	<1	26	3		<1	1	1	80
S213	SSH042	<.1	<10	<.1	<1	<10	24	135	3.74		612	1	23	5		<1	1	1	38
S214	SSH043	<.1	<10	<.1	<1	<10	41	114	2.22		270	<1	33	2		<1	2	1	21
S215	SSH045	0.1	<10	<.1	<1	<10	48	111	3.29		342	1	33	3		<1	1	1	23
S216	SSH046	0.1	<10	<.1	<1	<10	42	135	3.45		361	1	32	5		<1	1	1	27
S217	SSE004	<.1	<10	<.1	<1	<10	31	74	2.57		657	2	20	2		<1	1	1	53
S218	SSR001	<.1	<10	<.1	<1	<10	37	110	2.27		690	2	27	6		<1	1	1	55
S219	SSE005	<.1	<10	<.1	<1	<10	55	336	3.60		944	2	44	2		<1	1	1	59
S220	SSR002	0.1	<10	<.1	<1	12	48	144	3.18		390	1	32	5		<1	1	1	45
S221	SSE006	0.1	<10	<.1	<1	16	44	177	4.01		846	2	32	<1		<1	1	1	72
S222	SSR058	<.1	<10	<.1	<1	<10	13	190	2.75		450	2	11	5		<1	1	1	35

Map No.	Field No.	Ag	As	Au	Cd	Co	Cr	Cu	Fe%	Hg	Mn	Mo	Ni	Pb	Pt	Sb	Sn	W	Zn
S223	SSE010	0.1	<10	<.1	<1	<10	28	161	3.15		504	2	19	7		<1	1	1	46
S224	SSE008	0.1	<10	<.1	<1	12	37	226	3.41		688	2	23	6		<1	1	1	61
S225	SSE009	0.1	<10	<.1	<1	12	39	360	.847		575	2	21	8		<1	2	1	81
S226	SSE007	0.1	<10	<.1	<1	13	42	281	3.38		748	3	26	10		<1	1	1	67
S227	SSR073	<.1	<10	<.1	<1	10	<10	24	3.57		554	2	19	6		<1			46
S228	SSE064	<.1	<10	<.1	<1	<10	29	187	3.08		410	1	18	4		<1	1	1	33
S229	SSH018	0.2	114	<.1	<1	<10	20	73	1.98		895	1	15	4		<1	1	1	50
S230	SST005	<.1	<10	<.1	<1	<10	27	114	2.95	80	480	1	14	3		<1	1	1	35
S231	SST006	0.1	12	<.1	<1	<10	<10	91	2.35	90	695	3	<10	5		<1	1	1	53
S232	SST004	<.1	23	<.1	<1	<10	15	136	2.29	70	521	2	12	3		<1	1	1	39
S233	SSR057	<.1	<10	<.1	<1	<10	<10	74	1.51		332	1	<10	3		<1	1	1	32
S234	SSE066	<.1	<10	<.1	<1	<10	16	137	2.77		626	2	15	2		<1			53
S235	SSE067	<.1	154	<.1	<1	<10	<10	45	2.64		859	2	<10	3		<1			94
S236	SSE068	0.1	<10	<.1	<1	<10	<10	159	2.58		628	2	<10	3		<1			74
S237	SSE069	0.1	<10	<.1	<1	<10	24	333	2.28		244	1	18	<1		<1			22
S238	SSE070	<.1	<10	<.1	<1	<10	22	294	2.08		238	1	17	1		<1			21
S239	SSE072	0.1	<10	<.1	<1	<10	25	244	1.73		237	1	18	<1		<1			19
S240	SSE071	<.1	<10	<.1	<1	12	26	483	2.58		308	4	20	1		<1			25
S241	SSH091	<.1	<10	<.1	<1	<10	19	181	1.87		274	1	17	3		<1	1	1	29
S242	SSH001	<.1	<10	<.1	<1	<10	16	40	1.54		187	<1	15	<1		<1	1	1	29
S243	SSH002	<.1	<10	<.1	<1	<10	27	87	2.26		367	<1	19	2		<1	1	1	48
S244	SSE001	<.1	<10	<.1	<1	<10	17	41	1.79		521	2	12	10		<1	1	1	60
S245	SSH003	0.1	<10	<.1	<1	<10	33	101	2.48		380	<1	21	2		<1	1	1	48
S246	SSH004	<.1	<10	<.1	<1	<10	30	128	1.97		448	1	20	2		<1	1	1	44
S247	SSH005	<.1	<10	<.1	<1	<10	36	129	2.19		382	<1	22	<1		<1	1	1	47
S248	SSH107	<.1	<10	<.1	<1	13	28	202	3.39		391	3	22	20		<1			47
S249	SSH008	0.1	<10	<.1	<1	<10	43	83	2.28		577	1	23	2		<1	1	1	37
S250	SSH010	0.1	<10	<.1	<1	<10	32	114	3.12		550	<1	23	5		<1	1	1	64
S251	SSH011	0.1	<10	<.1	<1	10	35	130	3.30		668	1	24	8		<1	1	1	71
S252	SSH012	0.2	<10	<.1	<1	17	66	245	4.36		651	1	40	1		<1	1	1	51
S253	SSH013	0.1	<10	<.1	<1	<10	26	47	2.25		418	<1	21	<1		<1	1	1	33
S254	SSH014	0.1	<10	<.1	<1	<10	33	46	3.52		508	1	25	4		<1	1	1	76
S255	SSE014	<.1	<10	<.1	<1	25	99	305	6.01		693	2	49	5		<1	1	1	56
S256	SSE013	<.1	<10	<.1	<1	25	74	245	6.44		575	2	46	<1		<1	1	1	52
S257	SSE012	<.1	<10	<.1	<1	25	72	248	6.11		568	2	46	<1		<1	1	1	55
S258	SSE011	<.1	<10	<.1	<1	24	75	253	6.82		602	3	46	<1		<1	1	2	55
S259	SSH009	<.1	<10	<.1	<1	<10	20	30	1.91		194	1	10	17		<1	1	1	17

ROCK GEOCHEMISTRY (in ppm)

Map No.	Field No.	Ag	As	Au	Cd	Co	Cr	Cu	Fe%	Hg	Mn	Mo	Ni	Pb	Pt	Sb	Sn	W	Zn
R001	SHH128	<.1	<10	<.1	<1	<10	32	23	2.03		512	1	<10	2		<1			29
R002	SHR108	<.1	<10	<.1	<1	<10	<10	19	2.46		1020	1	12	2		<1			71
R003	SHR096	0.8	<10	0.1	<1	<10	27	29	7.64		91	3	<10	3		<1			5
R004	SHE057	<.1	<10	<.1	<1	<10	32	2	3.54		458	1	<10	2		<1			83
R005	SHE045	<.1	<10	<.1	<1	<10	39	2	2.65		419	2	<10	2		<1			64
R006	SHE076	<.1	<10	<.1	<1	<10	56	1	1.41		234	2	<10	4		<1			50
R007	SRE004	50.5	13	<.1	<1	<10	80	1580	1.14		377	128	<10	170		<1	1	1	74
R008	SRH005	<.1	10	<.1	<1	15	71	28	5.47		853	2	13	7		<1	1	1	97
R009	SHC010	<.1	<10	<.1	<1	<10	41	1	2.33		382	<1	<10	3		<1			69
R010	SRC003	<.1	<10	<.1	<1	<10	27	1	2.05		337	<1	<10	9		1			74

Map No.	Field No.	Ag	As	Au	Cd	Co	Cr	Cu	Fe%	Hg	Mn	Mo	Ni	Pb	Pt	Sb	Sn	W	Zn
R011	SHE189	<.1	<10	<.1	<1	<10	<10	<1	1.67		179	2	<10	3		<1			46
R012	SRE010	<.1	<10	<.1	<1	<10	48	2	1.87		292	2	<10	18		<1			56
R013	SHE164	<.1	<10	<.1	<1	<10	<10	6	.875		137	1	<10	1		<1			10
R014	SHR086	0.4	<10	<.1	<1	39	47	2620	6.91		789	2	153	1		<1			176
R015	SHE087	<.1	<10	<.1	<1	<10	49	11	2.01		506	1	<10	2		<1			52
R016	SHE178	<.1	<10	<.1	<1	<10	33	<1	.691		118	2	<10	2		<1			22
R017	SHE175	<.1	<10	<.1	<1	<10	<10	6	.663		213	2	<10	5		<1			18
R018	SRE008	0.2	<10	<.1	<1	<10	126	66	2.48		323	5	35	4		<1			52
R019	SHE129	<.1	<10	<.1	<1	<10	37	<1	1.96		275	3	<10	4		<1			49
R020	SRE007	3.1	<10	<.1	<1	68	41	535	7.07	80	96	3	27	25		<1	1	1	46
R021	SHE125	<.1	<10	<.1	<1	<10	27	<1	1.81		293	1	<10	4		<1			56
R022	SRE011	<.1	<10	<.1	<1	<10	35	11	3.44		4040	2	<10	8		<1			62
R023	SRH010	<.1	<10	<.1	<1	11	15	33	3.07		2220	2	<10	14		<1			120
R024	SRH011	0.1	<10	<.1	<1	<10	15	30	2.24		716	<1	<10	14		<1			38
R025	SHE168	<.1	<10	<.1	<1	<10	14	6	.596		167	2	<10	1		<1			13
R026	SRE009	2.3	<10	0.7	<1	<10	84	12	1.24		268	137	10	25		2			13
R027	SHR108	<.1	<10	<.1	<1	<10	31	21	2.29		665	2	<10	1		<1			50
R028	SRH006	0.1	<10	<.1	<1	38	89	225	3.97		3920	18	69	5		<1	1	1	125
R029	SRE006	1.7	109	<.1	<1	<10	71	37	2.61	40	257	4	17	114		<1	1	1	105
R030	SHH055	<.1	<10	<.1	<1	<10	37	3	2.86		374	1	<10	3		<1			57
R031	SHR057	<.1	<10	<.1	<1	<10	54	33	3.00		331	1	19	3		<1			22
R032	SHR039	<.1	<10	<.1	<1	<10	44	10	1.81		467	<1	<10	4		1			26
R033	SHR055	<.1	<10	<.1	<1	<10	27	6	1.31		320	1	<10	2		<1			21
R034	SHR008	<.1	<10	<.1	<1	16	33	117	5.88		274	2	25	<1		<1	1	1	31
R035	SRR010	20.9	<10	0.1	<1	<10	28	5.73%	2.59		433	2	<10	14		<1	1	1	99
R036	SRR008	1.7	<10	<.1	<1	<10	153	4860	.378		35	2	<10	4		<1	1	1	55
R037	SRE005	<.1	93	<.1	<1	<10	22	26	2.39	50	710	1	16	15		<1	1	1	63
R038	SHE013	<.1	<10	<.1	<1	<10	34	1	.526		154	1	<10	2		<1			9
R039	SRE001	0.3	<10	<.1	<1	<10	127	520	.600		74	<1	<10	2		<1	1	1	4
R040	SHE021	<.1	<10	<.1	<1	14	55	114	3.72		308	1	29	1		<1			30
R041	SHE037	<.1	<10	0.1	<1	10	63	307	4.29		320	2	15	1		<1			11
R042	SHT018	<.1	<10	<.1	<1	<10	56	4	.396		80	<1	<10	6		2			7
R043	SHE154	<.1	<10	<.1	<1	<10	19	86	1.83		207	1	10	1		<1			17
R044	SRE002	0.1	<10	<.1	<1	<10	74	9	.849		134	<1	<10	2		<1	1	1	25
R045	SHE003	<.1	<10	<.1	<1	<10	39	14	.433		81	1	<10	4		<1			8
R046	SHE005	<.1	<10	<.1	<1	<10	38	18	1.32		357	1	<10	2		<1			42
R047	SHE007	<.1	<10	<.1	<1	<10	59	15	1.61		594	1	<10	2		<1			70
R048	SHH002	<.1	<10	<.1	<1	<10	52	3	1.65		479	1	<10	4		<1			34
R049	SRH003	0.6	<10	<.1	<1	<10	134	163	.485		65	2	<10	4		<1	1	1	10
R050	SRH004	<.1	<10	<.1	<1	<10	89	9	.334		70	1	<10	5		<1	1	1	10
R051	SRE003	0.1	<10	<.1	<1	<10	46	87	3.69		393	4	11	3		<1	1	1	44
R052	SHE027	<.1	<10	<.1	<1	28	<10	342	9.64		1100	2	25	1		<1			70
R053	SHH138	0.1	<10	<.1	<1	23	<10	16	8.99		467	1	21	10		<1			30
R054	SHE035	<.1	<10	<.1	<1	44	83	9	13.4		724	2	114	<1		<1			26

SOIL GEOCHEMISTRY (in ppm)

Map No.	Field No.	Ag	As	Au	Cd	Co	Cr	Cu	Fe%	Hg	Mn	Mo	Ni	Pb	Pt	Sb	Sn	W	Zn
D001	SDC001	<.1	<10	<.1	<1	<10	14	5	3.24		728	1	18	14		<1	1	1	127
D002	SDC002	<.1	<10	<.1	<1	<10	11	3	3.56		1570	5	16	37		<1	1	1	111
D003	SDC003	<.1	<10	<.1	<1	<10	10	2	2.94		1270	1	17	19		<1	1	1	87

Map No.	Field No.	Ag	As	Au	Cd	Co	Cr	Cu	Fe%	Hg	Mn	Mo	Ni	Pb	Pt	Sb	Sn	W	Zn
D004	SDR002	<.1	<10	<.1	<1	<10	<10	21	1.58		655	1	<10	3		<1	1	1	47
D005	SDR001	<.1	<10	<.1	<1	<10	10	26	2.24		728	1	18	6		<1	1	1	49

PAN CONCENTRATE GEOCHEMISTRY (in ppm)

Map No.	Field No.	Ag	As	Au	Cd	Co	Cr	Cu	Fe%	Hg	Mn	Mo	Ni	Pb	Pt	Sb	Sn	W	Zn
P001	SPE008	<.1	<10	<.1	<1	31	55	44	32.2	30	1250	3	23	5		<1	1	1	74
P002	SPH011	<.1	<10	<.1	<1	<10	45	16	5.87	20	563	2	<10	5		<1	1	3	27
P003	SPR005	<.1	<10	<.1	<1	15	47	79	7.54	200	1120	3	16	5		<1	1	1	39
P004	SPE007	<.1	<10	<.1	<1	19	52	103	9.05	30	1200	3	14	3		<1	1	1	64
P005	SPE006	<.1	<10	<.1	<1	34	<10	48	52.1	20	2910	2	<10	<1		<1	1	1	234
P006	SPR003	<.1	<10	<.1	<1	<10	121	33	26.2	30	965	1	20	<1		<1	1	1	57
P007	SPH009	<.1	<10	<.1	<1	31	20	74	28.0	30	1630	1	25	5		<1	1	1	196
P008	SPR004	<.1	<10	<.1	<1	13	82	115	7.93	30	1370	6	23	4		<1	1	1	43
P009	SPH010	<.1	<10	<.1	<1	15	90	31	35.5	20	936	1	49	4		<1	1	1	29
P010	SPE005	<.1	<10	<.1	<1	18	90	55	27.6	30	1510	2	40	4		<1	1	1	24
P011	SPH005	<.1	<10	<.1	<1	11	78	33	9.46	30	1140	2	14	3		<1	1	1	18
P012	SPE001	<.1	<10	<.1	<1	<10	87	4	.982	20	156	2	<10	3		<1	1	8	26
P013	SHE002	<.1	<10	<.1	<1	<10	125	4	1.94	20	320	3	<10	5		<1	1	2	47
P014	SHE003	<.1	<10	<.1	<1	<10	48	7	2.40	20	548	1	<10	3		<1	1	1	45
P015	SPH006	<.1	<10	<.1	<1	<10	61	13	5.77	20	409	1	<10	2		<1	1	1	21
P016	SPE004	<.1	<10	<.1	<1	<10	60	5	2.85	20	403	3	14	2		<1	1	7	62
P017	SPH007	<.1	<10	<.1	<1	<10	102	16	5.99	20	820	2	11	3		<1	1	1	39
P018	SPR001	<.1	<10	<.1	<1	<10	51	19	4.67	30	575	2	10	3		<1	1	2	39
P019	SPH004	<.1	<10	<.1	<1	<10	115	6	1.78	30	254	2	<10	3		<1	1	1	34
P020	SPH014	<.1	<10	<.1								3		3		<1			
P021	SPH013	<.1	<10	<.1								3		2		<1			
P022	SPH012	<.1	<10	<.1								4		2		<1			
P023	SPH008	<.1	<10	<.1	<1	<10	96	4	2.71	20	340	2	<10	4		<1	1	1	80
P024	SPH001	<.1	<10	<.1	<1	16	92	59	17.9	100	694	2	24	7		<1	1	1	50
P025	SPH002	<.1	<10	<.1	<1	11	111	79	6.36	150	588	2	28	3		<1	1	1	54
P026	SPH003	0.1	<10	<.1	<1	24	95	174	14.0	40	666	3	62	<1		<1	1	1	40