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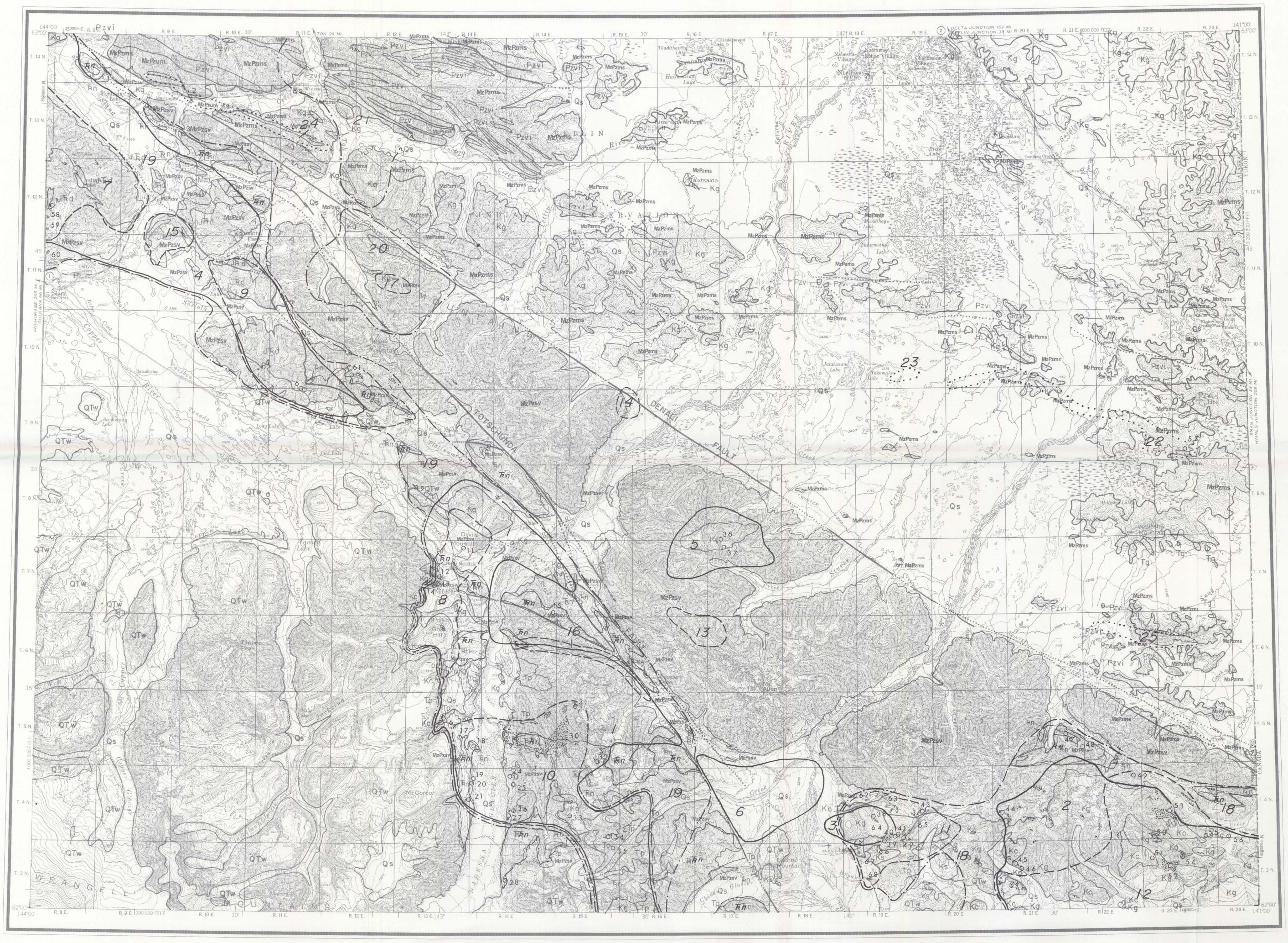
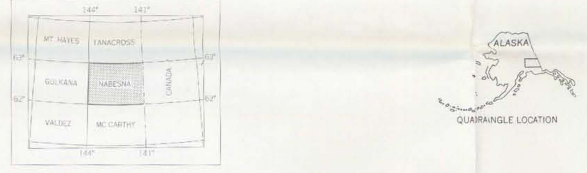
MISCELLANEOUS FIELD STUDIES MAP MF-655K
FOLIO OF THE NABESNA QUADRANGLE, ALASKA




BASE BY U. S. GEOLOGICAL SURVEY, 1965

TRUE NORTH
MAGNETIC NORTH
29°
APPROXIMATE MEAN DECLINATION, 1963

SCALE 1:250 000
5 0 5 10 15 20 25 MILES
5 0 5 10 15 20 25 KILOMETERS
CONTOUR INTERVAL 200 FEET
DATUM IS MEAN SEA LEVEL




## EXPLANATION FOR MINERAL RESOURCES MAP

°17 Lode mineral deposit. Includes mines, prospects, and mineral occurrences; number corresponds to number in accompanying table describing the mineral deposits of the Nabesna quadrangle.

63 Placer deposits. Principally old and largely depleted gold placers; number corresponds to number in accompanying table describing the mineral deposits of the Nabesna quadrangle.

Altered area. Principally areas containing conspicuous secondary hydrous iron oxide and sulfate minerals resulting from the weathering and oxidation of iron-bearing sulfide minerals. Only larger areas shown.

### POTENTIALLY FAVORABLE MINERAL RESOURCE AREAS

(2) Porphyry copper and/or porphyry molybdenum deposits

(areas listed in order of decreasing potential)

Areas — [1]Criteria used to define areas

1, 2
a. Known porphyry deposits (16, 22, 30, 31, 44, 45-46, 50, 52, 53, 54)
b. Known mineralization associated with porphyry deposits (17, 23, 26, 33, 35, 51)
c. Favorable rock types
d. Observed surface alteration
e. Interpreted alteration from aeromagnetics
f. High copper, gold, lead, and cobalt values in stream sediments[2]
g. ERTS simulated true and false color anomalies and area of abundant Tertiary intrusives in southern part of area 1

3, 4, 5
a. Favorable rock types
b. Known vein copper occurrences in areas 3 and 5 (36, 38)
c. Observed surface alteration in areas 3 and 4
d. Interpreted alteration from aeromagnetics in area 3
e. High copper, gold, and cobalt values in stream sediments in area 4, and high copper and cobalt values in stream sediments in area 5

6
a. Inferred fault offset of favorable rock type
b. Aeromagnetic anomalies

(12) Disseminated, contact-metamorphic, and vein gold and silver deposits

(areas listed in apparent order of decreasing potential)

Areas — Criteria used to define areas

7, 8
a. Known disseminated gold occurrences (1, 14)
b. Known contact metamorphic gold deposits in area 8 (12, 13)
c. Placer gold deposits in area 7 (58, 59)
d. High gold, copper, and silver values in stream sediments in area 7; high copper values in stream sediments in area 8
e. Observed surface alteration
f. ERTS simulated true and false color anomalies
g. Limestone-plutonic rock contact in area 8

9, 10, 11, 12
a. Known gold and silver occurrences (5, 26, 33, 35, 39, 40, 41, 42, 43, 55, 56)
b. Known contact metamorphic deposits in area 10 (17, 19, 21, 23)
c. Observed surface alteration
d. High gold, silver, and copper values in stream sediments in areas 9, 10, and 12; high lead values in stream sediments in area 11
e. ERTS simulated true and false color anomalies

13, 14, 15, 16, 17
a. Observed surface alteration in area 15
b. High gold, copper, lead, and silver values in stream sediments in areas 13 and 15; high gold values in stream sediments in areas 14 and 17
c. Limestone-plutonic rock contact in area 16

(20) Vein, stockwork, contact-metamorphic, and breccia-pipe copper, lead, zinc, and silver deposits

(areas listed in order of decreasing potential)

Areas — Criteria used to define areas

18, 19
a. Known mineral occurrences (5, 8, 9, 18, 24, 25, 27, 29, 32, 33, 34, 35, 43, 49, 51, 55, 56)
b. Observed surface alteration
c. High copper, lead, zinc, and silver values in stream sediments
d. ERTS simulated true and false color anomalies

20, 21
a. Observed surface alteration
b. High copper and lead values in stream sediments

(23) Podiform chromite deposits

Areas — Criteria used to define areas

22, 23, 24, 25
a. Float of massive chromite near eastern end of area 22 (57)
b. Favorable rock type in areas 22, 24 and 25
c. Aeromagnetic anomalies
d. High chromium and nickel values in stream sediments in areas 22, 24, and 25

(Ꝍn) Copper in Nikolai Greenstone

Includes all outcrop areas of the Nikolai Greenstone. The Nikolai is characterized by high copper, chromium, nickel, and cobalt values in the stream sediments, local concentrations of copper minerals, and ERTS simulated true and false color anomalies.

[1]Sources of the various criteria are: Richter (1975), geology; Griscom (1975), aeromagnetics; Marsh (1975a-e), geochemistry; and Albert (1975), ERTS imagery.

[2]High geochemical stream sediment values used in this report are: gold, any detectable; copper, 150 ppm or greater; lead, 30 ppm or greater; cobalt, 50 ppm or greater; chromium, 300 ppm or greater. With the exception of gold, which has a lower limit of detection of 0.02 ppm, these values are approximately 2 times the mode for the Nabesna quadrangle and are somewhat lower than the anomalous values shown on the geochemical maps of this folio (Marsh, 1975 a-e).

## EXPLANATION FOR GENERALIZED GEOLOGIC MAP

[Geology generalized from Richter (1975)]

### CORRELATION OF MAP UNITS

SURFICIAL DEPOSITS

Qs } QUATERNARY

SEDIMENTARY AND VOLCANIC ROCKS

QTw } QUATERNARY AND TERTIARY
Ks } Upper(?) Cretaceous } CRETACEOUS
Kc } Lower Cretaceous
Ꝍn } Upper and(or) Middle Triassic } TRIASSIC
MzPzsv } MESOZOIC AND PALEOZOIC

INTRUSIVE, METAMORPHIC, AND ULTRAMAFIC ROCKS

Tp, Tg } TERTIARY
Kg } CRETACEOUS
JꝌd } JURASSIC AND TRIASSIC
Mza } MESOZOIC
MzPzms, MzPzum } MESOZOIC AND PALEOZOIC
Pzvi } PALEOZOIC

### DESCRIPTION OF MAP UNITS

SURFICIAL DEPOSITS

Qs UNCONSOLIDATED SEDIMENTARY DEPOSITS (Quaternary)

SEDIMENTARY AND VOLCANIC ROCKS

QTw WRANGELL LAVA (Quaternary and Tertiary)
Ks CONTINENTAL SEDIMENTARY ROCKS (Upper? Cretaceous)
Kc CHISANA FORMATION (Lower Cretaceous) Marine and subaerial volcanic rocks
Ꝍn NIKOLAI GREENSTONE (Upper and(or) Middle Triassic)
MzPzsv UNDIVIDED SEDIMENTARY AND VOLCANIC ROCKS (Mesozoic and Paleozoic)

INTRUSIVE, METAMORPHIC, AND ULTRAMAFIC ROCKS

Tp PORPHYRY (Tertiary) Porphyritic andesite to rhyodacite
Tg UNDIVIDED GRANITIC ROCKS (Tertiary) Chiefly quartz monzonite
Kg UNDIVIDED GRANITIC ROCKS (Cretaceous) Chiefly granodiorite and quartz monzonite
JꝌd DIORITE COMPLEX (Jurassic and Triassic)
Mza ANORTHOSITE (Mesozoic)
MzPzms UNDIVIDED METAMORPHOSED SEDIMENTARY ROCKS (Mesozoic and Paleozoic)
MzPzum UNDIVIDED ULTRAMAFIC ROCKS (Mesozoic and Paleozoic)
Pzvi UNDIVIDED METAMORPHOSED MAFIC VOLCANIC AND INTRUSIVE ROCKS (Paleozoic)

Contact. Dotted where concealed
Fault. Dotted where concealed

## MINERAL RESOURCE POTENTIAL

### OIL AND GAS

The oil and gas potential of the Nabesna quadrangle is apparently nil. The upper Tanana basin, which extends into the northeastern part of the quadrangle, had at one time been considered a possible petroleum basin (Miller and others, 1959, p. 86-87), but more recent resource summaries of the State (Resource Planning Team, 1974, p. 351) do not recognize the basin as a potential petroleum source. The basin is small, shallow, and filled with unconsolidated sediments of Quaternary age; gas, probably methane, has been found in a few shallow (less than 100 m) wells.

### COAL

No coal deposits are known within the Nabesna quadrangle. Carbonaceous debris and fragments of lignitized wood are scattered throughout the Upper Cretaceous(?) continental sedimentary rock unit in the Chisana area, and locally clasts of lignitized wood are found in some of the older glacial deposits.

### GEOTHERMAL ENERGY

Most of the southwest quarter of the Nabesna quadrangle, which is underlain by the Wrangell Lava of Tertiary and Quaternary age, has been classified as potentially valuable for geothermal steam (Godwin and others, 1971). The name Wrangell Lava refers to an extensive calc-alkaline volcanic province in southcentral Alaska and includes flows, tuffs, and breccias that are products of a number of composite stratovolcanoes, shield volcanoes, and smaller eruptive centers and domes and shallow intrusive rocks (Richter, 1975). Recent studies have shown that most of the volcanic activity in the Nabesna quadrangle is older than 1.5 m.y. indicating that the heat potential in this part of the volcanic pile is probably low. Mt. Wrangell, a presently active large shield volcano whose summit caldera lies just beyond the southwest corner of the quadrangle, shows more promise as a geothermal resource.

### RADIOACTIVE MINERALS

No deposits of radioactive minerals have been found in the Nabesna quadrangle nor have any strong radioactivity anomalies been reported. Strata rich in organic material in the Upper Cretaceous(?) continental sedimentary rocks that fill small intermontane basins could provide a suitable environment for the deposition of uranium minerals, but samples of these rocks have failed to show any anomalous radioactivity.

### METALS

Copper

Copper is the principal mineral resource of the Nabesna quadrangle. It occurs in a variety of deposit types - porphyry, vein, stockwork, breccia pipe, contact metamorphic, and volcanogenic - but only the porphyry copper deposits appear to be economically significant at the present time.

Eight porphyry copper deposits (22, 30, 44, 45-46, 50, 52, 53, and 54) have been identified in the quadrangle. These deposits occur within a variety of middle Cretaceous granitic plutons or their contact zones, and all appear to be genetically related to the granitic rocks. The deposits have a low copper and molybdenum content by comparison with deposits in the conterminous United States, but they are similar in grade, tonnage, and some geologic features to many deposits in British Columbia and the Yukon Territory, some of which are presently being exploited. Only the Orange Hill deposit (22) has been rather extensively explored; the Bond Creek (30), Horsfeld (52), and Baultoff (53) deposits have been drilled to a limited extent, and the remainder have been subject only to surface exploration.

Two approaches have been taken to estimate the resource potential of the porphyry copper deposits. The first, concerned with the known deposits, is based largely on field investigations, especially a 19-day study in August 1974 when five of the larger deposits (22, 30, 45-46, 52, 53) were examined and sampled. Data from these investigations, including an estimate of the copper resource, are given in the table below. Both the tonnages and grades were estimated chiefly from surface data; no drill core has been examined, nor has subsurface information from the mineral industry, other than what has been reported for Orange Hill (Van Alstine and Black, 1946), been available to us. On the basis of these limited data, the indicated[1] and inferred copper resource in the porphyry copper deposits is estimated at 3.1 million tonnes (metric tons) of copper.

The second approach involves a statistical estimate of the resources of the Nabesna quadrangle on the basis of an extrapolation from a population of porphyry copper deposits in a similar area. Since available data are insufficient on the grades and tonnages of porphyry copper deposits in Alaska, information from frequency distributions of grades and tonnages in 21 porphyries in western Canada provides a means for estimating the total (indicated, inferred, and hypothetical) porphyry copper resource in the Nabesna quadrangle (Singer and others, 1975). The deposit geology and tectonic environment are sufficiently similar in these two regions to make this extrapolation of grades and tonnages valid.

Using a median tonnage of 180 million tonnes that is based on the Canadian deposits and an estimated median average grade of 0.30 percent copper that is based on the best available data from the Nabesna quadrangle, median estimates and confidence limits for tonnage and grade of the porphyry deposits are:

| Tonnage | Grade |
|---|---|
| 90 percent > 60 million tonnes | 90 percent > 0.1 percent Cu |
| 50 percent (median) = 180 million tonnes | 50 percent (median) = 0.30 percent Cu |
| 10 percent > 500 million tonnes | 10 percent > 0.55 percent Cu |

The median estimate and confidence limits on the number of deposits are:

90 percent > 8 deposits
50 percent (median) = 10 deposits
10 percent > 12 deposits

The above values are subjective and are based upon the known mineralized areas that may be porphyry deposits and upon numerous areas favorable for porphyries, such as near deposit 1 and the altered areas indicated by aeromagnetics (Griscom, 1975), many of which have not been adequately explored. Using the median values for tonnage, grade, and number of deposits, the potential total copper resource in the porphyry deposits is: 180 million tonnes x 0.30 percent copper x 10 deposits = 5.4 million tonnes.

Copper in the vein stockwork deposits may be economically significant, but there are virtually no data available to assess its potential. The four known deposits are limited to a few acres in areal extent, and surface sampling indicates average grades of less than 0.1 percent copper. Three of the vein stockworks (24, 25, and 27) occur in altered quartz porphyries that are believed to be shallow silicic intrusions, tuffs, or domes in the Tetelna Volcanics of Pennsylvanian and Permian age. The other stockwork deposit (18) occurs in an altered Tertiary porphyry dike (or dikes) cutting the Nikolai Greenstone. Some drilling in this deposit indicate grades as high as 0.3 percent copper, with minor silver and zinc values.

Some of the contact metamorphic deposits contain small amounts of copper that could prove significant if they also contain sufficient quantities of other metals, such as gold, to warrant mining. At the presently inactive Nabesna gold mine (13), chalcopyrite occurs sparsely in some of the lodes, and some copper was reportedly produced (Wayland, 1943). Small outcrops of chalcopyrite-bearing tactite along the west side of the Nabesna Glacier (19 and 21) are apparently related to the Nabesna pluton, and float of massive garnet-actinolite rock with segregations of chalcopyrite and pyrrhotite (11) suggests the possibility of other contact metamorphic deposits associated with the Devils Mountain pluton.

The copper-bearing veins and breccia pipe deposits in the quadrangle are considered more as mineralogical anomalies than as potential resources. The veins are generally narrow and discontinuous and the breccia pipes small. Small amounts of other base metal sulfides are locally abundant in these deposits, but gold and silver values are low.

The Nikolai Greenstone, which crops out over large areas south of the Denali fault, may constitute a future copper resource. The formation, consisting of a series of predominantly subaerial amygdaloidal basalt flows about 2000 m thick, contains an average of 150 ppm (0.015%) copper. In addition to their intrinsically high copper content, the flows contain local concentrations of native copper, bornite, chalcocite, and rarely chalcopyrite in amygdules, flow tops and bottoms, fractures, and veins. Although the known grades are low, even in the locally enriched zones, technological advances in the recovery of low-grade ores and an accelerating demand for copper may increase the significance of this resource.

The possibility of other types of copper deposits in the Nabesna quadrangle, such as the Kennicott-type lodes of the southern Wrangell Mountains and the massive copper-nickel sulfide deposits in nearby Yukon Territory, should not be overlooked. Both types of deposits occur in geologic settings similar to that found in many parts of the Nabesna quadrangle. The Kennicott lodes, consisting chiefly of massive chalcocite, occur in the Upper Triassic Chitistone Limestone just above the contact with the underlying Nikolai Greenstone (Miller, 1946). In the Nabesna quadrangle, thin-bedded and massive Triassic limestone, which is probably correlative in part with the Chitistone Limestone, and the underlying Nikolai Greenstone crop out throughout the eastern Alaska Range and the northern Wrangell Mountains (Richter, 1975). The massive copper-nickel sulfide deposits in the White River-Kluane Lake area of Yukon Territory are associated with ultramafic rocks emplaced in volcanic and volcaniclastic strata of Permian or younger age south of the Shakwak segment of the Denali fault (Muller, 1967). These volcanic rocks are correlative with the Tetelna Volcanics exposed throughout the Nabesna quadrangle south of the Denali fault in a similar structural setting but without known ultramafic rocks.

Molybdenum

Molybdenum is a significant resource in at least two of the porphyry copper deposits (Orange Hill, 22 and Bond Creek, 30). On the basis of the limited data available, as discussed in the section on copper, the indicated and inferred molybdenum resource of these copper porphyries is estimated at 820 million tonnes containing 0.02 percent Mo, or about 164,000 tonnes of molybdenum. Two porphyry molybdenum deposits (East Fork, 31 and Monte Cristo Creek, 16) known in the quadrangle are also associated with altered rocks of the middle Cretaceous Nabesna pluton. These deposits are considerably smaller than the porphyry copper deposits, and their grades, again deduced from surface sampling, are apparently lower. Each deposit is estimated to contain about 50 million tonnes averaging 0.01 percent Mo, or an additional indicated and inferred molybdenum resource of 10,000 tonnes. Because of the small sample size, no attempt is made at estimating the hypothetical molybdenum resource.

The molybdenum resource of the pegmatite molybdenum prospect on Rock Creek (6) is minor. The pegmatite, which occurs in gneissic rocks of the diorite complex, was explored by an adit in the late 1930's. No exploitable volume of ore was discovered, and the prospect has been inactive since then; no other molybdenum-bearing pegmatites have been found in the area.

Gold

Gold has been the principal metallic mineral commodity mined in the Nabesna quadrangle. Major deposits were the contact metamorphic lodes at the Nabesna mine that produced about $1,870,000 between 1931 and 1940 (Wayland, 1943), and the Bonanza placers near Chisana that have yielded about $1 million (Moffit, 1943) since their discovery in 1913. Today, however, the principal gold resource is byproduct gold in the porphyry copper deposits. Other potentially significant resources are the disseminated gold deposits and to a lesser degree vein, contact metamorphic, and placer deposits.

Although gold is present in all the porphyry copper deposits, the only significant data on the grade, available for this assessment, are from the Orange Hill deposit (22). There, gold values range from not detectable to 0.04 ounces per ton (Van Alstine and Black, 1946) with an average of probably 0.005 ounces per ton. Using this average grade and the tonnages given in the section on copper, the indicated and inferred gold resource in the known porphyry copper deposits is on the order of 5.4 million ounces. On the basis of these statistics, the total (indicated, inferred, and hypothetical) gold resource in the porphyry copper deposits is 9 million ounces.

The disseminated gold deposits in the quadrangle may be economically significant. Two such deposits (1 and 14), consisting of disseminated pyrite with quartz-pyrite veinlets in small diorite stocks, are known, and others are possible, especially in rocks of the diorite complex and the more mafic phases of the Cretaceous plutons. Very meager data are available concerning the grade and tonnages of these deposits, and no attempt is made to estimate the gold resource. At deposit no. 1, near Indian Pass, grades may run as high as 0.01 ounces per ton (Richter and Matson, 1968), and at the old Royal Development Company deposit (14), near Nabesna, some ore containing 1½ ounces of gold per ton was mined (Wayland, 1943). These latter high values were probably restricted to selected small quartz-pyrite veins in the diorite and are not representative of the deposit as a whole.

Exploration at the Nabesna mine during its last two years of operation failed to locate additional gold-bearing lodes, but the extensive development of tactite in the mine area suggests that more ore could be present. Just north of the Nabesna mine at the Rambler mine (12), a mass of pyrrhotite in recrystallized limestone has been delineated that contains 4000 tonnes of ore averaging 1 ounce of gold per ton (Wayland, 1943). Favorable areas for other gold-bearing contact-metamorphic deposits are in the contact zone of the Nabesna pluton, especially where the pluton intrudes limestone.

[1] The terms, "indicated," "inferred," and "hypothetical" defining specific resource categories, are used in the sense adopted jointly by the U.S. Geological Survey and U.S. Bureau of Mines:

Indicated - material for which estimates of the quality and quantity have been computed partly from sample analyses and measurements and partly from reasonable geologic projections.

Inferred - material in unexplored but identified deposits for which estimates of the quality and size are based largely on geologic evidence and projection.

Hypothetical - undiscovered materials that may reasonably be expected to exist in a known mining district under known geologic conditions.

Gold-bearing veins are scattered through the quadrangle south of the Denali fault, but other than as indicators of mineralization the veins do not appear economically significant. An exception is a unique gold-bearing cobaltite-calcite vein deposit (20) along the west side of the Nabesna Glacier. This vein, which is 10 to 20 cm wide and of unknown length, contains as much as 10 ounces of gold per ton.

Small, undiscovered placer deposits probably still exist in the Bonanaza placers district (62-67) and in the Porcupine Creek area (58, 59, and 60) but their contribution to the total gold resource is probably small. However, the Tertiary gravels capping Gold Hill, near Chisana, which are considered an intermediate source of the Bonanza gold, may have future significance. These gravels contain minor amounts of gold and have an estimated volume of 40 million $m^3$.

Silver

Like gold, the principal silver resource in the quadrangle is byproduct silver in the porphyry copper deposits. On the basis of the assay data from the Orange Hill deposit, where silver averages 0.01 ounces per ton (Van Alstine and Black, 1946), and the estimated tonnages of the porphyry deposits, the indicated and inferred silver resource is 10.8 million ounces. The total (indicated, inferred, and hypothetical) resource is 18 million ounces. Byproduct silver may also be economically important in some of the contact metamorphic and stockwork deposits.

Lead and zinc

Galena and sphalerite, the common ore minerals of lead and zinc, occur in many of the vein, contact metamorphic, and breccia-pipe deposits in the quadrangle south of the Denali fault. None of these known deposits, however, approach exploitable quality exclusively for lead and zinc. Possibly byproduct lead and zinc could be recovered if gold-bearing contact-metamorphic deposits, especially those associated with the Nabesna pluton, were mined.

Platinum-group metals

No platinum-group minerals have been observed in the heavy mineral concentrates from the Bonanza or Porcupine Creek gold placers (Moffit, 1954), and with the exception of an undocumented story concerning Platinum Creek, there are no known reports of platinum minerals occurring in the Nabesna quadrangle. Platinum Creek, as a local story relates, owes its name to a thumbnail size nugget of platinum that was found there in the early 1900's. The absence of ultramafic or other favorable host rocks in the drainage basin of Platinum Creek, however, suggests that bedrock source of the nugget, if the story is true, was elsewhere.

Trace amounts of the platinum-group elements, on the other hand, have been detected spectroscopically in the ultramafic bodies north of the Denali fault, suggesting that these rocks may be potential resources. Serpentinized dunite in the ultramafic body near Mentasta Pass in the northwestern part of the quadrangle has been found to contain as much as 0.3 ppm palladium and 0.1 ppm platinum (W. N. Sharp and D. H. Richter, unpub. data).

Chromite

Massive chromite float (57) from an alpine ultramafic body near Mirror Creek suggests that this and other ultramafic bodies north of the Denali fault may contain significant podiform-type chromite deposits. Although the ultramafic bodies are largely covered by surficial deposits, especially in the eastern part of the quadrangle, their size and extent are indicated by aeromagnetics (Griscom, 1975).

### SUMMARY OF COPPER, MOLYBDENUM, GOLD, AND SILVER RESOURCES

| | Measured | Indicated | Inferred | Hypothetical[1] |
|---|---|---|---|---|
| Copper (tonnes) | | 2,620,000 | 520,000 | 2,300,000 |
| [deposits] | | [22,30] | [44,45-46,50,52,53,54] | |
| Molybdenum (tonnes) | | 164,000 | 10,000 | |
| [deposits] | | [22,30] | [16,31] | |
| Gold (ounces) | 4,000 | 4,100,000 | 1,300,000 | 4,500,000 |
| [deposits] | [12] | [22,30] | [44,45-46,50,52,53,54] | |
| Silver (ounces) | | 8,200,000 | 2,600,000 | 7,200,000 |
| [deposits] | | [22,30] | [44,45-46,50,52,53,54] | |

[1] Difference between the total (indicated, inferred and hypothetical) resource by statistical approach and indicated and inferred resources of identified deposits.

### NON-METALS

Sand, gravel, rock, and limestone

The Nabesna quadrangle contains large quantities of (1) sand and gravel in alluvial and eolian surficial deposits, (2) rock material suitable for crushed stone and ballast, and (3) limestone for lime and possibly cement. The economic significance of these nonmetallic commodities, however, depends largely on their proximity to urban population centers where they are principally utilized. Hence, in the Nabesna quadrangle, which is far removed from any urban center, the economic potential of these commodities is low, and even in the foreseeable future their exploitation will probably be limited to local highway construction needs and other local demands.

Corundum

Corundum crystals, some of gem quality, are found in a few alkali pegmatite dikes (7) that cut syenite and monzonite gneiss in the diorite complex. A number of attempts have been made to exploit the deposit, but the generally poor quality and scarcity of the crystals preclude an economic gem industry (Richter, 1970).

Jade

A deposit (2) of jade (variety nephrite) in the alpine ultramafic body near Mentasta Pass, has yielded a number of pounds of semiprecious stone over the past 10 years. Other deposits of jade in the ultramafic rocks of the quadrangle appear likely.

Magnetite

Small high-grade magnetite bodies in the Nabesna mine and possibly elsewhere in the contact metamorphic tactites around the Nabesna pluton may have limited potential for industrial use. One such use of importance in Alaska would be for high-density ballast to weight oil and gas pipelines.

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______ 1975d, Geochemical and generalized geologic map showing distribution and abundance of chromium in the Nabesna quadrangle, Alaska: U.S. Geol. Survey Misc. Field Studies Map MF-655E, 1 sheet, scale 1:250,000.

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### MINERAL DEPOSITS OF THE NABESNA QUADRANGLE

| MAP NO. | NAME(S) | LOCATION | RESOURCE(S) | TYPE OF DEPOSIT | DEVELOPMENT CATEGORY[1] | BRIEF DESCRIPTION | REFERENCES[2] |
|---|---|---|---|---|---|---|---|
| 1 | | T.12N.,R.8E. | Au | Disseminated gold | 0 | Small hornblende diorite stock with disseminated pyrite and small quartz-pyrite veins and veinlets | Richter and Matson, 1968, p. 3-4 |
| 2 | | T.13N.,R.9E. | Nephrite | Metamorphic | P/A | Nephrite associated with rodingite inclusions in serpentinized alpine-type ultramafic rocks. | Richter, 1967, p. 18-19 |
| 3 | | T.13N.,R.9E. | Cu | Volcanogenic | 0 | Bornite in vesicles and as irregular segregations in epidotized basalt flows. | Richter, 1967, p. 18 |
| 4 | | T.13N.,R.10E. | Cu | Volcanogenic | 0 | Zone of strong malachite and azurite stain in amygdaloidal basalt flows. | |
| 5 | | T.10N.,R.10E. | Au, Ag | Vein | P/I | Stringers of quartz containing pyrite, galena, sphalerite, and gold in altered volcanic rocks. | Moffit, 1941, p. 155; 1954, p. 203 |
| 6 | Rock Creek | T.10N.,R.11E. | Mo | Pegmatite | P/I | Coarse molybdenite in small alkali pegmatite dike. | Moffit, 1941, p. 150-153; 1954, p. 209-210 |
| 7 | | T.9N.,R.11E. | Corundum | Pegmatite | P/A | Gray, blue-gray corundum crystals as long as 8 cm, in small alkali pegmatite dikes. | Richter, 1970 |
| 8 | | T.10N.,R.12E. | Pb,Zn,Ag | Vein | 0 | Small quartz-carbonate veins with galena, sphalerite, and tetrahedrite in border zone of small stock. | |
| 9 | | T.8N.,R.13E. | Cu | Vein | 0 | Quartz vein with pyrite and chalcopyrite in fault-shear zone in volcaniclastic rocks. | |
| 10 | | T.9N.,R.13E. | Cu | Volcanogenic | 0 | Native copper in fractures in amygdaloidal basalt flows | |
| 11 | | T.7N.,R.13E. | Cu | Contact metamorphic | 0 | Large boulders (1 x 1 x 2 m) of massive pyrrhotite, chalcopyrite, actinolite, and garnet. Source unknown | |
| 12 | Golden Eagle group; Rambler Mine | T.7N.,R.13E. | Au | Contact metamorphic | P/A | Massive gold-bearing pyrrhotite and pyrite in recrystallized limestone. | Wayland, 1943 |
| 13 | Nabesna Mine | T.7N.,R.13E. | Au,Cu,Ag, magnetite | Contact metamorphic | M/I/1940 P/A | Massive magnetite with pyrite, veins and masses of pyrrhotite, and veins of gold-bearing pyrite at contact of quartz diorite and limestone. Production when mine closed (1940) was $1,870,000. | Wayland, 1943 |
| 14 | Royal Development Co. | T.7N.,R.13E | Au | Disseminated gold | M/I/1907 | Quartz diorite stock with disseminated pyrite and small quartz-pyrite veins. Sixty tons of ore milled in 1907. | Wayland, 1943 |
| 15 | Camp Creek | T.7N.,R.14E | Cu | Volcanogenic | 0 | Chalcocite vein in amygdaloidal basalt flows. | Mendenhall and Schrader, 1903, p. 39 |
| 16 | Monte Cristo Creek; Marie Nabesna | T.5N.,R.13E. | Mo | Porphyry molybdenum | P/A | Disseminated molybdenite and quartz-pyrite-molybdenite veins in strongly altered zone at contact of granodiorite pluton and volcanic breccia. | |
| 17 | | T.5N.,R.13E. | Au,Pb,Zn,Ag | Contact metamorphic | P/I | Quartz veins with sphalerite, galena, and minor chalcopyrite in recrystallized limestone. | |
| 18 | Nabesna River | T5N.,R.13E. | Cu,Ag,Zn | Stockworks in hypabyssal rocks | P/A | Quartz-pyrite veins and veinlets with minor chalcopyrite in hornblende dacite dike and volcanic country rock. | |
| 19 | | T.4N.,R.14E. | Cu | Contact metamorphic | 0 | Massive magnetite with pyrite and minor chalcopyrite in amphibolitized volcanic rock. | |
| 20 | | T.4N.,R.14E. | Au,Co | Vein | 0 | Thin (10-20 cm) calcite vein that contains gold and cobaltite. | |
| 21 | | T.4N.,R.13E. | Cu | Contact metamorphic | 0 | Small irregular masses of pyrite and minor chalcopyrite in contact zone of diorite stock. | |
| 22 | Orange Hill | T.5N.,R.14E. | Cu,Mo,Au,Ag | Porphyry copper | P/A | Pyrite, chalcopyrite, and minor molybdenite in quartz veinlets and as disseminations in quartz diorite. Additional data given in "Description of porphyry copper deposits." | Van Alstine and Black, 1946 |
| 23 | Lemon Claims | T.5N.,R.14E. | Cu,Zn,Ag,Au | Contact metamorphic | P/A | Disseminated pyrrhotite, pyrite, and chalcopyrite in magnetite; and veins of pyrite, chalcopyrite, and sphalerite in magnetite and calc-silicate rock. | Van Alstine and Black, 1946 |
| 24 | | T.4N.,R.14E. | Cu | Stockworks in volcanic rocks | P/A | Quartz-pyrite veins and veinlets with minor chalcopyrite in volcanic flows. | |
| 25 | | T.4N.,R.14E. | Cu | Stockworks in volcanic rocks | P/A | Quartz-pyrite veins and veinlets with minor chalcopyrite in quartz-eye volcanic flows or shallow intrusive. | |
| 26 | | T.4N.,R.14E. | Cu,Zn | Vein | 0 | Quartz-pyrite vein with minor chalcopyrite and sphalerite in quartz-eye volcanic flow or shallow intrusive. | |
| 27 | Nabesna Glacier | T.4N.,R.14E. | Cu,Zn,Au | Stockworks in volcanic rocks | P/A | Quartz-pyrite veins and veinlets, with minor sphalerite, in altered quartz-eye volcanic flow or shallow intrusive. Locally gold bearing. | |
| 28 | | T.3N.,R.14E. | Cu | Volcanogenic | 0 | Zone of malachite and azurite stain in amygdaloidal basalt flows. | |
| 29 | | T.5N.,R.14E | Pb,Cu,Ag | Breccia pipe? | 0 | Zone of intense hydrothermal alteration in volcanic flows containing brecciated rock cemented by quartz that contains minor pyrite, chalcopyrite, and galena. | |
| 30 | Bond Creek | T.5N.,R.15E. | Cu,Mo,Au,Ag | Porphyry copper | P/A | Pyrite, chalcopyrite, and minor molybdenite in quartz veinlets and as disseminations in granodiorite and quartz monzonite porphyry. Additional data given in "Description of porphyry copper deposits." | |
| 31 | East Fork | T.5N.,R.15E. | Mo | Porphyry molybdenum | P/A | Quartz-pyrite-molybdenite veins and veinlets in strongly altered and brecciated trondhjemite. | |
| 32 | | T.5N.,R.15E. | Cu | Breccia pipe? | 0 | Fragments of volcanic rock cemented with quartz and minor pyrite and chalcopyrite in area of intense hydrothermal alteration. | |
| 33 | | T.4N.,R.15E. | Cu,Pb,Zn,Ag | Vein | 0 | Quartz vein with minor chalcopyrite, galena and sphalerite. | |
| 34 | Cross Creek | T.4N.,R.15E. | Cu,Pb,Zn,Ag | Breccia pipe | P/I | Zone of strong hydrothermal alteration containing fragments of volcanic rock cemented by quartz containing minor pyrite, sphalerite, galena, and chalcopyrite. | Moffit, 1943, p. 143-145 |
| 35 | | T.3N.,R.15E. | Cu,Pb,Zn | Vein | 0 | Quartz vein with minor pyrite, chalcopyrite, galena, and sphalerite in volcanic and volcaniclastic rocks. | |
| 36 | | T.8N.,R.17E. | Cu | Vein | 0 | Quartz veinlets with minor chalcopyrite, pyrite, and bornite in syenodiorite. | |
| 37 | | T.7N.,R.17E. | Cu | Vein? | 0 | Segregations of pyrite and chalcopyrite in hornblendite. | |
| 38 | Big Eldorado | T.4N.,R.19E. | Cu,Au | Vein | P/A | Quartz vein with pyrite, chalcopyrite and gold in syenodiorite. | |
| 39 | | T.4N.,R.19E. | Au | Vein | P/I | Quartz vein with pyrite in volcanic breccias. | |
| 40, 41, 42 | | T.4N.,R.19E. | Au | Vein | P/I | Locally gold bearing quartz-pyrite veins in small altered zones in volcanic breccias. | Capps, 1916, p. 118 |
| 43 | | T.4N.,R.20E. | Zn,Pb,Cu,Ag | Vein | P/I | Quartz-carbonate veins with sphalerite, galena, and minor chalcopyrite in argillite. | |
| 44 | Johnson Creek | T.4N.,R.21E. | Cu | Porphyry copper | P/A | Disseminated pyrite and chalcopyrite in small diorite stock and surrounding hornfelsed argillite. | |
| 45, 46 | Carl Creek | T.3N.,R.21E. | Cu,Mo,Au,Ag | Porphyry copper | P/A | Pyrite and chalcopyrite in quartz veinlets and as disseminations in granodiorite and quartz monzonite. Additional data given in "Description of porphyry copper deposits." | |
| 47 | O'Hara; Sulzer; Cosmopoliton Copper group | T.5N.,R.21E. | Cu | Volcanogenic | P/I | Malachite in fractures, amygdules and breccias in amygdaloidal basalt flows. | Moffit, 1943 |
| 48 | Reynolds; Butte Creek Copper group | T.5N.,R.21E. | Cu | Volcanogenic | P/I | Small veins of bornite, chalcocite, and calcite in amygdaloidal basalt flows. | Moffit, 1943 |
| 49 | | T.4N.,R.22E. | Cu | Vein | 0 | Massive quartz vein with minor pyrite and chalcopyrite in marine volcaniclastic rocks. | |
| 50 | | T.4N.,R.23E. | Cu | Porphyry copper | P/A | Disseminated pyrite and minor chalcopyrite in small diorite stock. | |
| 51 | | T.3N.,R.23E. | Cu | Vein | P/I | Quartz vein with chalcopyrite in volcanic breccias. | |
| 52 | Horsfeld | T.3N.,R.23E. | Cu,Au,Ag | Porphyry copper | P/A | Pyrite and chalcopyrite in quartz veinlets and as disseminations in monzonite and monzonite porphyry. Additional data given in "Description of porphyry copper deposits." | |
| 53 | Baultoff | T.4N.,R.23E. | Cu,Au,Ag | Porphyry copper | P/A | Disseminated pyrite and chalcopyrite in diorite and quartz porphyry. Additional data given in "Description of porphyry copper deposits." | |
| 54 | | T.3N.,R.23E. | Cu | Porphyry copper | 0 | Disseminated pyrite and chalcopyrite in porphyritic mafic diorite. | |
| 55 | | T.4N.,R.23E. | Pb,Ag,Au | Vein | 0 | Quartz-barite vein with minor galena in marine sedimentary rocks. | |
| 56 | | T.4N.,R.24E. | Cu,Ag | Vein | 0 | Quartz veins with minor chalcopyrite in small quartz monzonite stock and volcanic country rock. | |
| 57 | | T.9N.,R.23E. | Chromite | Magmatic segregation | 0 | Cobble-size float of massive chromite derived from alpine-type ultramafic rocks. | |
| 58 | Slope Creek | T.12N.,R.8E. | Au,Ag | Placer | M/I/1958 | Fine-grained rough gold and minor wire silver. Production probably less than $10,000. | Moffit, 1938, p. 50-51; Richter, 1966, p. 34 |
| 59 | Boulder Creek | T.12N.,R.8E. | Au | Placer | P/A | Coarse-grained smooth gold; minor production. | Richter, 1966, p. 54 |
| 60 | Willow Creek | T.11N.,R.8E. | Au | Placer | P/I | Evidence of placer operation or exploration, but no data available. | Richter, 1966, p. 34 |
| 61 | Trail Creek | T.10N.,R.12E. | Au | Placer | P/I | Evidence of placer operation or exploration, but no data available. | Moffit, 1941, p. 155 |
| 62, 63, 64, 65, 66, 67 | Chisana (Bonanza) district | T.4,5N.,R.19,20E. | Au | Placer | M/A | Chiefly coarse-grained smooth gold; coarse-grained rough gold from placer deposit #64. Production of about $1,000,000 principally from deposits 63 and 65. About half of total production was from years 1913-1915; some mining has continued to present time. | Capps, 1916, p. 92-116; Moffit, 1943 p. 170-173 |
| 68 | Bryan Creek | T.3N.,R.19E. | Au,Cu | Placer | P/I | Some coarse-grained gold and native copper recovered. | Moffit, 1954, p. 200 |

[1] Symbols used:
0 - Occurrence, no known exploration or development work
P - Prospect
A - Active prospect, exploration or development work since 1967
I - Inactive prospect, no known exploration or development work since 1967
M - Mine
A - Active mine, production since 1967
I - Inactive mine, no production since 1967, with year mine ceased production

[2] Deposits not referenced have not been described previously and are chiefly occurrences observed during the course of recent geologic mapping. Locations are also shown on published larger scale (1:63,360) geologic maps of the Nabesna quadrangle.

### PORPHYRY COPPER DEPOSITS

| NAME | MAP NO. | ASSOCIATED ROCKS | ALTERATION MINERALS AND APPROXIMATE DIMENSIONS OF ALTERED ZONES (METRES): CENTRAL ZONE | OUTER ZONES | AVERAGE GRADES FROM SURFACE SAMPLING[1] (%): Cu | Mo | ESTIMATED GRADE[2] (%): Cu | Mo | INDICATED AND INFERRED TONNAGE[3] [MILLION TONNES (METRIC TONS)] |
|---|---|---|---|---|---|---|---|---|---|
| Orange Hill | 22 | Quartz diorite and granodiorite intruded by quartz-plagioclase porphyry | Abundant biotite, quartz veinlets, minor K-feldspar, chlorite and sericite. Late anhydrite veins. 400 x 2000 | Chlorite, minor sericite and anhydrite. 1000 x 3000 | 0.25, all below 0.4 | 0.01, up to 0.8 in porphyry | 0.35 | 0.02 | 320[4] |
| Bond Creek | 30 | Metavolcanic rocks, quartz diorite and granodiorite intruded by leuco-quartz monzonite porphyry | Abundant chlorite, minor biotite and K-feldspar, spotty sericite. Late anhydrite veins. 600 x 2000? | Minor chlorite, epidote, and anhydrite. 2000 x 3000 | 0.15, all below 0.3 | 0.01 | 0.30 | 0.02 | 500 |
| Baultoff | 53 | Diorite intruded by quartz diorite porphyry | Chlorite, sericite and albite. Late anhydrite veins. 400 x 1000 | Intense sericite and pyrite. 1000 x 2000 | 0.10, all below 0.25 | < 0.01 | 0.20 | very low | 160 |
| Horsfeld | 52 | Granodiorite, monzonite and monzonite porphyry | K-feldspar, actinolite and magnetite. 200 x 700 | 800 x 1500 | 0.10, all below 0.5 | < 0.01 | 0.20 | very low | 60 |
| Carl Creek | 45,46 | Granodiorite and quartz monzonite | Quartz and sericite in veinlets. Two altered areas each about 100 x 200 | | 0.10, all below 1.5 | < 0.01 | 0.20 | very low | 16 |
| Johnson Creek | 44 | Small stock of diorite and hornfelsed argillite | 100 x 100 | | 0.15 | <0.01 | 0.20 | very low | 8 |
| Unnamed | 54 | Small stock of porphyritic diorite | 50 x 100 | | <0.10 | <0.01 | 0.10 | very low | 4 |
| Unnamed | 50 | Small stock of diorite and hornfelsed argillite | 100 x 300 | | | | 0.20 | very low | 12 |

[1] Surface grades are from investigation in 1974 and from geochemical studies in the Nabesna A-1 and A-2 quadrangles during 1969 and 1970 (Matson and Richter, 1971; and Richter and Matson, 1970).

[2] Estimated grades based largely on comparison of surface and subsurface analytical data from Orange Hill and on discussions with mineral industry personnel, which indicate that the tenor of surface samples is approximately half that of subsurface samples. Difference apparently due to surface leaching of ore minerals.

[3] Tonnage based largely on the volume of the central altered zone, assuming an arbitrary thickness of 200 m., and a density of 2.7 $g/cm^3$.

[4] Resources previously reported for the Orange Hill copper porphyry are: 210,000,000 short tons of 0.4 percent Cu and 0.02 percent Mo (Van Alstine and Black, 1946) and 86,000,000 short tons with more than 0.3 percent Cu and 0.015 percent $MoS_2$ (Linn, 1973).

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# MINERAL RESOURCES MAP OF THE NABESNA QUADRANGLE, ALASKA

BY

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1975

For sale by U. S. Geological Survey, price $.50