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Mineral Resource Assessment of the Circle Quadrangle, Alaska

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Introduction

This report, as part of the Alaska Mineral Resource Assessment Program (AMRAP), assesses, by tract and by deposit type, the metalliferous mineral resource potential of the Circle quadrangle, Alaska and briefly discusses the occurrence of selected non-metallic resources. The assessment is based upon investigations of the geology, geochemistry, and geophysics of the area. Specific investigations included: regional-scale (1:250,000) reconnaissance geologic mapping (Foster and others, 1983), potassium argon (Wilson and Shew, 1981) and uranium lead age determinations (Aleinikoff and others, in press), chemical analysis of mineralized and background rocks, chemical analysis of the minus-80-mesh fraction of stream sediment samples (Tripp and Crim, 1983), chemical analysis of and identification of selected minerals in nonmagnetic, heavy-mineral concentrate samples from stream sediments (Tripp and Houston, 1983, and Tripp, O'Leary, and Rizolli, 1983), interpretation of aeromagnetic data (Cady and Weber, 1983), interpretation of gravity data (Cady and Barnes, 1983), investigation of placer deposits (Yeend, 1982), and interpretation of Landsat images (S. L. Simpson, oral commun., 1982).

The Circle quadrangle has been an area of gold placer mining since the 1890's. During the period of fieldwork (1977-1982) for this report, the price of gold rose considerably. This led to increased placer mining. In addition, exploration for lode deposits in the quadrangle increased beginning in the early 1970's.

The first section of this report discusses the methods used in the assessment; a second section models types of ore deposits which may occur within the quadrangle. The third section discusses areas (tracts) which may contain particular types of deposits and gives the geological characteristics used to delineate these areas. In the final section of the report the extent to which characteristics of deposit types are present in individual tracts are summarized and estimates of the numbers of deposits that may occur in the tracts are given.

ACKNOWLEDGMENTS

The preparation of this report was facilitated by the efforts of a number of people. Discussions with Jeff Burton and Bob Schafer of MAPCO, Incorporated, and Cynthia T. Cunningham of HIM, Incorporated, were helpful in understanding the geology of particular parts of the quadrangle. James Barker of the U.S. Bureau of Mines provided information on mineral occurrences in the Circle quadrangle.

Jim Carson of Central, Alaska, assisted by providing information and contacts with local miners.

A large number of colleagues at the U.S. Geological Survey assisted in completing the report. Terry Keith provided petrographic and x-ray

diffraction analysis of samples of altered rocks. Discussions with B. L. Reed and G. D. Eberlein about the geology of tin deposits and discussions with Jo Laird about contact metamorphic and plutonic rocks were particularly useful. James Bliss assisted with the statistical analysis of rock geochemical data and Gail Jones helped prepare the models of tin vein/greisen and tungsten skarn deposits. Florence Weber provided useful information about the general geology of the quadrangle and Cori Condon gave able assistance in preparing the map and table of mineral occurrences.

METHODOLOGY

This report follows the general methodology of the AMRAP program (Singer, 1975), which consists of (1) delineation of tracts as permissive for the occurrence of mineral deposits by type, (2) construction of statistical models of important characteristics, such as grade and tonnage of the types of deposit, and (3) estimation of the number of deposits likely to occur within delineated tracts.

As with other AMRAP studies, the methodology has been adjusted to be consistent with the types and amounts of information available. The deposit type models in the present report differ from previous AMRAP reports in that they include a description of geologic characteristics of the deposits along with a statistical model of deposit grades and tonnages. The descriptions are based upon compilations of geologic characteristics of individual deposits from throughout the world. The quality of the grade/tonnage models varies depending upon sample size and the degree of geological similarity of the deposits. This report contains descriptive models of tungsten skarn deposits, tin vein/greisen deposits, uranium deposits hosted by peraluminous granites, and lode gold deposits in metasedimentary terranes and shale-hosted lead-zinc deposits. Grade/tonnage models are presented for tungsten skarn deposits, tin vein/greisen deposits, and shale-hosted lead-zinc deposits. The tungsten skarn model is based upon figures that were formed by combining all occurrences related to an individual pluton to form a single grade and tonnage estimate. The tin vein/greisen model is a new model built with deposits from Europe, Australia, Asia, and North America; it must be regarded as preliminary because the deposits used to construct the model come from a number of settings within an overall vein/greisen environment. Nevertheless, the model should provide a guide to the importance of such deposits. No grade/tonnage models are available for the other two deposit types.

Several other adjustments in the method merit mention. In two cases stream sediment samples from drainages that contain particular rock units were geochemically anomalous for suites of elements. Because of a lack of good exposures of these units it was not possible to determine whether anomalies were caused by locally elevated background levels in the rock units, or by particular types of mineralization. The rock units were delineated and possible sources of the anomalies are enumerated. Finally, this report presents summary tables that relate the characteristics of individual tracts to the characteristics of the deposit types.

DESCRIPTIVE AND GRADE/TONNAGE MODELS OF DEPOSIT TYPES WHICH MAY OCCUR WITHIN THE CIRCLE QUADRANGLE

The Circle quadrangle in this report is divided into three areas (fig. 1): the largest is a complexly deformed, regionally metamorphosed terrane of mostly quartzitic and pelitic rocks south of the Tintina fault zone; the second is the area north of the Tintina fault zone which consists mostly of folded Proterozoic(?) and(or) Paleozoic sedimentary rocks which are only very slightly metamorphosed. These sedimentary rocks are in probable thrust contact with mafic igneous rocks and associated chert of late Paleozoic and early Mesozoic age (Circle Volcanics). Minor clastic deposits of probable Tertiary age occur in topographically low areas just north of the southern margin of the Tintina fault zone. The third area consists of the northwestern part of the quadrangle and is comprised largely of folded and slightly metamorphosed Precambrian(?) and(or) Paleozoic sedimentary rocks, Mesozoic clastic rocks, and tuffs and tuffaceous sedimentary rocks of Paleozoic and(or) Mesozoic age.

The area south of the Tintina fault zone and the northwestern part of the quadrangle are intruded by granitic plutons which post-date regional metamorphism and associated deformation. The intrusions are composite and dominantly of peraluminous biotite granite. All three parts of the quadrangle have minor mafic and ultramafic rocks. The ultramafic rocks are probably mostly in fault contact with adjacent rocks.

The geologic setting of the Circle quadrangle, especially the presence of post-orogenic plutons intruded into regionally metamorphosed rocks, is similar to regions, such as eastern Australia, southwestern England, northern New England, and southeastern Canada, that contain tin vein/greisen deposits, tungsten skarn deposits, lode gold deposits with associated placers, and uranium deposits hosted by peraluminous granites. The presence of very small bodies of ultramafic rocks would permit the occurrence of chromite, nickel, and asbestos deposits although supporting geologic and geochemical evidence for such deposits has not been found within the quadrangle. Finally, in many places in the northern Cordillera, Paleozoic clastic and carbonate rocks host stratiform lead-zinc deposits. Models of these deposits are presented below.

TIN VEIN/GREISEN DEPOSIT MODEL

Permissive rock types: Greisen tin deposits are associated with composite, greisenized granitic plutons, which commonly have a well established differentiation sequence. The stanniferous phase is generally the youngest and most differentiated phase of the magmatic sequence, occurring in the cupola of the pluton. The granitic rock is most commonly peraluminous (that is the weight percent $(Al_2O_3/(CaO+NA_2O+K_2O))\geq 1$ (Clark, 1981)) and generally is a biotite- or two-mica-granite. These granites normally contain at least 70 percent (by weight) SiO_2, are enriched in K_2O relative to Na_2O $(K_2O/Na_2O)\geq 1.2$, and are depleted in Fe_2O_3.

Taylor (1979) and Strong (1981) characterized tin deposits by the depth of emplacement of the intrusives. Deposits in the following two plutonic environments may occur in the Circle quadrangle:

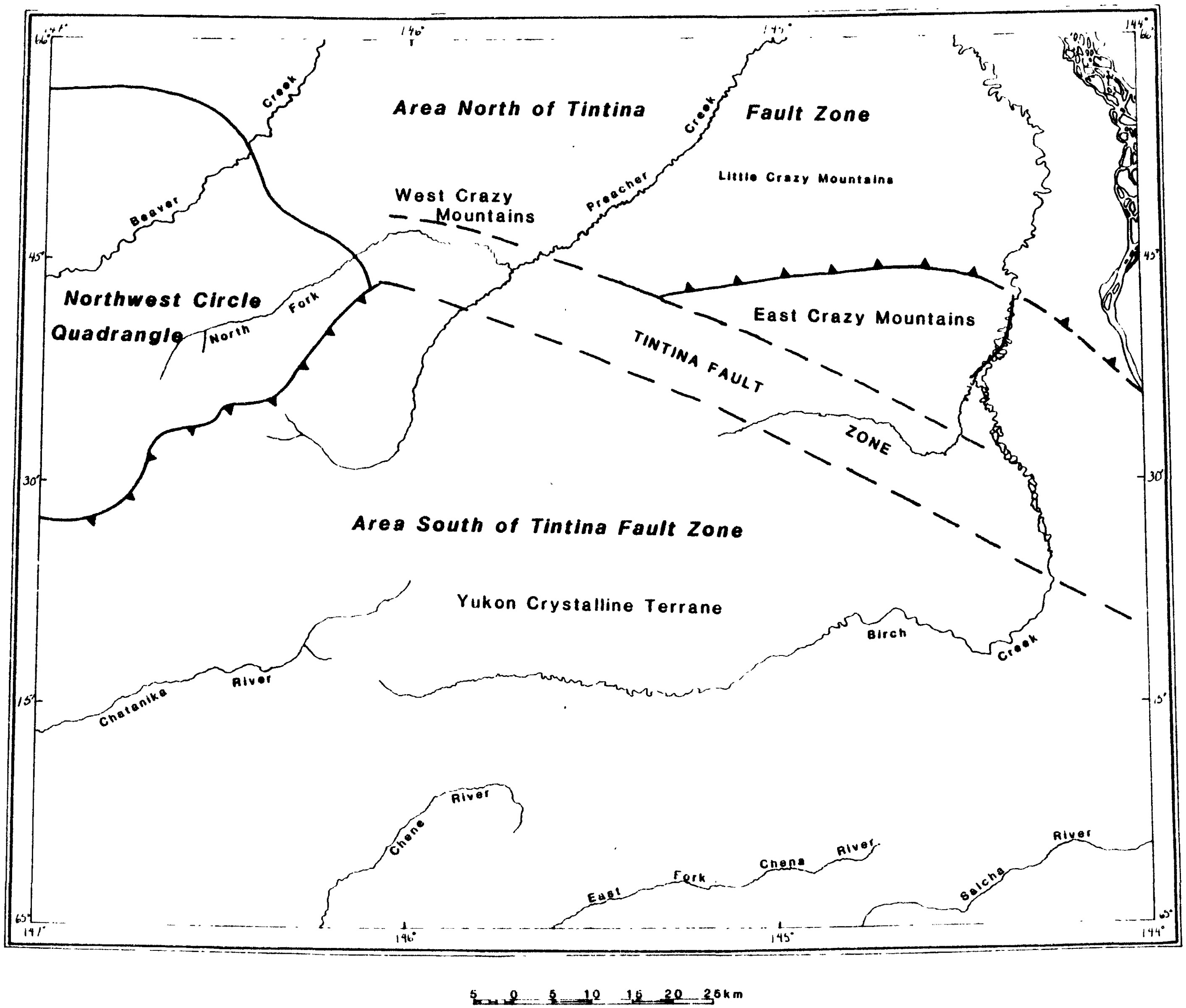


Figure 1. Map showing parts of the Circle quadrangle.

1. Deposits of entirely plutonic character in which cassiterite occurs in the sheet-like greisenized apical phase of the pluton emplaced at a depth of approximately 4-8 km (Blue Tier batholith, Tasmania, Australia, Erzgebirge, German Democratic Republic (G.D.R.), and Czechoslovakia).

2. Deposits of an environment transitional between plutonic and deep volcanic, in which the tin occurs in small stocklike bodies, commonly associated with regional structures which reflect a buried batholith (Chukotka, U.S.S.R.), and as dilational quartz vein systems.

In the transitional environment, tin deposits may also occur in the country rock. For instance, mineralized country rock may be associated with dikes and sills just above the cupolas.

Ore mineralogy: In deposits of the plutonic and transitional environment, quartz-cassiterite veins and stockworks in which cassiterite is generally the only economic ore mineral are commonly accompanied by any of the following: fluorite, pyrite, chalcopyrite, arsenopyrite, wolframite, and molybdenite. Topaz, tourmaline, galena, and sphalerite are also common. Accessory minerals may include muscovite, chlorite, hematite, stannite, pyrrhotite, scheelite, bismuthinite, and carbonates.

Controls on mineralization: The contacts of granite or dikes with country rock and occurrence of faults and fractures are important factors related to the localization of cassiterite. Cassiterite commonly occurs in sheetlike bodies in greisenized late-stage leucogranite at the apex of the pluton or in fissure veins, stockwork, open spaces adjacent to faults, or in pipes formed by intersecting structures in granites or adjacent country rock.

Geochemical zoning: Generalized vertical zoning consists of tin minerals, perhaps with molybdenum minerals, in the "emanative center" followed by tungsten and bismuth with copper, and lead and zinc farthest out from the center. The tin zone generally plunges at an angle less than that of the local slope of the granite contact (Garnett, 1966). However, numerous periods of jointing tend to mask vertical zoning (Dumler, 1978).

In the Miao Chang region, mineralization extends about 1,000 m vertically. Tourmaline occurs below chlorite which is followed by rocks with higher sulfide mineral content in the upper zones. Chalcopyrite gives way to cassiterite with depth (Taylor, 1979).

Greisenized rock: High temperature fluids, rich in fluorine and chlorine that emanate from a granitic magma are thought to leach plagioclase and primary mafic minerals and replace them with quartz and mica, commonly accompanied by topaz, fluorite, tourmaline, feldspar, and ore minerals (Scherba, 1970). The resulting greisen may replace the country rock adjacent to the granitic body as well as the granite. Greisens develop most extensively in quartzites, shales and their metamorphic equivalents (Reed, 1982).

Grade/tonnage model: Figure 2 presents a preliminary grade/tonnage model of tin vein/greisen deposits which is based upon 23 deposits from around the world. It should be regarded as preliminary, because of the small number of

Variable	Number of deposits in the model	90%	50%	10%
tonnes $x10^6$	23	.66	4.5	30.5
percent Sn	23	.15	.47	1.40

correlation of tonnage and Sn grade = -.30

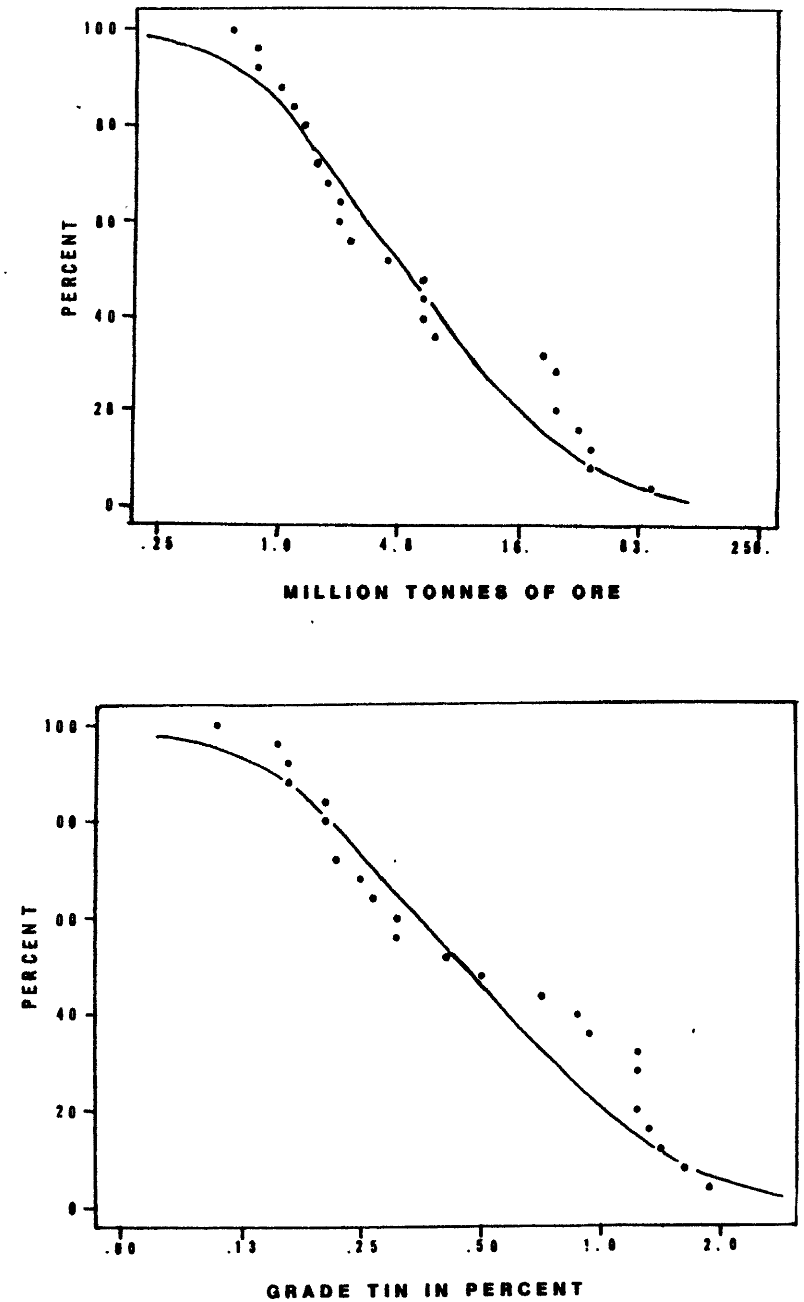


Figure 2. Grade/tonnage model of tin vein/greisen deposits (percent of deposits that equal or exceed a given tonnage or grade).

deposits upon which it is based and because the deposits in the sample come from a number of settings within the vein/greisen environment.

TUNGSTEN SKARN DEPOSIT MODEL

This descriptive model is based upon the recent, comprehensive review of skarn deposits by Einaudi, Meinert, and Newberry (1981), and upon descriptions of individual deposits, especially those in the western United States.

Host rocks: Scheelite occurs in contact metamorphosed carbonate rocks adjacent to felsic intrusives. The ore zones of these deposits may follow the intrusive--skarn contact or the bedding of the metasomatized marble depending upon a number of factors such as purity of the carbonate host and the presence of overlying or intercalated shales.

Associated intrusive rocks: Contact metasomatism and tungsten mineralization are associated with intrusions of relatively unfractured, calc-alkaline granitic bodies, which may be batholith or stock size, or dikes and sills. The plutons are commonly coarse-grained, porphyritic, and have compositions from granodiorite to alaskite (Einaudi, Meinert, and Newberry, 1981).

Altered rocks: The intrusive rocks generally show no alteration effects other than the occurrence of quartz-feldspar myrmekite. However garnet, pyroxene, and scheelite skarn in carbonate rocks adjacent to felsic plutons is a common characteristic of tungsten skarn deposits. The kind of garnet and/or pyroxene present depends upon the types of country rock and depth of the pluton. Skarns which contain hedenbergetic pyroxene, almandine-rich garnet, biotite and hornblende form adjacent to plutons emplaced at great depth or in carbonaceous country rocks. Plutons emplaced at shallow depths or in hematitic or non-carbonaceous country rocks form skarn which contain andraditic garnet and epidote. Large tungsten skarns form in deep plutonic environments (Einaudi, Meinert, and Newberry, 1981). The Circle quadrangle may contain both types of skarns.

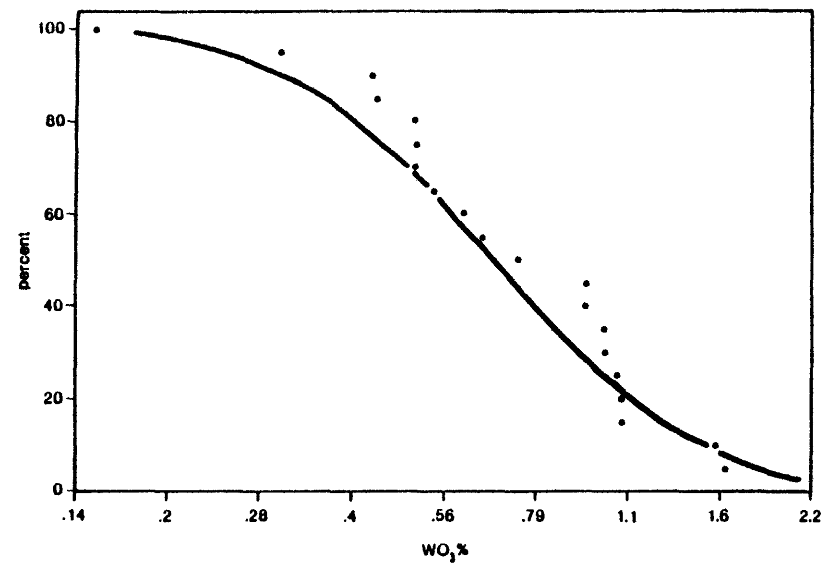
Ore mineralogy: The mineralogy of tungsten skarn deposits may include high-molybdenum and low-molybdenum scheelite and sulfides, particularly chalcopyrite, molybdenite, pyrite and pyrrhotite. The sulfide minerals may be zoned; sphalerite is often distal to chalcopyrite (Einaudi, Meinert, and Newberry, 1981).

Controls on mineralization: The contact between the favorable limestone beds and the intrusive body is the major ore control of skarn tungsten deposits. The disseminated scheelite generally occurs parallel to the intrusive contact or as ore shoots within the skarn zones. Ore shoots may extend away from the intrusive contact along original bedding planes of the limestone, or adjacent to dikes or sills.

Grade/tonnage model: Figure 3 presents a grade/tonnage model of tungsten skarn deposits. The model is based upon data from 20 districts in the North American Cordillera.

Variable	Number of deposits in the model	90%	50%	10%
tonnes $\times 10^6$	20	.05	.8	14.
percent WO_3	20	.3	.7	1.4

Correlation of tonnage and WO_3 grade = -.17



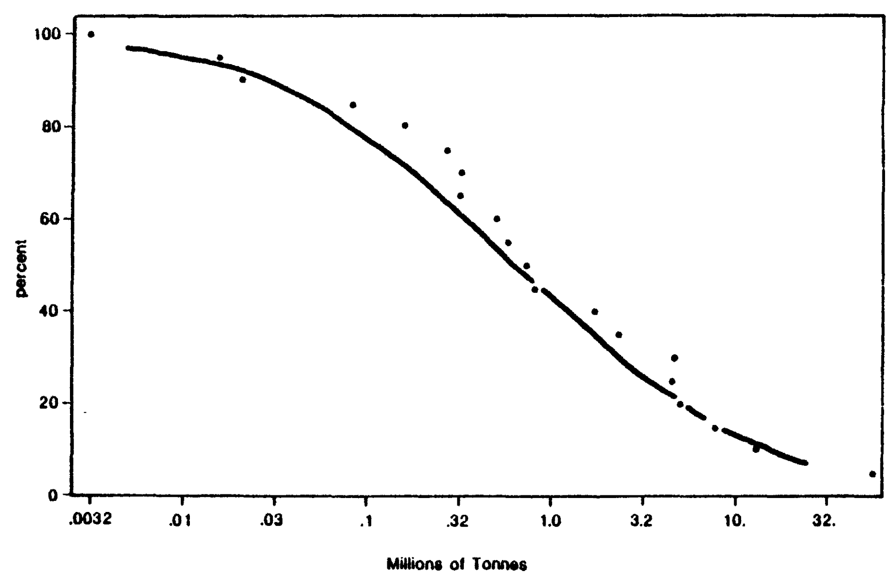


Figure 3. Grade/tonnage model of tungsten skarn deposits (percent of deposits that equal or exceed a given tonnage or grade).

URANIUM DEPOSITS HOSTED BY PERALUMINOUS GRANITES

This model is based upon recent literature on uranium deposits in peraluminous granites, including reports by Chatterjee and Muecke (1982), Darnley (1982), and Strong (1981).

Permissive rock types: The deposits are associated with late-tectonic to post-tectonic peraluminous granites. The granites are thought to result both from anatexis (Leroy, 1978) and from differentiation of biotite granite melts (Chatterjee and Muecke, 1982). In the latter case the deposits are associated with the most differentiated, generally last, phase of the biotite granite suite.

Altered rocks: Hydrothermally altered rocks commonly occur in narrow zones adjacent to uranium-bearing veins and shear zones. Types of altered rocks adjacent to these deposits include granites with secondary muscovite, clay minerals or sericite replacing feldspars, secondary albite, phosphates or hematite, and greisen.

Mineralogy: The uranium minerals in the deposits include autinite, meta-autinite, torbernite, and pitchblende. Other minerals include calcite, quartz, hematite, pyrite, chalcopyrite, apatite, lithium-bearing mica, albite, fluorapatite and barite.

Ore controls: The main controls are petrologic (late, highly differentiated phases of biotite granite plutons) and structural (shear zones and pipes formed at intersecting fractures in the granites). Chatterjee and Muecke (1982) conclude that the South Mountain batholith, Nova Scotia, was rapidly uplifted shortly after it was emplaced, and that uranium minerals were deposited by hydrothermal solutions in shear zones related to the uplift.

Geochemical characteristics: These deposits and the late plutonic rocks associated with them are enriched in uranium, but depleted in thorium relative to plutons associated with tin mineralization . Late stage intrusives associated with the deposits are enriched relative to earlier intrusive phases in F, Be, Li, Rb, Cs, Ta, Sn, and U, and are depleted in Sr, Ba, REE, Sc, Zr, and Hf (Chatterjee and Muecke, 1982).

Grade/tonnage information: Deposits occur as veins, pipes, and disseminated deposits and tend to have small tonnages of ore compared to other types of uranium deposits.

LODE GOLD DEPOSITS IN METASEDIMENTARY ROCKS

This model is based upon a classification and descriptions of deposits by Boyle (1979). The deposits are mainly gold-bearing quartz veins, breccias and saddle reefs but may also include disseminated deposits in chemically favorable rocks adjacent to veins and breccias.

Host and associated rocks: Deposits of this type are mostly hosted by metamorphosed clastic sedimentary rocks. These rocks are always folded and in most cases have undergone extensive and complex deformation. The lodes occur in areas where the metasedimentary rocks have been intruded by granites. However, the lodes rarely occur in granite, and it is debatable whether the granites bear any genetic relationship to the lodes (Boyle, 1979).

Altered rocks: Boyle (1979) states that the wall rocks of the lodes show only minimal effects of hyrothermal alteration. He reports that rocks adjacent to lodes may contain local, thin zones of chlorite, sericite, carbonate, or tourmaline. Pyrite and arsenopyrite may be disseminated in adjacent wall rocks.

Ore and gangue mineralogy: The primary ore minerals of these deposits are native gold with a low silver content, auriferous pyrite, and auriferous arsenopyrite. Galena, chalcopyrite, sphalerite, pyrrhotite, and molybdenite are common sulfides. Tungsten, bismuth minerals and stibnite are locally present; sulfosalts are rarely present. Gangue minerals include ribbon quartz, feldspar, micas, and chlorite; calcite and ankerite are commonly present, but only in small amounts.

Ore controls: The main controls on these deposits are structural; the deposits occur in faults, fractures, and in fold noses in anticlinal structures. The composition of rock units will affect the development of zones of dilation during folding. The composition of the host unit may also affect ore deposition; high grade lodes are developed in zones of dilation in carbonaceous rocks in some districts (Boyle, 1979).

Geochemistry: Boyle (1979) reports that the best pathfinder elements for detecting these deposits are Cu, Ag, Mg, Ca, Zn, Cd, B, Si, Pb, As, Sb, S, W, Mn, and Fe.

Examples: The following districts may be regarded as belonging to this type of deposit: Cariboo district, British Columbia; Meguma Group deposits, Nova Scotias, and the Bendigo-Ballarat districts, Australia.

Grade/tonnage information: Extensive data on the grades and tonnages of these deposits were not available for analysis. Boyle (1979) reports grades from 0.15 oz Au/ton to 1.5 oz Au/ton for some deposits. The gold generally had a fineness greater than 800. Most production from deposits around the world was from relatively high grade lodes; lower grade material may exist in lodes or disseminated in favorable locations adjacent to lodes.

SHALE-HOSTED LEAD-ZINC DEPOSITS

The classification of stratiform and stratabound lead-zinc deposits has changed rapidly in recent years. This model, based primarily upon Large (1979) but supplemented by the findings of other workers, is empirical and descriptive. It covers deposits which have been described by some authors as "sedimentary exhalative."

Tectonic environment: The tectonic environment in which this type of deposit forms is one of extensional faulting within or at the margin of a continent. Deposits occur along major lineaments and normal faults. Faulting is contemporaneous with sedimentation and ore formation (Large, 1979).

Host and associated rock types: The deposits occur most commonly in tuffaceous sediments and black shales, but siltstones and sandstones, detrital dolostones, and micritic limestones may also host deposits. Chemical sediments particularly chert or exhalite, gypsum, and halite commonly are spatially associated with the deposits. Though igneous rocks are not generally directly related to the deposits, potassium rich volcanic and subvolcanic rocks may be spatially or stratigraphically associated with them (Large, 1979).

Sedimentary features: Deposits occur within marine sediments that were deposited in organic rich, oxygen-poor environments (Carne, 1979). The host sediments commonly contain diagenetic pyrite. The deposits in many places are hosted by units that are characterized by rapid facies changes; sedimentary facies with some deposits include shallow marine, delta front, continental rise, and pelagic and abyssal shales and cherts. In most deposits, ore occurs preferentially in finer grained sediments (Large, 1979).

Altered rocks: Hydrothermally altered rocks are a feature common to many of these deposits. Altered rocks are commonly, but not always, confined to footwall units and are especially well developed near cross-cutting, or stringer, zones which are copper bearing (Large, 1979). The types of altered rock which have been identified in deposits of this type include: silicified, dolomitized, silica-dolomitized, tourmalinized, chloritized, and sericitized rocks.

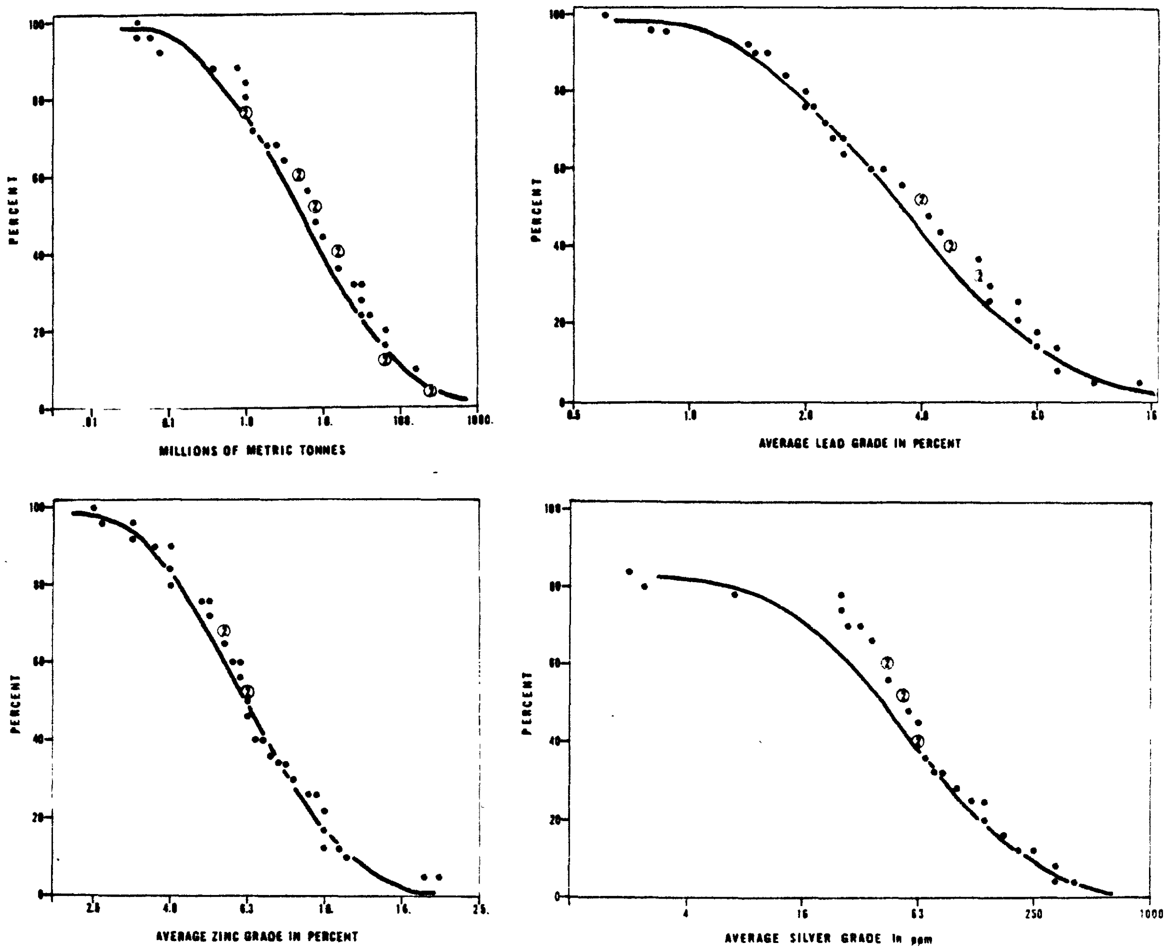
Ore and gangue minerals: The major ore minerals that occur in these deposits are: sphalerite, galena, and, to a lesser extent, chalcopyrite. Ore minerals that occur in lesser amounts and in only some deposits are: arsenopyrite, tetrahedrite-tennanite, bornite, chalcocite, and cassiterite. Common gangue minerals include pyrite, pyrrhotite, marcasite, magnetite, barite, calcite, dolomite, fluorite, and quartz.

Ore textures and mineral zonation: Three ore textures are commonly mentioned in reports on these deposits: finely laminated ores, massive ores, and stringers of copper ore in brecciated and altered footwall rocks.

A feature common to some of these deposits is mineral zonation. The four zones most commonly identified are: a stringer copper, an iron core, a lead-zinc (or sulfide), and a barite zone. The stringer copper zone, if present, in most cases occurs stratigraphically beneath the central portions of the deposit. A central core of iron minerals, often pyrrhotite, is present in some deposits. The lead-zinc zone is the ore; commonly the ratio of lead to zinc decreases outward from the center of the deposits (Large, 1979). A barite zone may occur lateral to, or stratigraphically above, the sulfide zone. Other zones have been identified in individual deposits.

Associated deposits: Shale-hosted lead-zinc deposits are, in some cases, associated with other types of deposits that are spatially distinct from the lead-zinc deposits. The two most common types of associated deposits are small copper vein deposits (Ireland) and stratiform barite deposits (Selwyn Basin, northern Yukon and northwest Brooks Range, Alaska). In addition, deposits may occur over a large stratigraphic range within a basin; for example, deposits in the Selwyn Basin occur in Lower Cambrian, Lower Silurian, and Upper Devonian rocks (Carne and Cathro, 1982).

Grade/tonnage model: Figure 4 presents a grade/tonnage model for shale-hosted lead-zinc deposits. The model is based upon 36 deposits from around the world.



Variable	number of deposits in the model	90%	50%	10%
tonnes $x10^6$	36	.11	5.5	286.
percent lead	36	1.	3.5	12.
percent zinc	36	2.8	6.3	14.
ppm silver	30	Ø	42.	240

Correlations of:

tonnage and lead grade =	-.10
tonnage and zinc grade =	.16
tonnage and silver grade =	-.33
lead grade and zinc grade =	.60
lead grade and silver grade =	.71
zinc grade and silver grade =	.43

Figure 4. Grade/tonnage model of shale-hosted lead-zinc deposits (percent of deposits that equal or exceed a given tonnage or grade).

CHARACTERISTICS OF TRACTS, TYPES OF DEPOSITS THEY MAY CONTAIN, DISCUSSION OF PLACERS AND SELECTED COMMODITIES

This section of the report summarizes the geologic characteristics used to delineate tracts and identifies the types of deposits that they may contain. In addition it discusses placer deposits and several commodities that may occur within the quadrangle, but did not lend themselves to delineation of tracts or representation by deposit models.

Tract I

Types of deposits that may occur within the tract:

1. Tin vein/greisen deposits

2. Uranium deposits hosted by peraluminous granites

Permissive rocks

The tract contains plutonic rocks, felsic dikes, fractured or contact metamorphosed country rocks and intensely altered granite and dike rocks which are similar to rocks which host or are associated with tin and uranium deposits.

Plutonic rocks: The pluton at Lime Peak is composite and composed primarily of peraluminous, biotite granite. At the summit of Lime Peak, at least three phases of biotite granite can be recognized on the basis of texture (Foster and others, 1983): a medium-grained, equigranular granite, porphyritic granite with a medium-grained groundmass, and a medium fine-grained, equigranular granite.

Dikes and hypabyssal rocks: The granites of the Lime Peak pluton and the adjacent country rocks are cut by felsic dikes which commonly have porphyritic texture with phenocrysts of dark gray smoky quartz and/or potassium feldspar, and less commonly plagioclase feldspar. In thin-section, these dikes have a fine-grained groundmass composed of intergrowths of quartz, feldspar, and light-green mica. Some samples contain exsolution textures. The intergrowths and exsolution textures indicate that some dikes have been hydrothermally altered and recrystallized (Keith, personal commun., 1983).

Country rocks: The country rocks adjacent to the Lime Peak pluton have been locally hornfelsed and are cut by boxworks of thin quartz veins and small breccia zones. The veins and breccias are commonly iron-stained.

Intensely altered rocks: Areas of iron and manganese stained rocks with granitoid textures occur adjacent to felsic dikes and at sharp breaks in slope that may indicate the location of small faults. These areas are especially abundant in the southeastern portion of the pluton. Although these rocks are dark colored, examination of thin sections indicates that most are hydrothermally altered granites and felsic dikes. Quartz, sericite replacing feldspar, and chlorite replacing mafic minerals are present in these rocks in varying amounts depending upon the degree of alteration. Fluorite occurs in veinlets or vugs in some samples and needles of green tourmaline, radially intergrown with colorless fluorite and quartz, occur in the vugs of an altered dike (Keith, personal commun., 1983).

Low temperature, probably hydrothermal alteration of feldspars to mixed-layer clays (Keith, personal commun., 1983) occurs in some granites adjacent to more intensely altered rocks and in the vicinity of felsic dikes. In one case, the altered feldspars were colored pink and in another, blue green; 5R 714 and 5BG 612 respectively on the rock color chart (Goddard and others, 1948).

Known occurrences (appendices 1 and 2)

Lime Peak area was staked about 1977 and exploration, including limited drilling, continued until 1981.

Stream-sediment geochemistry and heavy-mineral concentrate mineralogy

Analyses of 22 minus-80-mesh stream sediment samples (table 1) from this tract showed anomalous values for the elements Be, La, Mo, Pb, Sn, Th, U, and Zn. This suite of elements is consistent for both uranium and tin deposits, although the presence of both U and Th anomalies is more suggestive of tin deposits. In addition, the combined suite of minerals found in heavy-mineral concentrates (table 2) of the 22 stream sediment samples also indicates such potential. Minerals identified in the concentrates include allanite(?), arsenopyrite, cassiterite, cyrtolite, fluorite, galena, monazite, scheelite, sphalerite, and uranothorite.

Rock geochemistry

Analysis of samples of 29 intensely altered granites and felsic dikes, 15 granites, 25 felsic dikes, 9 hornfelses, 16 veins and 9 mafic dikes also indicates that the tract may contain tin deposits. The distribution of tin in granites (median (m) = 7 ppm, upper quartile (uq) = 10 ppm), felsic dikes (m = 15 ppm, uq = 30 ppm, maximum = 1000 ppm) and intensely altered rocks (m = 100 ppm, uq = 300 ppm, maximum = greater than 1000 ppm) indicates that tin was enriched in later formed parts of the pluton and in hydrothermal fluids which could form tin deposits. The intensely altered rocks are also enriched in zinc (m = 500 ppm, uq = 1000), molybdenum (uq = 5 ppm, maximum = 100 ppm) and silver (m = .7 ppm, uq = 1.5 ppm, maximum = 10 ppm).

Tract II

Types of deposits that may occur within the tract:

1. Tin vein/greisen deposits

2. Uranium deposits hosted by peraluminous granites

3. Lode gold deposits in metasedimentary terranes

Permissive rocks

The tract contains plutonic rocks, felsic dikes, and fractured or contact metamorphosed country rocks which are similar to rocks which host or are associated with uranium and tin deposits. In addition, quartz veins, quartz-healed breccias, and iron-stained quartzites may contain small lode gold deposits.

Table 1. Number of samples from delineated tracts and number of times that indicated elements reached anomalous levels in stream sediment and heavy mineral concentrate samples (1)

		Elements(2)																
		Stream Sediments													Heavy Mineral Concentrates			
Tract	Number of samples	Ag	Au	Ba	Be	Cu	La	Mo	Pb	Sn	Th	U	W	Zn	Au	Mo	Sn	W
I	22	6	2	0	21	10	11	1	12	3	10	12	0	17	0	6	16	0
II	36	0	0	0	20	1	3	0	0	7	3	23	3	0	0	0	15	5
III	30	1	2	0	0	7	1	1	0	0	2	0	3	0	1	2	1	15
IV	96	12	15	0	4	17	3	0	3	3	2	2	1	1	12	3	24	14
V	22	2	0	0	10	2	3	0	5	0	0	17	1	0	0	0	3	2
VI	151	5	1	35	18	18	29	0	4	2	3	10	5	7	0	0	8	36
VII	36	7	2	26	0	3	0	3	0	0	0	0	2	14	0	0	0	3
VIII	20	15	0	15	2	12	2	14	1	0	0	0	0	1	0	10	3	0

(1) Definition of geochemical anomalies (approximately upper 5-10 percent of samples from the entire quadrangle) in ppm

Stream sediments: Ag $\geq$ .7, Au $\geq$ .1, Be detected at $\geq$ 5, Cu $\geq$ 50, Mo $\geq$ 7, Pb $\geq$ 100, Sn $\geq$ 50, Th detected at 100, U $\geq$ 4, W $\geq$ 50, Zn $\geq$ 170

Heavy mineral concentrates: Au detected at 20, Mo $\geq$ 10, Sn $\geq$ 1000, W $\geq$ 500

(2) Element determined by six-step semiquantitative emission spectrographic methods except for Au, U, Th, and Zn for stream sediment samples which were determined by atomic absorption methods.

Table 2. Frequencies that minerals were identified in heavy mineral concentrate samples from streams that drain delineated tracts

Tract	Number of samples	Cassiterite	Scheelite	Fluorite	Sulfides py, gal, sph	Crytolite	Monazite	Uranothorite	Powellite	Gold
I	22	20	10	4	2 6 3	2	16	12	0	0
II	35	20	24	1	aspy=2 cpy=2 1 1 1	0	8	4	0	2
III	30	13	24	0	aspy=6 cpy=1 0 5 0	0	3	0	1	2
IV	92	43	62	0	aspy=16 cpy=5 stibnite=8 1 9 1	0	18	6	0	32
V	22	12	20	0	0	0	2	1	1	0
VI	150	34	135	0	aspy=4 cpy=1 6 0 2	0	24	7	0	1
VII	36	1	18	0	cpy=7 11 2 2	0	8	1	0	4
VIII	20	9	3	0	cpy=7 1 1 5	litharge=1 0	9	0	0	0

Abbreviations: py (pyrite), gal (galena), sph (sphalerite), aspy (arsenopyrite), cpy (chalcopyrite), stibnite

Plutonic rocks: The largest bodies of granite in the tract belong to the Mount Prindle and Quartz Creek plutons. Several smaller bodies of hornblende granite, mainly to the southeast of the main part of the Mount Prindle pluton probably belong to a separate body. The Mount Prindle pluton is composed primarily of biotite granite that was emplaced during two major intrusive events. The granites of both events vary texturally, but are very similar mineralogically, consisting primarily of potassium feldspar, quartz, plagioclase, and biotite with minor and accessory minerals which include muscovite, tourmaline, and topaz. Most granitic rocks are somewhat altered with the feldspars incipiently to completely altered to clay minerals and sericite. Commonly biotite is partly to completely altered to chlorite. Some altered plagioclase in granitic rocks of the early intrusive phase has a pink color (Holm, 1973).

Felsic dikes: The granites and adjacent country rocks are cut by many aplite, pegmatite, quartz porphyry, and felsite dikes. Holm (1973) reports that some aplites grade into complex pegmatites composed of quartz, muscovite, biotite, potassium feldspar, and tourmaline. He also states that in the Hope Creek drainage, pegmatites and a nearby biotite granite contain an unusual green mineral of the illite group.

Country rocks: Locally the country rocks have been hornfelsed adjacent to plutons and in roof pendents that overlie the Mount Prindle pluton. Quartzites adjacent to the pluton contain small quartz veins, breccias, and iron-stained zones. Breccias occur adjacent to small felsic dikes (Holm, 1973, p. 31-32). Iron-stained zones of brecciated quartz are found within the Nome Creek fault zone in T7N,R6E,S9. East of VABM Hope the metamorphic rocks are cut by many felsic dikes, which are commonly altered and associated with iron-stained breccias.

Known occurrences

Parts of the Mount Prindle pluton were staked in 1977 and were actively explored during the years just before and after 1977. Green fluorite occurs in breccia on the south side of the Mount Prindle pluton in the drainage of Hope Creek (T7N,R6E,S34), and Holm (1973) reports that fluorite also occurs in float on the east side of the Mount Prindle pluton in Fluorite Creek (T7N,R6E). Barker and Clautice (1977) report a series of radioactive springs on the southwest side of the Mount Prindle pluton (T7N,R5E,S25).

Stream sediment geochemistry and heavy mineral concentrate mineralogy

Analyses of 36 minus-80-mesh stream sediment samples (table 1) show anomalous values for the elements Be, La, Sn, Th, and U. Whereas these values are consistent with both uranium and tin deposits, the predominance of U anomalies over Th in stream sediment samples is more suggestive of U deposits. In addition, 35 heavy-mineral concentrate samples collected from streams draining this tract target potentially mineralized areas, as the mineral suite (table 2) included allanite(?), arsenopyrite, cassiterite, chalcopyrite, fluorite, galena, gold, monazite, scheelite, sphalerite, and thorite.

Rock geochemistry

Semiquantitative spectrographic analysis of 10 granite, 20 felsic dike, 18 hornfels, 5 vein, quartz breccia or iron-stained quartzite, 26 quartzite or schist and 3 marble grab samples indicates that the samples of granite and hornfels are enriched in both tin and boron. The median amount of tin in the granite samples is 20 ppm and a quarter of the samples contained at least 40 ppm. The median amount of tin in samples of hornfels is 15 ppm, a quarter contain at least 30 ppm and one sample contained 200 ppm. The median of amount of boron in the granites is 200 ppm, and it is 150 ppm in the hornfels. A quarter of the granite samples contain at least 500 ppm boron and there is 300 ppm or more in one fourth of the hornfels samples. While the felsic dikes are also enriched in tin, one half of the samples contain at least 15 ppm and a quarter of the samples contain 30 ppm, they are not enriched relative to the granites and hornfelses. This may indicate that tin did not concentrate in late phases of the igneous rocks or in hydrothermal fluids.

Tract III

Types of deposits that may occur within the tract:

1. Tin vein/greisen deposits

2. Tungsten skarn deposits

3. Lode gold deposits in metasedimentary terranes

Permissive rocks

The tract contains plutonic rocks, felsic dikes and fractured or contact metamorphosed country rocks that are similar to rocks which host or are associated with tin deposits. The country rock adjacent to the pluton may host tungsten skarn deposits. Lode gold deposits may occur in fractures in the country rock or adjacent to felsic dikes.

Plutonic rocks: Granitic rocks outcrop over a very small portion (2 sq km) of the tract. However, the distribution of contact metamorphosed rocks and the configuration of an aeromagnetic anomaly suggests that granite underlies more of the tract than is indicated by its area of outcrop (Burack and others, 1983). The granite is composite; both coarse-grained, equigranular, biotite granite and porphyritic biotite granite with a fine-grained groundmass are exposed.

Felsic dikes and hypabyssal rocks: Felsic dike and hypabyssal rocks are especially abundant near Table Mountain, southwest of the granite, and in the southwest part of the tract. Most of the dike and hypabyssal rocks in these two areas are aphanitic or less commonly porphyritic with an aphanitic groundmass and have a high color index. Some have orange brown streaks or bands, some of which are formed by specks of limonite after pyrite(?) and fluorite has been identified in one dike.

Country rocks: For a considerable distance northeast and southwest of the pluton, the country rocks have been hornfelsed; calc-silicate rocks may have undergone metasomatism from fluids emanating from the nearby granitic pluton, or the sequence of mineral assemblages observed could be the result of thermal metamorphism of compositionally distinct layers (Burack and others, 1983). Quartzites contain veins, breccias, and iron-stained quartzites. Thin quartz veins with arsenopyrite selvages were observed parallel to the foliation of quartzites; the veins and silicified breccia occur near an altered hypabyssal dike.

Known occurrences

Five blocks of lode claims are known to have been staked within the tract (appendix 2). These claims were all staked after 1968 and three of the claim blocks were active as recently as 1981. Many streams in the tract have been staked for placer deposits; the only streams with known production of gold are located in the southwest end of the tract (appendix 1).

Stream sediment geochemistry and heavy-mineral concentrate mineralogy

Analyses of 30 minus-80-mesh stream sediment samples (table 1) show anomalous values for the elements Ag, Au, Cu, La, Mo, Ni, Th, and W. Mineralogical data of 30 samples of stream concentrates (table 2) is indicative of probable mineralization in areas of this tract. Minerals of interest include allanite, arsenopyrite, cassiterite, chalcopyrite, galena, gold, monazite, powellite, and scheelite.

Rock geochemistry

Analysis of 4 granite, 18 felsic dike and hypabyssal, 4 hornfels, 5 vein, breccia and iron-stained quartzite, 3 mafic dike, 9 quartzite, and 8 marble samples indicate that the tract may contain tin, tungsten and gold deposits. The distribution of tin in the granites (median (m) = 15 ppm, upper quartile (uq) = 50 ppm) and dikes (m = 50 ppm, uq = 70 ppm) indicates that tin was enriched in later formed parts of the pluton. Samples of country rock, especially marbles contained tungsten. Two samples of black quartzite located near silicified breccia and an altered felsic dike contain unusually large amounts of gold (140 and 40 ppm). Finally felsic dikes and country rocks at two localities near the pluton contained unusually large amounts of beryllium. Three samples of dikes contain 700, 1000 and 1500 ppm; two samples of hornfels contain 700 and 1500 ppm, two samples of quartzite contained 1000 ppm and two other quartzite samples contain 200 and 300 ppm beryllium.

Tract IV

Types of deposits that may occur within the tract:

1. Tin vein/greisen deposits
2. Uranium deposits hosted by peraluminous granites
3. Lode gold deposits in metasedimentary terranes

Permissive rocks

The plutonic rocks, felsic dikes and fractured or contact metamorphosed country rocks of this tract are similar to rocks which host or are associated with tin and uranium deposits. The tract may contain lode gold deposits in quartz veins, breccias, silicified zones in the country rocks and adjacent to felsic dikes.

Plutonic rocks: The pluton near Circle Hot Springs is multiphase and composed mostly of biotite granite with minor biotite-hornblende granite and some biotite granite with minor white mica, especially in granites of the eastern part of the tract (Foster and others, 1983). Granite outcrops in the eastern part of the tract generally occur at elevations less than 3000 ft. In the western part of the tract, which is mainly above 3000 ft, granite outcrops are fewer and smaller in area. Because dikes occur in the western part of the tract and because granite is present in topographic lows, it is likely that granite underlies most of the tract but is below 3000 ft above sea level.

Felsic dike and hypabyssal rocks: Felsic dikes cut the granites and country rocks at many places in the tract. The dikes contain quartz, feldspar, and biotite and have textures that range from porphyritic to aplitic to pegmatitic. At occurrence 37 (table 2), a series of arsenopyrite-bearing, intensely altered felsic dikes(?) intrude the country rock either parallel to, or at a low angle to, foliation of the country rocks. In addition to being intensely altered, the dikes(?) have been sheared.

Country rocks: The country rocks in the tract belong to the quartzite and quartzitic schist (PzpЄq) unit and the mafic schist (PzpЄm) unit (Foster and others, 1983). Quartzites and schists of the PzpЄq unit locally are hornfelsed near contacts with the pluton, and at many places in the tract quartz veins cut the metamorphic rocks. Many of the veins are thin, one-eighth to one inch thick, with limonite pseudomorphs in them or in adjacent metamorphic rock. The veins occur individually, or as intersecting stockworks. Some veins are offset but are not folded, whereas others are folded indicating there has been more than one period of vein formation. One vein contained arsenopyrite(?) and was coated with a yellow stain. Veins from occurrence 37 have abundant, large fluid inclusions which contain, at room temperatures, three phases: water, liquid carbon dioxide and vapor (mostly carbon dioxide). At the same location, iron-stained quartz pods, which appear to occur along the margins of sheared, altered felsic dikes(?), contain large fluid inclusions which, at room temperatures, contain water, liquid carbon dioxide, vapor and crystals of salt(?). The presence of salt indicates that the fluids trapped in the inclusions were capable of carrying metals in solution; Boyle (1979) noted that carbon dioxide-bearing fluid inclusions are closely associated with gold. At several locations in the tract (T8N,R12E,S24; T7N,R14E,S8; T7N,R14E,S18; T7NR14E,S10 and T7N,R14E,S12) small zones (less than .65 sq km) were noted in which quartzites did not break with foliation and which contained minor breccia, limonite and arsenopyrite(?). These zones may represent areas in which rocks have been contact metamorphosed, or more probably areas of hydrothermal alteration (redistribution of silica(?)). Some breccias are probably related to regional deformation of the metamorphic rocks, but others were probably formed in conjunction with the intrusion of the pluton, or with post-intrusive faulting.

Known occurrences

The tract contains many claims and most of the streams in the tract have been mined for placer gold (appendix 1). A few lode claims (appendix 2) have been staked but none are known to have any recent significant activity.

Stream-sediment geochemistry and heavy-concentrate mineralogy

Analyses of 96 minus-80-mesh stream sediment samples (table 1) show anomalous values for the elements Ag, Au, Be, Cu, La, Pb, Sn, Th, U, W, and Zn. Mineralogical data of 92 samples of stream concentrates (table 2) are typical of results from a large gold placer area; minerals noted include allanite(?), arsenopyrite, cassiterite, chalcopyrite, galena, gold, monazite, scheelite, sphalerite, stibnite and its alteration products, and thorite.

Rock geochemistry

Analyses of 18 granite, 28 felsic dike, 4 mafic dike, 1 hornfels, 23 vein, breccia, and iron-stained quartzite, 77 quartzite and quartzitic schist unit (Pzp€q), and 44 mafic schist unit (Pzp€m) samples show important differences in element concentrations among rock types; individual elements are also zoned within the tract. Gold was detected in approximately 25 percent of the samples of veins, breccias and iron-stained quartzites, 20 percent of the samples of felsic dikes and 10 percent of the samples of the quartzite unit (Pzp€q). Gold was detected in only one sample of the mafic schist unit (Pzp€m), and was not detected in the samples of granite. Arsenic was detected in 30 percent of the veins, breccias and iron-stained quartzites and in 25 percent of the felsic dikes. Approximately one half of the felsic dike and vein, breccia and iron-stained quartzite samples contained silver and more than half of the samples of the quartzite unit contain detectable silver. Tin was detected, in amounts of 50 ppm or less, in half of the granite and 25 percent of the felsic dike samples. Rock geochemical data for individual elements are spatially zoned within the tract. The proportion of rock samples that contain detectable gold and arsenic is larger in the western part of the tract where metamorphic rocks are the primary exposed rock types than in the eastern part of the tract, where granitic rocks are the primary exposed type of rock. In contrast silver and tin were detected in a larger proportion of samples from the eastern part of the tract than from the western part. The distribution of gold by rock type and by its location suggests that gold occurs in small fracture zones, veins and associated with felsic dikes, that developed and were emplaced above the Circle pluton.

Tract V

Types of deposits that may occur within the tract:

1. Uranium deposits hosted by peraluminous granites

Permissive rocks

The tract contains plutonic rocks, felsic dikes and fractured and contact metamorphosed country rocks which are similar to rocks which host or are associated with uranium deposits.

Plutonic rocks: The pluton near Chena Hot Springs has been separated into three phases on the basis of grain size and mafic mineral content (Biggar and Forbes, 1980). The most abundant phase is a coarse-grained biotite granite; a fine-grained biotite granite occurs along Monument Creek. Minor hornblende-biotite granite is known east of the hot springs and north of Monument Creek. The coarse-grained biotite granite exhibits varying degrees of hydrothermal alteration (Biggar and Forbes, 1980).

Felsic dike and hypabyssal rocks: Biggar and Forbes (1980) identified three types of felsic dikes within and adjacent to the pluton. Fragments of rhyolitic dikes occur mixed with metamorphic rocks. Aplitic dikes up to one meter thick and porphyritic dikes, with potassium feldspar phenocrysts, cut the coarse-grained biotite granite.

Country rocks: The country rocks adjacent to the pluton belong to the quartzite and quartzitic schist (Pzp€q) unit of Foster and others (1983) and are mostly quartzite, quartzitic schist and pelitic schist metamorphosed to the greenschist and lower amphibolite facies. Biggar and Forbes (1980) estimate that the country rocks within about one-half km of the pluton have been contact metamorphosed and that such rocks can be recognized by gneissic textures in the schists and by the presence of tourmaline aggregates.

Known occurrences

The tract does not contain any known lode claims. However, placer claims on Monument Creek and the North Fork of the Chena River were active in 1981 (appendix 1).

Stream sediment geochemistry and heavy-mineral concentrate mineralogy

Analyses of 22 minus-80-mesh stream sediment samples (table 1) from this tract show anomalous values for the elements Be, Cu, La, Pb, U, and W. This group of elements is consistent with the possibility of uranium mineralization in the igneous rocks of this tract. The minerals found in 22 stream concentrate samples (table 2) include cassiterite, monazite, powellite, and scheelite.

Rock geochemistry

Analyses of 4 granite, 3 felsic dike, 2 hornfels, 7 vein, breccia, or iron-stained rock, 1 mafic dike, 10 quartzite and schist, 2 augen gneiss, 2 amphibolite, and 1 calc-silicate samples contain only a few anomalous results. The sample of a felsic dike contains 300 ppm tin; the calc-silicte contains 100 ppm tin, one vein sample contains 70 ppm tin, and one sample of granite contains 10 ppm tin.

Tract VI

Types of deposits that may occur within the tract:

1. Tungsten skarn deposits

Permissive rocks

The tract contains plutonic rocks and country rocks that are similar to those which host or are associated with tungsten skarn deposits.

Plutonic rocks: The tract contains three large plutons (the pluton north of Yukon Fork, the pluton in T4N,R15E and the pluton near Big Windy Creek) and a number of smaller plutons. The pluton north of Yukon Fork is a medium to coarse grained biotite granite; parts of the pluton contain muscovite and individual samples contain garnet (Foster and others, 1983). The pluton in T4N,R15E is a medium- to coarse-grained hypidiomorphic granular to porphyritic biotite granite that contains minor muscovite (Foster and others, 1983) and garnet. The pluton near Big Windy Creek is a medium-grained biotite muscovite granite; the muscovite is primary (Foster and others, 1983). Most of the plutons in the tract contain some muscovite and tourmaline; they apparently are not composite.

Felsic dikes: Most of the dikes of the tract fall into two types: fine-grained, equigranular rocks composed of quartz, microcline, garnet, muscovite and in some cases biotite, and coarse-grained, equigranular rocks composed of quartz, feldspar, biotite, muscovite and, in one case, chlorite.

Country rocks: Most of the country rocks of the tract belong to the pelitic schist (PzpЄs) unit of Foster and others (1983) and consist of medium- to coarse-grained pelitic schists and gneisses with interlayers of quartzite, quartzitic schist, marble, calc-silicate rock, and minor amphibolite. The tract also contains an augen gneiss (unit Da of Foster and others, 1983) which was probably intruded into the pelitic schist. Contact metamorphic rocks occur at the contact of the plutons and near the augen gneiss unit. Thin veins, breccias, and small iron-stained zones occur scattered throughout the tract. Most quartz veins do not appear related to the igneous rocks. Small zones of iron-stained breccia may be related to igneous contacts or to minor faults.

Known occurrences

The tract contains several large blocks of lode claims which were actively explored for tungsten during the late 1970's and 1980's (appendix 2). The area was sampled extensively and a drilling program was conducted.

Stream sediment geochemistry and heavy-mineral concentrate mineralogy

One hundred fifty-one minus-80-mesh stream sediments were sampled from this relatively large tract; some show anomalous values for the elements Ba, Co, Cu, La, Ni, Pb, Sn, Th, U, W, and Zn. Additionally, 135 of 150 heavy-mineral concentrate samples (table 2) collected from streams draining this tract contain scheelite. The widespread occurrence of scheelite in stream concentrate samples is consistent with the possibility that the tract contains tungsten skarn deposits. A lesser number of samples contained allanite(?), arsenopyrite, cassiterite, gold, monazite, sphalerite, and thorite(?).

Rock geochemistry

Analyses of 39 granite, 15 hornfels or skarn, 63 vein, breccia or iron-stained rock, 6 mafic dike, 7 amphibolite or mafic metamorphic rock, 134 quartzite and pelitic schist, 35 marble, 18 calc-silicate rock, 21 gneiss, and 17 felsic dike rock samples were surprisingly deficient in W; only two samples contain detectable W. The felsic dike rocks are enriched in boron (over half of the samples contain at least 100 ppm), beryllium (median (m) = 10 ppm, upper quartile (uq) = 150 ppm), and tin (m = 30 ppm, uq = 100 ppm).

Tract VII

Types of deposits that may occur within the two parts of this tract:

1. Shale-hosted lead-zinc deposits

Permissive rocks

The rocks of the tract belong to two units: the quartzite, meta-argillite, and phyllite (Pzq) unit and the phyllite, calcareous phyllite, and marble (Pzm) unit (Foster and others, 1983). The Pzq unit occurs in the part of the tract west of Clums Fork; both the Pzq and Pzm unit occur in the part of the tract along the Middle Fork of the Chena River.

Stream sediment geochemistry and heavy-mineral concentrate mineralogy

Thirty-six minus-80-mesh stream sediment samples (table 1) collected from streams draining this tract contain anomalous amounts of Ag, Au, Ba, Cu, Mo, W, and Zn. The widespread occurrence of samples with anomalous Ag, Ba, and Zn is consistent with the possibility of the tract containing lead-zinc deposits. The mineral suite of 36 stream sediment concentrates (table 2) include cassiterite, chalcopyrite, galena, gold, monazite, pyrite, scheelite, and sphalerite. Pyrite, galena, and sphalerite are the most common sulfide minerals in shale-hosted lead-zinc deposits.

Rock geochemistry

Only 6 rock samples from the two parts of this tract were analyzed; all were iron-stained quartz or quartzite. Three of the samples contained detectable silver, one contained 2 ppm, one contained 5 ppm, and in one silver was detected at less than .5 ppm. Four samples contained detectable zinc, one at the detection limit of 140 ppm, the others contain 200, 500, 5000 ppm.

Tract VIII

Types of deposits that may occur within the tract:

1. Shale-hosted lead-zinc deposits

Permissive rocks

The argillite, tuff, quartzite, and conglomerate (MzPzat) unit (Foster and others, 1983) consists of tuffaceous rocks associated with black or dark gray argillite and conglomerate. Tuffaceous sediments are commonly hosts for, or associated with, shale-hosted lead-zinc deposits. Several springs which flow from the unit have an orange-brown stain deposited on surrounding rocks and vegetation.

Stream sediment geochemistry and heavy mineral concentrate mineralogy

Twenty minus-80-mesh stream sediment samples (table 1) collected from streams draining this tract were anomalous for the elements Ag, Ba, Be, Cu, La, Mo, and Zn. The collective mineral suite of stream sediment concentrates (table 2) included cassiterite, chalcopyrite, galena, natural(?) litharge, monazite, pyrite, scheelite, and sphalerite. These elements and minerals are consistent with the possibility of the tract containing lead-zinc deposits.

Rock geochemistry

Analyses of 6 quartzite, argillite or carbonate rock, 5 vein, breccia or iron-stained rock, 6 tuff or tuffaceous conglomerate, and 2 intermediate igneous rock samples are also consistent with the possibility of lead-zinc deposits. The rock types are not obviously different in their rock geochemistry, except that all of the tuffaceous conglomerates and tuffs contain detectable zinc, while zinc was detected in about half of the samples of other rock types. Seven samples contain detectable silver and seven contain detectable molybdenum.

Placer Gold

Placer claims (appendix 1) are widely distributed throughout the Circle quadrangle, but placer mining has been concentrated in four areas and a fifth area may contain buried placers. These five areas are shown on plate 1 by dot pattern and are identified by a large letter.

Area A includes Bachelor, Charity, Deep, Faith, Homestake, Hope, Nome, and Sourdough Creeks. Gold was discovered on most of these creeks and initial production took place in the early 1900's. Most streams, except Bachelor Creek, have been thoroughly mined, especially in periods of high gold prices. Nome Creek was the only creek to be mined by dredge. Analyses of gold from creeks indicate that the gold fineness was in excess of 900.

Area B includes Clums Fork, Lawson, Munson, and Volcano Creeks. These creeks were mined in the 1970's and early 1980's. Volcano Creek may have been mined much earlier. Analyses of gold from Volcano Creek indicate that gold fineness on this stream is approximately 725. The stream valleys in this area are narrow and contain small volumes of gravel relative to the other areas.

Area C includes part of the East Fork of the Chena River and streams that drain into the East Fork: Wolf, Ohio, Shamrock, Palmer, and Montana Creeks. These creeks have been mined intermittently since the early 1900's. Analyses of gold from Van Curlers bar indicate that the gold there has a fineness of approximately 840. The Chena River gravels are extensive and probably contain scattered low tenor placers. The "bench" gravels along the Chena also may contain gold.

Area D, which is coextensive with tract IV, includes streams of the Circle mining district. Gold has been produced from the district since the late 1890's. The main productive streams include Bonanza, Butte, Deadwood, Eagle, Gold Dust, North Fork of Harrison, Independence, Ketchem, Mammoth, Mastadon, Miller, Porcupine, and Portage Creeks. Deadwood Creek was dredged briefly in the 1930's; Mastadon Creek was dredged during two periods between 1912 and 1926. The upstream and peripheral parts of many streams in the district were actively mined during the period that the field studies for this report were conducted (1978-1982). The areas peripheral to former mining are covered by thick frozen muck. The fineness of gold in streams varies systematically from approximately 850 in streams of the west end of the area to approximately 775 in streams of the east end of the area. The changes in gold fineness vary with the amount of granite exposed in drainages of streams. Streams that drain granite generally have lower fineness of gold. The most productive streams have been those which drain metamorphic rocks near Mastadon Dome in the western part of the area.

Area E is a large area with only a few placer claims along modern streams. Crooked Creek, which drains parts of Area D, has been placer mined and mining was ongoing while field studies for this report were conducted. Area E is underlain by a small sedimentary basin that is filled with Tertiary and Quaternary detritus. Gold has been panned from sediments of both ages (Yeend, 1982). Much of the material that fills the basin was undoubtedly eroded from tract IV. The distribution of gold in rocks of tract IV suggests that gold-bearing rock was probably eroded from above the granite in the eastern part of that tract. If such material were concentrated by stream processes at favorable sites, such as along the Hot Springs fault, large tonnage, though probably low tenor, placer deposits may have formed within the sediment that fill the basin of area E.

Other Types of Resources

In addition to the deposit types discussed above, the Circle quadrangle may contain resources of uranium in sedimentary rocks, chromite, nickel or asbestos in ultramafic rocks, and sources for crushed stone and sand and gravel.

The sedimentary basin that underlies gold placer area E is also permissive for the occurrence of uranium deposits in sedimentary rocks. Such deposits could form in organic rich sediments in the basin if uranium related to hot springs or to vein deposits were transported by ground water into the basin.

The presence of small bodies of ultramafic rock would permit the occurrence of chromite, nickel, platinum, and asbestos deposits, although geologic and geochemical evidence supporting their occurrence are lacking. If chromite deposits are present they are likely to be small podiform deposits. At a number of places in the quadrangle, rock has been quarried for road metal. In addition, the quadrangle has sufficient sand and gravel for local construction uses.

SUMMARY AND ESTIMATES OF RESOURCES

Many of the tracts contain features that are characteristic of one or more of the deposit type models presented above. Tracts I, II, III, and IV were delineated as being permissive for the occurrence of tin vein and greisen deposits. Table 3 summarizes the characteristics of vein and greisen deposits

Table 3. Summary of the extent that characteristics of the tin vein/greisen deposit model have been identified in individual tracts.

Tract	Permissive Rocks				Hydrothermal Alteration			Permissive structures	Permissive Geochemistry		
	Post tectonic granites	Peralum-inous granites	Differ-entiated suite	Epizonal intrusive	Chlorite	Sericite	Greisen	post intrusive faults	Anomalous pathfinder elements in: stream sediments or heavy mineral concentrates	rocks	Indicative minerals in pan concen-trates
I	Yes	Yes	Yes	Yes	Yes	Yes	Possibly	Yes	Yes	Yes	Yes
II	Yes	probably	Yes	Yes?	-	-	-	Yes	Yes but some differences	-	Yes
III	Yes	?	probably	probably	-	-	-	possibly	-	dikes enriched	Yes
IV	Yes	possibly	Yes	?	Yes	Yes	-	?	-	-	Yes sluice box

that are present in each of these tracts. These tracts differ in their geochemical profiles (fig. 5); this may be due to different amounts and/or kinds of mineralization, to different levels of erosion of the plutons or to a combination of these reasons. While no vein and greisen deposits are presently known in the Circle quadrangle, tract I possesses many characteristics of areas that do contain such deposits. Because such deposits rarely occur in isolation, it is possible that additional deposits occur in other tracts. Thus, we estimate that there is a 50 percent chance that there is one or more deposits and a 10 percent chance that there are 3 or more tin vein and greisen deposits in the delineated tracts. If such deposits are present, the preliminary grade/tonnage model of tin vein/greisen deposits provides some basis for evaluating their significance.

Tracts I, II, IV, and V were delineated as being permissive for the occurrence of uranium deposits associated with peraluminous granites. Table 4 summarizes the degree to which characteristics of such deposits are present in the tracts. Tract II contains springs that have anomalous levels of uranium (Barker and Claudice, 1977) and tract V has a geochemical profile very similar to tract II. No estimate of undiscovered deposits has been made for this deposit type because without a grade/tonnage model such estimates would not be useful.

Tracts III and VI which were delineated as being permissive for the occurrence of skarn tungsten deposits are summarized in table 5. Although no skarn tungsten deposits are presently known within the quadrangle, scheelite is present in many streams. In addition, parts of tract VI have been extensively explored for tungsten skarn deposits. We estimate that while the quadrangle may not contain any tungsten skarn deposits similar to those in the deposit model, there is a 50 percent chance that there is one or more tungsten skarn deposits and a 10 percent chance that there are 2 or more tungsten skarn deposits in tracts III and VI.

The quadrangle has three tracts (II, III, IV) that are permissive for the occurrence of lode gold deposits; their characteristics are compared with the descriptive model in table 6. If large vein deposits were present within these tracts, it is likely they would have been discovered, especially in tract IV which has been very extensively prospected. However, these tracts may contain low grade deposits or deposits in more complex settings such as saddle reefs, brecciated or crushed zones which might have been overlooked by prospectors. It has not been possible to provide a grade/tonnage model of what such deposits would contain.

The Circle quadrangle has produced a considerable amount of gold from placer deposits along streams, and operations continue in ground marginal to old mining areas. In addition to these areas, the sedimentary basin of area E could contain a very significant resource of gold if settings favorable for its concentration existed while the basin was being filled with sediment. An evaluation of this resource would require seismic information on the basin's characteristics and drilling to determine the extent and tenor of gold in the sediments.

Two tracts (VII and VIII) were delineated as permissive for the occurrence of shale-hosted lead-zinc deposits. These delineations were made primarily on the basis of permissive rock types and anomalous geochemistry in

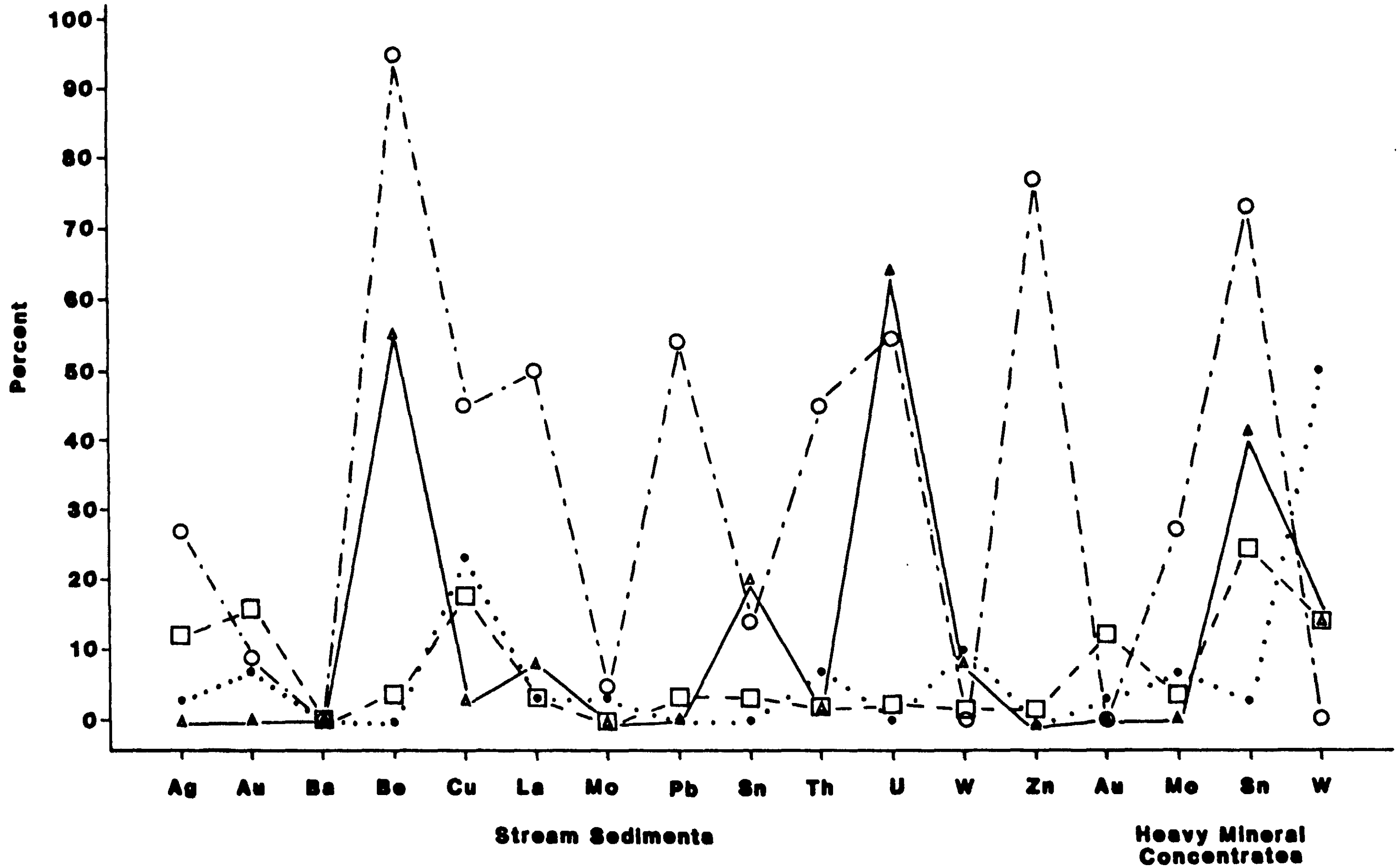


Figure 5. Plot of the percent of samples that reach anomalous levels for selected elements for tracts I (O), II (Δ), III (·), and IV (□). Data from Table 1.

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Table 5. Summary of extent that characteritics of the tungsten and individual tracts skarn/tactite models have been identified.

Tract	Calc-alkaline intrusion(s) without intrusion related faults	Skarn/hornfels rocks	Known scheelite occurrence	Anomalous pathfinder elements in stream sediment and/or heavy mineral concentrate samples	Anomalous pathfinder elements in rock samples
III	Intrusion present; probably cut by faults	yes	no	yes	some
VI	Intrusives present, probably largely unfractured	yes	yes	yes	in only a few samples

Table 6. Summary of the extent that characteristics of the lode gold in metasedimentary rocks deposit model have been identified in individual tracts

Tract	Permissive Rocks	Hydrothermal Alteration	Permissive Structures	Permissive Geochemistry			Known Occurrences
	Metasedimentary rocks			Anomalous Pathfinder elements in stream or heavy mineral concentrates	Rocks	Indicative minerals in heavy concentrates	
II	Yes	Iron-stained rocks	Yes	No	Some	Some	Yes?
III	Yes	Iron-stained rocks	?	A few	Some	Some	No
IV	Yes	Iron-stained rocks	?	Yes	Some	Yes	Yes?

stream sediment samples. It is not possible with available information to know whether the anomalies result from mineralization or from barren rock such as black shale, that is slightly enriched in metallic elements. However, Paleozoic sedimentary rocks and metasedimentary rocks elsewhere in the northern Cordillera contain shale-hosted lead-zinc deposits and the rocks of these tracts (VII and VIII) and other Paleozoic sedimentary rocks in the quadrangle would be permissive for such deposits.

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Appendix 1.--Placer mines and prospects, Circle quadrangle, Alaska

[Summarizes information available through September 1982. Much of the information previous to 1976 is from the table which accompanies Open-File Map 77-168D (Eberlein and others, 1977), and much of the later data on mining activity is from the Mining Kardex File of the Mining Information Office, Division of Geological and Geophysical Surveys, Department of Natural Resources, College, Alaska (abbreviated ADGS in references). Names of prospects and mines, or mining areas are listed alphabetically. Most locations are named for creeks. Mines and claims are approximately located on the map by numbered symbols which correspond to the numbers in this table. In many places one location number is given for all claims, prospects, or mines in an area and may represent properties belonging to several different people or companies. Where there are many claims, the symbol is generally near the central part of the area of activity. On some long creeks on which places of activity are widely spaced more than one symbol may be given to indicate approximate locations of the greatest activity. All of the locations on a given creek have the same number and the several locations are differentiated by a letter designation following the number. Abbreviations used: M--mine with known activity since 1970, m--mine not known to be active since 1970 (a mine is defined as a mineral deposit with recorded production), P--prospect with known activity since 1970, p--prospect not known to be active since 1970 (a prospect is defined as a deposit or (potential) possible deposit that has been staked or had exploratory work but has no known production), O--occurrence (mineralized area not staked or mined). In the resource column, the main metallic commodity is indicated by the conventional chemical symbol. Byproducts produced in minor amounts, potential byproducts, and possibly significant minor constituents are similarly indicated, parenthetically. English units of measure are retained for most of this table in order to quote the source material more easily and correctly. References considered to be most informative about the individual deposits are cited in abbreviated form. A more complete reference is given in the reference list at the end of this report.]

Map No.	Name	Township and Range	Development Category	Resource	Description	Reference
1	Acme Creek	T5N,R11E	P		Years of known activity: 1977, 1980, and 1981	ADGS
2	Albert Creek	T9N,R14E	P		Some activity between 1976 and 1982	ADGS
3	American Creek	T8N,R7E	P		Years of known activity: 1954, 1974, and 1975	ADGS
4	Anvil Creek	T5N,R12E	P		Years of known activity: 1977-1981	ADGS
5	Bachelor Creek (tributary to Preacher Creek)	T8N,R8E	M	Au	Placer gold discovered 1908. Considerable mining activity during the summer of 1909. In 1910 small-scale mining of bench gravel. Present stream gravels are unfrozen, average 7 to 8 ft thick, and consist mainly of schist with considerable proportion of vein quartz and some granite porphyry. Only reported production was from low bench gravels 20 ft thick on east side of creek. Bedrock principally quartz-mica, quartzitic, and carbonaceous schist (Paleozoic and(or) Precambrian cut by sill-like body of granite porphyry 75 ft thick, parallel to schistosity (N 60° E)	Ellsworth, 1910, p. 238; Prindle, 1910, p. 208; Eberlein and others, 1977, p. 18; Cobb, 1976, p. 5
6	Bates Creek	T7N,R11E	P		Years of known activity: 1974, 1976, 1979, and 1981	ADGS
7	Bear Creek	T7N,R10E	P		Years of known activity: 1972-1981	ADGS
8	Bear Creek	T3N,R12E	P		Years of known activity: 1979-1981	ADGS
9	Bear Creek	T7N,R4E	P		Claims were active on upper Bear Creek (9a) from 1976-1981 and on lower Bear Creek (9b) in 1976	ADGS
10	Bedrock Creek	T8N,R13E	O	Cu,W,Th	Granitic intrusion (Late Cretaceous-early Tertiary) into mica schist (Paleozoic and(or) Precambrian?). Sample of granite when concentrated contained 10 percent monazite and a small amount of scheelite. Also present: pyrrhotite, garnet, ilmenite, zircon, biotite, topaz, and malachite. Fluorometric tests indicated the presence of uranium in several minerals but not in amounts to be of economic interest. Concentrates from gravel on upper Bedrock Creek contain tin and tungsten	Eberlein and others, 1977, p. 18; Barker, 1979, p. 10; Nelson, West, and Matzko, 1954, p. 13
11	Berry Creek	T5N,R4E	P		Active in 1982	ADGS
12	Big Windy Creek	T4N,R15E	P		Years of known activity: 1976-1981	ADGS

Appendix 1. Continued

Map No.	Name	Township and Range	Development Category	Resource	Description	Reference
13	Birch Creek	T5N,R11E	M	Au	Gold was discovered somewhere on on Birch Creek in 1893, and was the initial discovery in the Circle district: Production began the following year. Placer production has been largely from major tributaries such as Harrison Creek (see Harrison Creek) but there has been minor production from Birch Creek proper, largely river bars, of which Buckley Bar was probably the most productive	Koschmann and Bergendahl, 1968, p. 23; Brooks, 1907, p. 192; Eberlein and others, 1977, p. 18
14	Birch Creek, South Fork	T5N,R16E	P		Years of known activity: 1977 and 1980	ADGS
15	Birch Creek, unnamed tributary	T7N,R16E	P		Activity in 1979	ADGS
16	Birch Creek, unnamed tributary (between Portage Creek and Buckley Bar Creek)	T6N,R15E	P		Years of known activity: 1974-1977, 1979-1981	ADGS
17	Birch Creek, unnamed tributary (northwest of Wolfe Creek)	T5N,R14E	P		Known activity: 1978-1981	ADGS
18	Bluff Creek	T10N,R15E	P		Known activity: 1974-1981	ADGS
19	Bonanza Creek	T8N,R12E	M	Au(Pb)	Placer gold known to be present in valley of Bonanza Creek since early days of the Circle camp (1895-1896), but serious mining apparently was not undertaken until 1927. Mining reported most years from 1929 to 1937. Work on upper part of creek in 1980. Pay streak in lower valley 75-150 ft wide. Locally derived gravel is well rounded, of moderate size, 3-6 ft thick, and overlain by 2-8 ft of muck. Most of mining on lower part of creek, where bedrock is mostly blocky quartzite and quartz-mica schist (Paleozoic and(or) Precambrian). Gold rather coarse with considable intergrown quartz. Nuggets reported as large as 10 1/2 oz. Little variation in fineness of the gold over a 10 yr mining period (mean = 850 gold, 140 silver). Gold, zircon, garnet, ilmenite, pyrolusite, pyrrhotite, pyrite, and galena present in heavy concentrate. On upper part of the creek 6 ft of gravel lies on weathered bedrock; pay streak is 150 ft to 200 ft wide. Some tin and zinc recovered with the gold. Largest nugget reported was 1 oz.	Eberlein and others, 1977, p. 18
20	Bottom Dollar Creek (tributary of Harrison Creek)	T7N,R14E	M	Au	Placer gold discovered in winter 1909-1910. Prospecting or small-scale-mining reported 1909-1910, 1912, 1936, 1938-1939. Sluicing in 1975. Some small operations in 1981. Pay streak narrow and gold distribution spotty. Most all gravels in narrow creek bed have been processed for gold at least once. Fineness reportedly ranged from 702-797 gold, 195-285 silver. (See also Half Dollar Creek and Two Bit Gulch)	Eberlein and others, 1977, p. 18
	Buckley Bar	T6N,R15E	P	Au	See Birch Creek	
21	Buckley Bar Creek	T6N,R15E	P	Au	Years of known activity: 1973, 1976-1980	ADGS

Map No.	Name	Township and Range	Development Category	Resource	Description	Reference
22	Boulder Creek (tributary of Crooked Creek)	T8N, R13E	M	Au,Sn,(Cu, RE's,U)	Good placer gold prospects reported in benches, 1916. Mining 1929 and possibly at other times. Mining operations were suspended in 1975 due to the difficulty of operating a sluice box in gravels with heavy concentrations of cassiterite. It was estimated by the miner that the pay gravels were yielding in excess of 2 lbs of cassiterite per yard at the mine. Gold occurred primarily as thin irregular flakes. Hematite, magnetite, and scheelite also occurred in the concentrate. Depths to bedrock about 8 ft with most of the gold localized in lower 3 1/2 ft of the gravel. Bedrock is schist intruded by granitic rocks of probable Late Cretaceous-early Tertiary age. Concentrate from sample of granite contained 45 percent allanite and 15 percent chalcopyrite (by volume) and several other minerals which gave positive fluorimetric tests for the presence of uranium. Granitic bedrock also contains vugs of fluorite	Eberlein and others, 1977, p. 18; Barker, 1979, p. 8
23	Butte Creek (tributary to Birch Creek southwest of Gold Dust Creek)	T7N,R11E	M	Au	Placer mining reported 1916, 1937, perhaps 1932, and 1980. A hydraulic plant was installed in 1916 but operated only a short time because of scarcity of water. No production data but weighted mean of all gold mined through 1937 was 900 parts gold and 88 parts silver per thousand. Stream drains bedrock area of quartz-mica schist of Paleozoic and(or) Precambrian(?) age. In 1980 garnets, pyrite, and a little black sand in the panned concentrates. Gravel deposits in the stream bed are 250 ft wide and consist of large rounded boulders of quartz and quartzite up to 1/2 m in diameter	Eberlein and others, 1977, p. 19; Brooks, 1918, p. 56
24	Champion Creek	T7N,R4E	P	Au	Staked for placer gold in 1976	Barker and Clautice, 1977, p. 4
25	Charity Creek	T7N,R7E	M	Au	Placer gold discovered in early 1900's or earlier. Development work that had been underway for several years was not continued in 1909. Mining in 1979. Creek drains area of schist intruded by granitic rocks of probable Late Cretaceous to early Tertiary age. Gravel thickness 6 ft-8 ft with little muck cover. Pay streak from top of gravel to 2 ft into bedrock. Richest values $10/yd at $300/oz gold. A sample panned in 1980 produced 1 color. (See also Homestake Creek)	Eberlein and others, 1977, p. 19
26	Chatanika River	T5N,R6E	P		Years of known activity: 1927, 1977, 1980-1981	ADGS
27	Chatanika River, unnamed tributary between Sourdough Creek and Cripple Creek	T6N,R6E	P		Years of known activity: 1978-1981	ADGS
28	Chena River Middle Fork	T3N,R12E	P		Prospecting at least as early as 1911. Mining reported in 1912, 1921, 1927-1940, 1957, and various mining and(or) prospecting years up to 1981. Most mining was probably at or near Van Curlers Bar	Cobb, 1976, p. 13; ADGS

Map No.	Name	Township and Range)	Development Category	Resource	Description	Reference
29	Chena River, North Fork	T3N,R9E	P		Activity reported in 1981	ADGS
30	Clums Fork	T4N,R11E	P		Years of known activity: 1974, 1976-1981	ADGS
31	Convert Creek	T8N,R7E	P		Years of known activity: 1974-1977	ADGS
32	Cripple Creek	T6N,R5E	P		Years of known activity: 1974-1976, 1980-1981	ADGS
33	Crooked Creek	T9N,R13E	P	Au	Gold known in the valley of Crooked Creek near mouth of Deadwood Creek since early 1900's but was too disseminated for profitable exploitation by the crude hand methods of that time. Placer mining in 1952 assumed to be near the mouth of Mammoth Creek. Mining activity from 1973-1981 near mouth of Mammoth Creek and eastward for several km. At least 2 units of gravel present; an upper gray gravel and an underlying, weathered, orange-colored gravel; both carry gold. Gold flakes very flattened, commonly 1-3 mm in largest dimension	Brooks, 1907, p. 192; Cobb, 1976, p. 15; Brown, Luong, and Forshang, 1982, p. 419
34	Crooked Creek (head of Birch Creek)	T5N,R9E	P		Years of known activity: 1980-1981	ADGS

Map No.	Name	Township and Range)	Development Category	Resource	Description	Reference
35	Deadwood Creek	T8N,R14E	M	Au,Sn,W, (Hg)	Placer gold discovered 1894 and mining has continued with few interruptions until the present time. Dredge operated in 1937-1938, but most of the production has been by other methods. Some claims worked in 1896 yielded 2 to 3 oz gold per man per day. One source (Prindle, 1905) reports total production through 1903 was about 72,570 oz; another (Brooks, 1907) indicates about 33,850 oz 1894-1906. Gold at that time had been found in commercial quantities from a point about a mile above the mouth throughout the length of the creek, a distance of nearly 9 mi. Gold placers in gravels of present creek and in benches along northwest side of valley. Principal bedrock is massive quartzite schist and quartz-mica schist with subordinate carbonaceous and chloritic schist (Paleozoic and(or) Precambrian) intruded in places by granitic rocks and their fine-grained equivalents (Late Cretaceous-early Tertiary). Mafic dikes also present. Alluvial deposits of valley floor range from 5-20 ft. Schist cut by numerous quartz veins, some of which contain metallic minerals. Gravel (3-14 ft thick) derived mostly from local bedrock; overlain by a few inches to 8 ft or more of muck. Gold occurs both in the gravels and in crevices in bedrock. Near the mountain front 6-9 ft of gray gravel overlies an orange brown silty-clayey pebble gravel with weathered clasts; both units contain fine gold. Creek gold is generally flattened and in places rather flaky; nuggets to 6 oz. Bench gold is rougher and more lumpy. Mean fineness on basis of seven assays from 1934 through 1936 production is 796 gold, 198 silver. Fineness remains constant downstream from Switch Creek, but increases upstream. Minerals in placer concentrates include gold, cassiterite, wolframite (all three of which were recovered during mining), scheelite, cinnabar, arsenopyrite, galena, pyrite, tourmaline and garnet. Several of these heavy minerals contain small amounts of uranium. Fluorite is present in granite. Gravels below Discovery Gulch contain wolframite and gold with pieces of quartz attached. Wolframite not known to occur in placers above this gulch. (See also Switch Creek)	Eberlein and others, 1977, p. 19; Brooks, 1907, p. 188-193; Prindle, 1905, p. 56-61; Cobb, 1976, p. 16
36	Deep Creek	T6N,R7E	m	Au	Small placer mine operated in 1946 with possible activity in 1968. No information on production, but probably small as indicated from workings. Creek drains schist bedrock (Paleozoic and(or) Precambrian) cut by bodies of granitic rocks (Late Cretaceous-early Tertiary). (See also Faith Creek)	Eberlein and others, 1977, p. 19; ADGS
37	Denver Creek	T5N,R10E	P		Years of known activity: 1980 and 1981	ADGS
38	Discovery Gulch	T7N,R14E	P		Years of known activity: 1968, 1979-1982. (Also see Deadwood Creek)	ADGS

Map No.	Name	Township and Range)	Development Category	Resource	Description	Reference
39	Eagle Creek	T7N,R11E	M	Au	Gold discovered in 1895. Since 1901 much profitable mining has been done on this stream from the mouth to near the heads of Mastodon and Miller forks. Mining reported nearly every year through 1981. Production through 1906 about 29,000 fine oz. Bedrock mainly quartzitic schist (Paleozoic and(or) Precambrian) cut by numerous quartz veins. Schistosity strikes N 60° E; dips 30°-4-° NW. Pay streak 150-200 ft wide extended down Mastodon Fork and Eagle Creek in present stream gravels 5-20 ft thick and overlain by 2-15 ft of muck. Gold in gravel and upper few feet of bedrock; coarse-grained and intergrown with considerable quartz. Most of the gravels in the main creek has been mined. Far gravels bordering Eagle Creek carry coarse gold and were being prospected in 1980. Fineness about 883 gold, 108 silver, with overall general increase downstream. Grade is about highest reported for Mammoth and Deadwood Creeks area	Brooks, 1907, p. 197; Spurr, 1898, p. 293, 354-355; Eberlein and others, 1977, p. 20; ADGS
40	Easley Creek	T8N,R14E	P		Bedrock is porphyritic granite which weathers to tors. Years of known activity: 1979 and 1980	ADGS
41	East Albert Creek	T9N,R14E	P		Thick silt cover here. Years of known activity 1980 and 1981. Several km to the northwest on Little Albert Creek gold was panned from Tertiary(?) gravels	ADGS
42	East Great Unknown Creek	T6N,R12E	P		Years of known activity: 1974 and 1976-1981	ADGS
43	Elliott Creek	T3N,R4E	P		Activity in 1981	ADGS
44	Faith Creek	T6N,R7E	M	Au	First reported finding of placer gold in 1906. Upper part of valley prospected in 1909. Other years of known activity include 1937-1940, 1953-1959, 1975-1977, and 1980-1982. Most of activity has been near mouth of Deep Creek, but claims were also active near mouth of Faith Creek 1975-1981 and on a south flowing tributary 2 km above the mouth in 1976-1977. Ninety percent of the clasts in creek are quartz-mica schist, quartzite, and quartz. (See also Deep Creek)	Eberlein and others, 1977, p. 20; ADGS
45	Fish Creek	T7N,R11E	P		Years of known activity: 1972-1981	ADGS
46	Flat Creek	T5N,R5E	P		Years of known activity: 1980 and 1981	ADGS
47	Frozen Creek	T5N,R7E	P		Years of known activity: 1953-1964, 1980-1981	ADGS
48	Fryingpan Creek	T6N,R11E	P	Au	Good values reported by prospectors during winter 1909-1910 in hole about 20 ft deep. More recent activity in 1974-1981. Schist (Paleozoic and (or) Precambrian) bedrock; 4-5 ft of pay gravel beneath 15 ft of overburden. No record of any production	Eberlein and others, 1977, p. 20; ADGS

Appendix 1. Continued

Map No.	Name	Township and Range)	Development Category	Resource	Description	Reference
49	Gold Dust Creek	T7N,R11E	M	Au	Gravel of Gold Dust Creek prospected during 1936. Two active placer operations during 1975 and active mining in 1980 to present. Stream heads south of Mastodon Dome and drains area underlain by quartz-mica schist and mafic schist (Paleozoic and(or) Precambrian). Gold also reported in a fracture zone on this creek. Average thickest of gravel 4 m, average gold value \$3.50-\$5.00/yd^3 at \$500./oz. Concentrates include ilmenite granules up to 1/2 cm. Hemitite nodules up to 2 cm, pyrite and scheelite. Gold fragments up to.75 cm across	Eberlein and others, 1977, p. 20; ADGS
50	Graveyard Creek	T8N,R14E	P		Years of unknown activity: 1977-1981	ADGS
51	Greenhorn Creek (Greenhorn Gulch)	T7N,R14E	M	Au(Ag)	Mined as early as 1896. Intermittent activity to present. Gravels about 4 ft thick on bedrock of schist. Fragments of vein quartz contain disseminated free gold and weathered sulfide minerals. One such fragment assayed 24 oz silver per ton	Eberlein and others, 1977, p. 20
52	Grizzly Creek	T5N,R14E	P		Years of known activity: 1976, 1979-1981	ADGS
53	Grouse Creek	T5N,R4E	P		Activity in 1980	ADGS
54	Gulch Creek	T3N,R18E	P		Some activity between 1962 and 1981	ADGS
55	Half Dollar Creek	T7N,R14E	M	Au(Sn,W)	Placer gold discovered winter 1909-1910. Prospecting and (or) mining 1909-1914, 1935, 1938-1942 and probably 1976-1980. Pay streak narrow and gold distributioin spotty. Cassiterite abundant and scheelite common in placer concentrates but no indication that either was recovered during mining. Granitic rocks (Late Cretaceous-early Tertiary) exposed in drainage basin contain allanite, garnet, hematite, limonite, pyrrhotite, sphene and zircon. Fluorimetric tests indicate the presence of uranium in several of these minerals. (See also Bottom Dollar Creek and Two Bit Gulch)	Eberlein and others, 1977, p. 20; ADGS
56	Harrington Fork	T5N,R9E	P		Years of known activity: 1963, 1976, 1977, 1980-1981	ADGS

Appendix 1. Continued

Map No.	Name	Township and Range)	Development Category	Resource	Description	Reference
57	Harrison Creek	T6N,R13E	M	Au,(Sn)	Gold discovered at Pitka Bar (at mouth of North Fork) in 1893. Intermittent mining until 1929. Mining reported annually except one year, 1929-1981. The most productive placers are located on the North Fork, where four companies were reported to be operating in 1975. Bedrock mainly weathered quartz-mica and mica schist (Paleozoic and(or) Precambrian?) cut by numerous quartz veins. Fragment of one such vein contained grains of gold as much as 3/16 in diameter. Gravel, mostly unfrozen, of moderate size, and 4-12 ft thick, with little or no overlying muck. Gravel composed mostly of pebbles and cobbles of locally derived schist and subordinate granitic rocks. Gold in lower 3 ft of gravel and upper foot or two of bedrock. Gold in the gravel tends to be fine grained, flaky and bright; that on and near bedrock is fairly coarse. Mean fineness, based on 13 North Fork assays, is 837 gold, 154 silver. Distribution of gold values and occurrence of attached quartz suggest derivation from diverse local sources. Concentrates contain a little cassiterite and considerable garnet and pyrite. This creek has been extensively mined. (See also Harrison Creek, North Fork, and South Fork	Eberlein and others, 1977, p. 21; Cobb, 1976, p. 30; ADGS
58	Harrison Creek, North Fork	T7N,R12E	P	Au	Before the middle of 1896 the whole of the North Fork of Harrison Creek was staked. Prospecting and(or) mining 1905, 1924, 1953-1981. Most of the creek has been mined. Hydraulic mining operations were going on in 1980. Gravels are about 4 m thick and the pay streak 30-40 m wide. Gold has worked its way into the fractures in the bedrock as far as 1 m. Three varieties of gold are present: an orange gold, a yellow gold, and silver-colored gold. Bedrock is tightly folded and fractured. (See also Harrison Creek)	Spurr, 1898, p. 351; Brooks, 1907, p. 188; Ellsworth, 1910, p. 238; ADGS
59	Harrison Creek, South Fork	T6N,R12E	P	Au	Years of known activity: 1977, 1979-1981	Eakins and Daniels, 1980, p. 19; ADGS
60	Holdem Creek	T8N,R14E	p	Au	Gold discovered in 1932. Mined 1933-1934. Bedrock is porphyritic granite which weathers to tors. (See also Ketchem Creek)	Eberlein and others, 1977, p. 21
61	Homestake Creek	T7N,R7E	m	Au	Placer gold mined in early 1900's. No mining reported in literature after 1912. Gravel 8 ft thick. Gold said to have been found in place along intrusive contact between schist (Paleozoic and(or) Precambrian) and granite porphyry (Late Cretaceous-early Tertiary). (See also Charity Creek)	Eberlein and others, 1977, p. 21

Appendix 1. Continued

Map No.	Name	Township and Range)	Development Category	Resource	Description	Reference
62	Hope Creek	T7N,R7E	p	Au	Placer gold discovered early 1900's, but apparently never mined extensively. Bedrock is quartzite and quartzitic schists intruded by granitic rocks. Samples of granite from near head of creek contained trace to small amounts of allanite(?), fluorite, galena, malachite, molybdenite, pyrite, pyrrhotite, rutile, scheelite, stibnite, and other heavy minerals. Stibnite, reported to have been found in bedrock in 1926, apparently buried	Cobb, 1976, p. 34
63	Hot Springs Creek	T8N,R15E	P		Scheelite, allanite, sphene and zircon present; last 3 minerals indicated as uranium and(or) thorium bearing, but no analytical data available	Cobb, 1976, p. 35
64	Idaho Creek	T6N,R8E	P		Scheelite, allanite, sphene and zircon present; last 3 minerals indicated as uranium and(or) thorium bearing, but no analytical data available	Cobb, 1976, p. 35
65	Independence Creek	T8N,R12E	M	Au(Pb,Sn, RE's,U,W)	Gold placers have been worked since 1894 or 1895. Creek has been a steady large producer to present time, although its pay streak is not as rich as the best part of the Mastodon Creek pay streak. The gravel in the center of the creek has been mined. There is some unmined gravel along the margins of the creek where it was covered by old mine tailings. Those were being mined in 1980. The gold is very "flat." Bedrock is mica schist, quartz-mica schist, and quartzite schist (Paleozoic and(or) Precambrian?) cut by numerous quartz veins. Pay gravel as much as 425 ft but generally no more than 325 ft wide, 4-8 ft thick, and overlain by 0-10 ft of muck. The gold is fine-grained and lies mainly within 3 ft of the gravel-bedrock contact. In one part of creek weighted mean fineness (eight assays) was 787 gold, 201 silver; in another it was 810 gold, 175 silver (five assays representing 1500 oz of gold). Gold fineness increases progressively downstream. Source of gold believed by miners to be localized in area of Mastodon Dome. Heavy minerals in placer concentrates; wolframite, xenotime, zircon, garnet, and hematite, some of which are slightly uraniferous. (See also Mammoth, Mastodon, and Miller Creeks)	Eberlein and others, 1977, p. 21

Appendix 1. Continued

Map No.	Name	Township and Range)	Development Category	Resource	Description	Reference
66	Ketchem Creek	T8N,R15E	M	Au(Sn,RE's, U,W)	Placer gold mined 1933-1940 and more recently including 1975 and 1981. Creek drains contact zone between quartz-mica schist (Paleozoic and(or) Precambrian?) and granitic intrusive (Late Cretaceous-early Tertiary). 4-17 ft of moderate sized gravel overlain by 3-7 ft of sand and muck. Granite boulders 3-4 ft diameter were a serious problem in the area just below Holdem Creek. Gold in lower part of gravel, in the upper part of the bedrock, and in a fine-grained arkosic sand that locally covers the bedrock surface. Gold is fine-grained, but pieces weighing 7-10 grains have been found. Some of the gold has considerable quartz attached. Fineness reported 783 parts gold and 207 parts silver per thousand. Heavy concentrates also contain scheelite, cassiterite, allanite, garnet, sphene, and zircon, some of which contain small amounts of uranium. (See also Holdem Creek)	Eberlein and others, 1977, p. 22
67	Lawson Creek	T3N,R11E	P	Au	Known years of activity include 1971, 1974, 1976-1981	ADGS
68	Little Champion Creek	T7N,R5E	P	Au (U)	Staked for placer gold in 1976. Anomalous amounts of uranium (as much as 570 ppm) were detected in sediment samples from springs localized along contact of the Mount Prindle granitic pluton (early Tertiary) with quartzite schist, micaceous quartzite and lesser amounts of quartz-mica, phyllitic and calcareous schist (Paleozoic and(or) Precambrian). Stream sediments in area were found to contain up to 400 ppm uranium.	Barker and Clautice, 1977, p. 4; Eberlein and others, 1977, p. 22
69	Little Chena River	T3N,R4E	P		Years of known activity: 1980-1981	ADGS
70	Loper Creek	T8-9N,R10E	P	Au	Good placer gold prospects reported as early as 1908 in unfrozen gravel less than 8 ft deep. Also prospected in 1932 but no record of any production. In 1976, 3 claims were staked near the mouth of Loper Creek. Two other localities (70a and b) had a few active claims from 1976 to 1981	Eberlein and others, 1977, p. 22; ADGS
71	Malburn Creek	T5N,R11E	P		Years of known activity: 1976, 1980 and 1981	ADGS

Map No.	Name	Township and Range)	Development Category	Resource	Description	Reference
72	Mammoth Creek	T8N,R12E	M	Au (Cu,Pb, RE's,U,Mo,W)	Gold discovered 1894. Production through 1906 almost 100,000 oz. Mined mostly by hydraulic methods before 1915. Dredging in 1915-1916 and 1936-1940. Bedrock mainly quartzitic and micaceous schist (Paleozoic and(or) Precambrian) cut by granitic bodies (Late Cretaceous-early Tertiary). About 12 ft of locally derived gravel overlain by 3 ft overburden. Gold in upper valley fairly coarse and light colored. Fineness about 840, increasing downstream. Source of gold believed to be quartz veins and mineralized zones in the bedrock. Sample of granite talus contained allanite, galena, molybdenite, scheelite, iron sulfide minerals and hematitic, copper carbonate minerals, garnet and topaz. Presence of uranium detected by fluorimetric tests. The main channel of the creek is completely mined, but some mining is being attempted along the margins of the channel, probably at least partly in colluvium. (See also Independence, Mastodon, and Miller Creeks)	Eberlein and others, 1977, p. 22; Cobb, 1976, p. 41
73	Mastodon Creek	T8N,R12E	M	Au (Sn)	Mined 1894 to as recently as 1981. Dredeges operated 1912-1913 and 1918-1926. Total gold production well over 150,000 oz (one of the largest producing creeks in Circle district). Bedrock mainly quartzite- and mica-schist (Paleozoic and(or) Precambrian) cut by numerous quartz veins and locally by granitic rocks (Late Cretaceous-early Tertiary). Closely folded impure limestone near mouth. Depth to bedrock 10-15 ft. Pay streak in lower valley about 200 ft wide and 7-10 ft thick in mostly unfrozen gravels. Gold coarsest near head of stream and contains much quartz. Downstream the gold becomes more flaky, carries less quartz and shows an increase in fineness (820-840). Cassiterite reported in concentrates. (See also Mammoth, Independence, and Miller Creeks)	Eberlein and others, 1977, p. 22; ADGS
74	McManus Creek	T6N,R8E	P		Years of known activity: 1980 and 1981	ADGS
75	McKinley Creek	T8N,R9E	P		Years of known activity: 1974-1977	ADGS
76	McLean Creek	T5N,R13E	P		Some work in 1910 although there may not have been any gold found. Other years of known activity include 1924, 1974 with various times up to 1981	Cobb, 1976, p. 46; ADGS
77	Medicine Lake (east inflow)	T7N,R16E	P		Years of known activity: at times from 1976-1980	ADGS
78	Medicine Lake (west inflow)	T7N,R16E	P		Known activity: 1979	ADGS

Map No.	Name	Township and Range)	Development Category	Resource	Description	Reference
79	Miller Creek	T8N,R12E	M	Au	Placer gold mined intermittently from 1894-1982, but apparently has not been a large producer. In 1980 the thick (10-20 m), ice-rich muck deposits overlying the gravel along the margins of the creek were being thawed. Bedrock mainly quartzite and quartzitic schist veined with quartz. Granitic dikes occur on divide between Miller and Eagle Creeks. Gravel 4-16 ft thick including about 4 ft of overlying admixed muck. Locally, up to 3 ft of clay between bedrock and gravel which contains most of the gold; at most places gold found in lower few feet of gravel and upper part of decomposed bedrock. Pay streak has maximum width of about 50 ft. Weighted mean, based on seven assays of production in 1919, 1920, 1923, 1924, and 1928, representing 965 oz of gold, had a fineness 832 gold, 162 silver. (See also Independence, Mastodon, and Mammoth Creeks)	Spurr, 1898, p. 349-350; ADGS; Eberlein and others, 1977, p. 23
80	Modoc Creek	T5N,R6E	P		Known activity in 1981	ADGS
81	Montana Creek	T3N,R11E	P		Years of known activity: 1973, 1980, 1981	ADGS
82	Montana Creek	T6N,R8E	P		Years of known activity: 1970 and various years through 1981	ADGS
83	Monument Creek	T3N,R9E	P		Years of known activity: 1980, 1981	ADGS
84	Moose Creek (east of Table Top Mountain)	T6N,R5E	P		Years of known activity: 1974-1981	ADGS
85	Munson Creek	T3N,R10E	P		Years of known activity: 1980, 1981	ADGS
86	Nome Creek	T6N,R5E	M	Au (Sn,Th)	Placer gold discovered 1910. Dredging 1926-1931, 1939-1940, 1946 and probably later. Mining in progress several seasons between 1960 and 1982. Most of the mining has been from about 1 km above the junction with Sumner Creek to the junction with Moose Creek, a distance of about 10km. Some work was also done on Sumner Creek just above its junction with Nome Creek. Creek heads in Mt. Prindle area where a small early Tertiary pluton intruded Paleozoic and(or) Precambrian schist. Ground about 15 ft deep with 2-4 ft of pay gravel. No data on production, but workings suggest total is substantial. Concentrates also contain cassiterite, monazite, topaz, and tourmaline. Heavy fraction reportedly contained eU of 0.012 percent	Eberlein and others, 1977, p. 23; Cobb, 1976, p. 50; ADGS
87	Ohio Creek	T2N,R12E	P		Years of known activity: 1960 and 1977	ADGS

Appendix 1. Continued

Map No.	Name	Township and Range)	Development Category	Resource	Description	Reference
88	Palmer Creek	T2N,R11E	m	Au	Placer mining produced a small amount of gold 1937-1941 and probably later. Concentrates contained abundant scheelite but no record that it was ever recovered. Numerous quartz and calcite veinlets which cut the country rock (quartzite and phyllite of probable Paleozoic age) have been considered the source of the gold by some workers. No granitic rocks are known to occur in the drainage area	Eberlein and others, 1977, p. 23
89	Porcupine Creek	T9N,R11E	M	Au (Sn)	Placer gold discovered in 1890's but mining was intermittent and on small scale until 1930's. Some mining in late 1950's and (or) early 1960's. Two operators active in 1975, and activity in 1980 and 1981. Placers mined in 1936 consisted of about 13 ft of gravel overlain by about 2 ft of muck with mining over about 1000 ft of creek bed. Bedrock is quartzitic schist and quartz mica schist (Paleozoic and (or) Precambrian) with vertical foliation, locally. Gravel composed mostly of bedrock material. Most pebbles do not exceed a foot in diameter and average size is much less. Some boulders as large as 3 ft in diameter have been uncovered in mining operations. Gold mainly on and in bedrock and is coarse, ragged and shotty. Numerous nuggets; some to 2-3 oz, all with considerable quartz attached. Weighted mean of gold mined 1934 and 1935 shows a fineness of 822 gold, 168 silver. An assay of gold produced in 1936 shows a fineness of 818 gold and 172 silver. Gravel being mined in 1980 is 3-8 m thick, pay streak 30-70 m wide, and there are 2 layers of "pay." Along with the gold, cassiterite and scheelite occur. A four-ounce nugget was recently recovered, although an 8 1/2 oz nugget was reportedly recovered and is the largest nugget known from the area. A little cassiterite occurs in the concentrates. A mineralized zone has been prospected near the head of Dome Creek, a small tributary of Porcupine Creek and may be a source of some gold and(or) tin in the placers. (See also Porcupine Dome and Yankee Creek)	Eberlein and others, 1977, p. 23; Eakins, and Daniels, 1980, p. 21

Appendix 1. Continued

Map No.	Name	Township and Range)	Development Category	Resource	Description	Reference
90	Portage Creek (flows into Medicine Lake)	T7N,R15E	M	Au (W,RE's, Sn)	Gold discovered in early 1900's. About 10 oz said to have been recovered from one claim in 1906. Sustained mining began about 1933. Mining hampered by many large boulders. Two operators active 1975 and other work has been done more recently. In 1980 colluvium (1-2 m thick) coming into Portage Creek was being mined. Values of $17.00/ yd^3 at $500/oz gold reported. Bedrock is Tertiary quartz monzonite porphyry. Cassiterite a common constituent of placer concentrates. No data on production or occurrence of the gold. Heavy concentrates also include allanite, arsenopyrite, hematite, ilenite, magnetite, monazite, uranothorite, zircon, apatite, sphalerite, sphene, garnet, scheelite, cassiterite, bismuthinite, wolframite, and topaz. Fluorite occurs in vugs in granite	Eberlein and others, 1977, p. 24
91	Portage Creek (tributary to Birch Creek)	T6N,R15E	P		Years of known activity: 1976, and 1979-1981	ADGS
92	Preacher Creek	T8-12N,R8-11E	P	Au	Gold strike reported in 1913, but may have been a strike on Bachelor Creek or Loper Creek. Numerous claims have been staked at various localities on Preacher Creek and minor tributaries in 1928 and 1976-1981. Claims near localities 92a, e, and g on the main stream were active 1978-1981; claims near locality 92c were active in 1928 and 1979-1981. Claims on small, unnamed tributaries near localities 92b, f, and h were active 1978-1981 and claims near 92d were active 1976-1981. No indication of any significant production from Preacher Creek.	Cobb, 1976, p. 56; ADGS
93	Preacher Creek, North Fork	T10-11N,R6-9E	P		Years of known activity: 1978-1981	ADGS
94	Ptarmigan Creek (heads below Porcupine Dome)	T7N,R11E	P		Sediments said to contain relatively large amounts of copper. Years of known activity are 1925, 1953, 1954 and 1969-1982	Burand, 1965, p. 28; ADGS
95	Ptarmigan Creek (tributary to Chatanika River)	T5N,R4E	P		Known activity in 1981. Little gravel but good colors can be obtained panning on bedrock on lower part of creek	ADGS
96	Quartz Creek	T9N,R16E	P		Known activity in 1980 and 1981	ADGS
97	Second Pup	T5N,R5E	P		Years of known activity: 1975-1982	ADGS
98	Shamrock Creek (tributary of Middle Fork of Chena River)	T2N,R11E	M	Au	Years of known activity: 1924, 1938-1939, 1966, 1968-1972, and 1976. Small scale suction dredging in 1980	ADGS; Eberlein and others, 1977, p. 24
99	Sawpit Creek	T8N,R13E	P		Years of known activity include 1958 with various years up to 1981	ADGS
100	Sheep Creek	T5N,R15E	P		Years of known activity: 1976, and 1978-1981	ADGS
101	Smith Creek	T5N,R7E	r		Years of known activity include 1968 and various years up through 1981	ADGS
102	Sorrels Creek	T4N,R4E	P		Years of known activity: 1979, 1981, and 1982	ADGS

Appendix 1. Continued

Map No.	Name	Township and Range	Development Category	Resource	Description	Reference
103	Sourdough Creek	T6N,R6E	M	Au (Sn,W,Sb)	Placer gold mined 1932-1940 and intermittently 1946-1959. Prospecting and maintenance work, 1966. Activity in various years through 1981. Total production not known, but about 2850 oz gold reportedly produced 1937-1941. 200 oz cleanup reported from single 300 ft by 150 ft cut on discovery claim. Little if any ground prospected ahead of mining. Creek has been largely mined. Gravel 10-11 ft thick. Gold reported to be mostly fine, 3/16 in to flour size. Largest nugget 1/4 in. by 3/4 in. and flat. Bedrock is quartzite and quartzitic schist of Paleozoic and(or) Precambrian age with a small granitic pluton of probable Late Cretaceous or early Tertiary near head of creek. Placer concentrates contain gold, stibnite, and sparse cassiterite. Stibnite and scheelite identified in samples of granitic rocks (talus). (See also Dempsey Pup)	Eberlein and others, 1977, p. 24
104	Squaw Creek (Squaw Gulch)	T7N,R14E	M	Au	Gold discovered as early as 1894. Prospected and mined on small scale through 1896 and some activity known from 1953-1981. The channel is narrow with little gravel but good color can be obtained by panning. In 1981 coarse gold with values of $5-15 ($yd^3$) at $500/oz gold were recovered from coarse gravel	Eberlein and others, 1977, p. 24; ADGS
105	Switch Creek	T7N,R14E	M	Au (Pb,W?)	Important source of placer gold from 1906 intermittently until World War II and 1942-1956. Some activity from 1963-1982 Both drift and hydraulic mining. Bedrock is mainly quartzitic schist and quartz-mica schist (Paleozoic and(or) Precambrian) cut by numerous quartz-feldspar veins and intruded by granitic plutons (Late Cretaceous-early Tertiary). Some of the quartz-feldspar veins carry arsenopyrite. Schist garnetiferous near contacts with granitic rocks. Both present creek and bench gravels carry gold. Gold coarse; large nuggets have quartz attached. Weighted mean of eight assays showed fineness of 760 gold, 231 silver (somewhat lower than that from Deadwood Creek). Concentrates contain gold, arsenopyrite, pyrite, galena, magnetite, ilmenite, garnet, tourmaline, and limonite. Wolframite reported on lower Switch Creek	Eberlein and others, 1977, p. 24
106	Thomas Creek	T6N,R13E	P		Years of known activity: 1974-1981	ADGS
107	Twelvemile Creek	T7N,R9E	P		Years of known activity: 1980-1982	ADGS
108	Twelvemile Creek, North Fork	T7R,R10E	P		Years of known activity include 1953 and various years up through 1981	ADGS

Appendix 1. Continued

Map No.	Name	Township and Range)	Development Category	Resource	Description	Reference
109	Two Bit Gulch	T7N,R14E	m	Au	Good placer gold prospects found and profitable mining during winter 1909-1910. Pay streak is narrow and irregular. Any other activity in this gulch probably was reported under Half Dollar Creek. (See also Half Dollar Creek)	Eberlein and others, 1977, p. 25
110	Van Curlers Bar	T2N,R11E	m	Au	Small dredge operation resulting in moderate production for many years prior to 1963. Intermittent minor activity to present. (See also Chena River)	Eberlein and others, 1977
111	Willow Creek	T3N,R18E	p		Only known year of acivity is 1962	ADGS
112	Willow Creek (between Bear Creek and Fish Creek)	T7N,R10E	P		Years of known activity: 1958 and 1972 and various other years up through 1981	ADGS
113	Willow Creek (east of Loper Creek)	T9N,R10E	P		Years of known activity: 1977-1978, and 1980-1981	ADGS
114	Wolf Creek	T5N,R13E	P		Years of known activity: 1975, 1977, and 1980-1981	ADGS
115	Wolf Creek	T2N,R12E	P		Known activity in 1980	ADGS
116	Yankee Creek	T8N,R11E	M	Au (Sn)	Small camp established in 1932 near junction with Porcupine Creek. Mined intermittently through 1981. Cassiterite associated with the placer gold. Source of both believed by miners to be mineralized zone on Porcupine Dome. (See also Porcupine Creek and Porcupine Dome)	Eberlein and others, 1977, p. 25; ADGS
117	Yukon Flats	T13N,R14E	P		Years of known activity: 1973-1981	ADGS

Appendix 2. Lode prospects and occurrences, Circle quadrangle, Alaska.

[Summarizes information available through September 1982. Much of the information previous to 1976 is from the table which accompanies Open-File Map 77-168D (Eberlein and others, 1977), and much of the later data is from the Mining Kardex File of the Mining Information Office, Division of Geological and Geophysical Surveys, Department of Natural Resources, College, Alaska (abbreviated ADGS in references). Names of prospects are listed alphabetically and are approximately located by numbered symbol on the map with the numbers corresponding to those in this table. In some places one location number may represent properties belonging to several different people or companies. Where there are many claims, the symbol is generally located near the central part of the claimed area. Abbreviations used: P--prospect with known activity since 1970, p--prospect not known to be active since 1970 (a prospect is defined as a deposit or (potential) possible deposit that has been staked or had exploratory work but has no known production), O--occurrence (mineralized area not staked or mined). In the resource column the main metallic commodity(s) is indicated by the conventional chemical symbol. Minor constituents are similarly indicated parenthetically. English units of measure are retained for most of this table in order to quote the source material more easily and correctly. References considered to be most informative about the individual deposits are cited in abbreviated form. A more complete reference is given in the reference list at the end of this report.]

Map No.	Name	Township and Range	Development Category	Resource	Description	Reference
1	Albert Creek Lode 1-5	T9N,R13E	p		Claims active 1953	ADGS
2	Bachelor Creek	T7N,R8E	P		Claims active 1968-1970	ADGS
3	Bedrock Creek	T8N,R13E	P		Claims located 100 yds east of creek; active 1976-1978. Bedrock consists mostly of quartz-mica schist cut by small discontinuous veins of quartz. A zone of schist stained by iron oxides is slightly radioactive. This zone was trenched and found to be from 1/2 ft to 2 ft in width throughout a length of about 8 ft. The iron-stained schist gives a radiometric reading of about 0.05 mr per hr, and unstained schist from nearby outcrops gives a reading of about 0.04 mr per hr. The prospect is on the site of a definite localized anomaly of radioactivity, but is small in size and low in grade. Uranium bearing minerals in the granitic bedrock south of this prospect are garnet, malachite, scheelite, topaz, and zircon	ADGS; Freeman 1956, p. 32; Nelson, West, and Matzko, 1954, p. 14
4	Big Windy Hot Springs	T5N,R16E	P	U?	Claims have been staked at site of some of the hot springs. Uranium concentrations of 1 ppb occur in water from the hot springs	ADGS; Keith, Presser, and Foster, 1981, p. B25
5	Bedrock Millsite	T9N,R14E	P		Claims active 1978-1981	ADGS
6	Birch Creek	T7N,R10E	P		Claims active 1975-1981	ADGS
7	Birch Creek NF	T7N,R10E	P		Claims active 1976, 1979-1981	ADGS
8	Bonanza Creek	T8N,R12E	P		Claims active 1978-1979	ADGS
9	Bottom Dollar Creek	T7N,R14E	P		Claims active 1979-1982	ADGS
10	Caribou Creek, Puzzle Gulch, and FUR	T4N,R17E	P	W	Parts of claim block active 1974-1982. Extensive exploration sampling and drilling in late 1970's and early 1980's. Tungsten skarns present. Area of high grade pelitic schists with minor augen gneiss (of probable granitic origin) intruded by late Cretaceous and early Tertiary granitic rocks	ADGS
11	Champion Creek	T8N,R6E	P		Claims active 1977-1981	ADGS
12	Champion-Nome Creek, Karen 1-10	T7N,R5E	P		Near contact of metamorphic rocks and a granitic pluton. Claims active 1977-1981	ADGS
13	Chena River/Montana Creek	T2N,R11E	P		Claims active 1969-1970 and 1976	ADGS
14	Crazy Mountains	T9N,R16E	P		Claims active 1979 and 1981	

Map No.	Name	Township and Range	Development Category	Resource	Description	Reference
15	Deadwood Creek	T8N,R14E	P	Pb,W,Au,Ag	Numerous small quartz-feldspar veinlets cut schist and porphyritic granite bedrock. Most are barren, but the rusty appearance of some suggests the former presence of sulfides. Mineralized fracture zone with veinlets of quartz, pyrite, and argentiferous galena occurs in schist bedrock on upper part of creek: reportedly carried about $6 in gold and $8 in silver (1907 prices). Small wolframite-bearing vein in schist near wolframite and cassiterite-bearing placers at junction with Discovery Gulch. Porphyritic granite contains fluorite in vugs. Claims active in 1981	Eberlein and others, 1977, p. 19; ADGS
16	Dempsey Pup	T6N,R6E	p	Sb,Au(?)	Quartz vein containing small lenses and stringers of stibnite and possibly gold explored by several short tunnels about 1920. Bedrock is quartzitic schist (Paleozoic and(or) Precambrian). In 1942 only a few thin seams of stibnite could be seen in place. A few discontinuous veinlets of stibnite also were observed in about 50 tons of mineralized quartz on dumps. One dump reportedly contained a few hundred pounds of low-grade ore (1950). Assay of best material showed about 28 percent antimony	Eberlein and others, p. 20, 1977
17	Dolly 368 CLMS	T7N,R9E	P		Bedrock mainly quartz-mica schist intruded by felsic igneous rock. Claims active 1974-1976	ADGS
18	Eagle Summit	T8N,R11E	P		Claims active 1979	ADGS
19	FED AID-A14	T11N,R11E	P		Claim active 1970	ADGS
20	Harrison Creek	T7N,R13E	P		Claims active 1972-1981	ADGS
21	Hope Creek	T7N,R6E	p	Sb,Cu,Pb, Mo,W	Bedrock is quartz-mica schist (Paleozoic and(or) Precambrian) intruded by granitic rocks (Late Cretaceous-early Tertiary). Samples of granite near head of creek contain trace to small amounts of fluorite, galena, molybdenite, allanite(?), pyrite, pyrrhotite, scheelite, rutile, and stibnite. Stibnite deposit found 1926 while constructing bedrock drain; apparently later covered. Reported occurrence of quartz-pyrite-fluorite veins in the schist could not be confirmed by USGS in field examination, 1952. No bedrock in the area found to contain more than 0.004 percent eU	Eberlein and others, 1977, p. 21; ADGS
22	Horse Creek	T5N,R6E	p		Claims active 1968	ADGS
23	Horse Creek/Chatanika River, Horse Creek NE bank	T5N,R6E	p		Claims active 1968	ADGS
24	Honker 1-42	T7N,R4E	P		Claims active 1977-1980	ADGS
25	Hot Springs Creek	T7N,R15E	P		Houston International is said to have tested sedimentary uranium shows in Tertiary sediments near Circle Hot Springs. Claims active 1978-1981	Eakins, 1981, p. 77
26	Idaho Creek Ridge	T6N,R7E	P		Claims active 1980-1981	ADGS

Appendix 2. Continued

Map No.	Name	Township and Range	Development Category	Resource	Description	Reference
27	Ketchum Dome	T7N,R14E	P	Au (Sn,RE's, U,W)	Contact zone between quartz-mica schist (Paleozoic and(or) Precambrian) and granitic intrusive (Late Cretaceous-early Tertiary). Abundant tourmaline in porphyritic granite. Minor sulfide minerals in country rock. Claims active 1978-1981	Eberlein and others, 1977, p. 22; ADGS
28	Lime Peak	T9N,R5E	P	Sn(?)	Some exploration and limited drilling was carried out, but no further development has taken place. Lime Peak is a Tertiary granitic pluton. Claims active 1977-1981	ADGS
29	Lime Peak	T9N,R4E	P		Claims were mostly in Tertiary granite or near contacts of granite and metamorphosed country rocks. Claims active 1977-1978	ADGS
30	Lion Mountains, White Mountains	T9N,R5E	P		Claims active 1955-1957	ADGS
31	Little Champion Creek Tributary	T7N,R5E	P		Claims active 1977-1981	ADGS
32	Little Champion Creek	T7N,R6E	P		Claims active 1977-1980	ADGS
33	Little Champion Creek	T7N,R5E	P		Claims active 1977-1978	ADGS
34	Little Champion Creek	T7N,R6E	P	U(?)	Some exploration and limited drilling carried out, but no further development has taken place. Work by the Bureau of Mines indicates a possible source in the Mt. Prindle area for high uranium values in stream sediment samples. Claims active 1977-1981	Barker, 1979, p. 8; ADGS
35	LUK	T3N,R16E	P		Claims active 1979-1980	ADGS
36	Middle Fork Chena River Drainage	T3N,R13E	P		Claims active 1981	ADGS
37	Miller House (Steese Highway)	T8N,R12E	O		Arsenopyrite occurs in probable felsic dike rock marked by several iron-zones within a road cut along Steese Highway. Three samples of arsenopyrite bearing rock contained .05, 1 and 3.9 ppm Au as determined by atomic absorption	
38	Mount Prindle	T7N,R7E	P		Claims active 1977-1981	ADGS
39	Nome-Champion Creek	T6N,R5E	P		Claims active 1977-1980	ADGS
40	Nome Creek Headwaters	T7N,R6E	P		Claims active 1977	ADGS
41	Polar Creek	T6N,R6E	P		Claims active 1969-1981	ADGS
42	Porcupine Dome	T8N,R11E	P	Au,Ag,Sn	Quartz veins, containing gold, silver, and cassiterite in metamorphic rocks. Prospected in 1930's. Granitic rocks not known to crop out in area. (See also Porcupine Creek)	Cobb, 1976, p. 53; Eberlein and others, 1977, p. 23
43	Portage Creek	T7N,R15E	O	Zn,RE's,W	Samples of quartz monzonite porphyry contain sphalerite, allanite, garnet, limonite, scheelite, sphene, topaz, zircon, and traces of cerite. Fluorite also occurs in vugs and one water sample contains an anomalous amount of uranium (40.2 ppm). No exploratory or development work	Eberlein and others, 1977, p. 24
44	Portage Creek	T8N,R15E	P		Claims active 1976-1978. Gold (scarse) can be panned from gravel along the Hot Springs landing strip	ADGS
45	Salcha River	T3N,R18E	P		Claims active 1975-1981	ADGS

Appendix 2. Continued

Map No.	Name	Township and Range	Development Category	Resource	Description	Reference
46	Smith Creek	T5N,R7E	P		Claims active 1968, 1980	ADGS
47	Sorrels Creek	T4N,R5E	P		Claims active 1981	ADGS
48	Sourdough Mountain SW	T6N,R6E	P		Bedrock vuggy quartzite, breccia, and schist. Fluorite and secondary quartz in vugs. Abundant manganese stain. Spring zone suggests faulting. Claims active 1957-1975	ADGS
49	South Fork Creek Tributary	T6N,R9E	P		Claims active 1981	ADGS
50	Squaw Creek Dis 1-3	T7N,R14E	P		Claims active 1968, 1970	ADGS
51	Steese Highway	T7N,R10E	P		Claims active 1975	ADGS
52	Steese Highway	T7N,R10E	P		Claims active 1970	ADGS
53	Switch Creek	T7N,R14E	P	W(Sn,Hg)	A nearby locality on Discovery Gulch has been reported to contain abundant wolframite and cassiterite in the gravels. Small shipments of tungsten concentrates were reported in 1916 when the price was higher. Minor cinnabar has also been reported on Deadwood Creek. Tin and tungsten minerals which are common in the placers of Deadwood Creek appear to be mostly derived from the tributaries of Discovery Gulch, and Switch Creek, which nearly parallel the south contact of the granite near which this prospect is located. A sample of siliceous granite in this area showed 30 ppm tin by semiquantitative emission spectrographic analysis. Claims active 1970	Barker, 1979, p. 12; ADGS
54	Table Mountain	T7N,R9E	P		Felsic dikes cut country rock of mostly quartzite and quartzitic schist. Local skarn and breccia. Claims active 1981	ADGS
55	Table Mountain	T8N,R9E	P		Claims active 1981	ADGS
56	Twenty Two Pup	T8N,R14E	P		Claims active 1957	ADGS
57	UR1-28	T7N,R5E	P		Claims active 1978, 1980-1981	ADGS
58	Williams Creek	T3N,R18E	P		Claims active 1976	ADGS