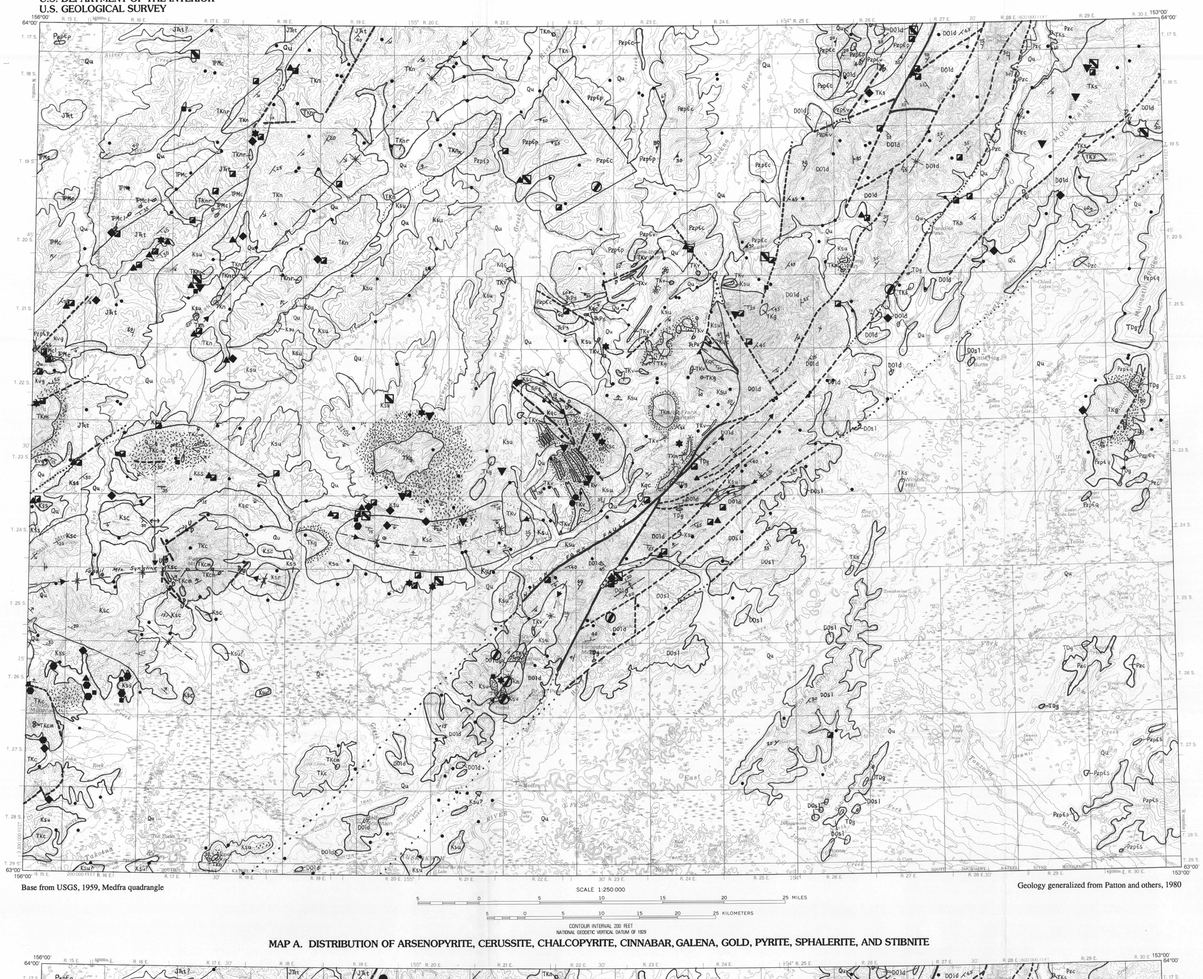
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

MISCELLANEOUS FIELD STUDIES
MAP MF-2207



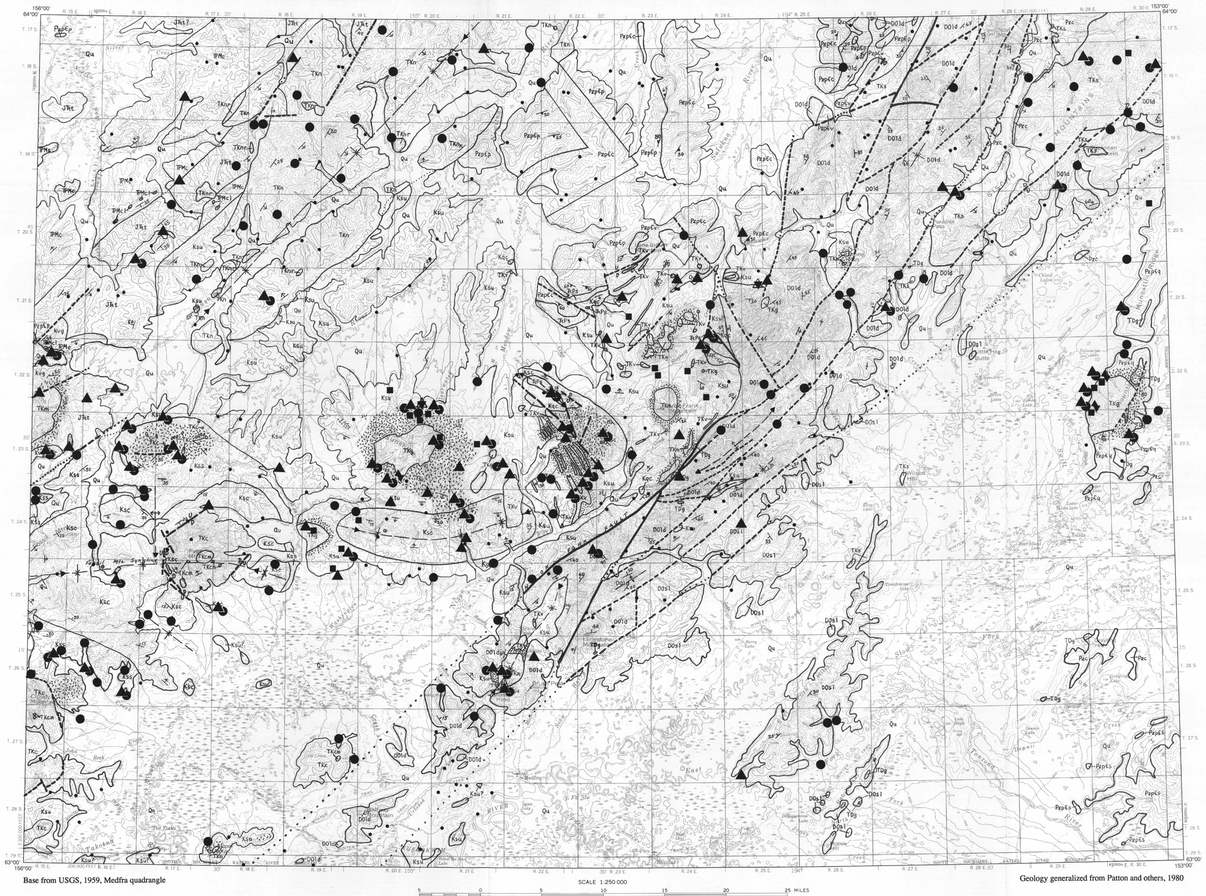
Base from USGS, 1959, Medfra quadrangle

Geology generalized from Patton and others, 1980

SCALE 1:250 000

CONTOUR INTERVAL 200 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

MAP A. DISTRIBUTION OF ARSENOPYRITE, CERUSSITE, CHALCOPYRITE, CINNABAR, GALENA, GOLD, PYRITE, SPHALERITE, AND STIBNITE



Base from USGS, 1959, Medfra quadrangle

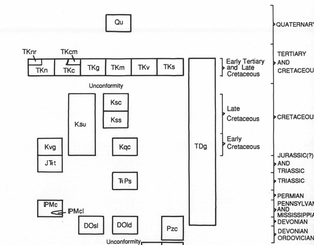
Geology generalized from Patton and others, 1980

SCALE 1:250 000

CONTOUR INTERVAL 200 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

MAP B. DISTRIBUTION OF CASSITERITE, CYRTOLITE, MONAZITE, POWELLITE, AND SCHEELITE

CORRELATION OF MAP UNITS



LIST OF MAP UNITS

[Location of contact between units PzpCc and PzpCq partly based on interpretation of aeromagnetic data (see Patton and others, 1982)].

Qu	SURFICIAL DEPOSITS, UNDIVIDED (QUATERNARY)
TKry TKn	VOLCANIC ROCKS OF THE NOWITNA RIVER AREA (EARLY TERTIARY AND LATE CRETACEOUS)--Chiefly trachyandesite, basaltic andesite, and andesite lava flows. TKry--Rhyolite domes, tuffs, and breccia
TKm TKc	MAFIC TO INTERMEDIATE VOLCANO-PLUTONIC COMPLEXES (EARLY TERTIARY AND LATE CRETACEOUS)--Altered basalt, andesite, and trachyandesite flows and hypabyssal intrusions. TKcm--Small bodies of monzonite, quartz monzonite, and granodiorite
TKg	GRANITE (EARLY TERTIARY AND LATE CRETACEOUS)
TKm	MONZONITE (EARLY TERTIARY AND LATE CRETACEOUS)
TKv	VOLCANIC ROCKS OF NIXON FORK-UPPER SULUKNA RIVER AREA (EARLY TERTIARY AND LATE CRETACEOUS)--Rhyolite, dacite, and trachyandesite sills, dikes, flows, and plugs
TKs	VOLCANIC ROCKS OF THE SISCHU MOUNTAINS (EARLY AND LATE CRETACEOUS)--Rhyolite and dacite flows
TDg	GABBRO (TERTIARY TO DEVONIAN)
Ksu	SHALE, SILTSTONE, AND SANDSTONE, UNDIVIDED (LATE AND EARLY CRETACEOUS)
Ksc	NONMARINE SANDSTONE AND QUARTZ-CHERT CONGLOMERATE (LATE CRETACEOUS)
Kss	MARINE SANDSTONE, SILTSTONE, AND SHALE (LATE CRETACEOUS)
Kqc	QUARTZ-CARBONATE SANDSTONE AND PEBBLY MUDSTONE (EARLY CRETACEOUS)
Kvg	VOLCANIC GRAYWACKE AND CONGLOMERATE (EARLY CRETACEOUS)
JTRt	CHERTY TUFF, CRYSTAL AND LITHIC TUFFS, AND VOLCANIC BRECCIA (JURASSIC ? AND TRIASSIC)
TRPs	SANDSTONE, SANDY LIMESTONE, SPICULITE, AND CONGLOMERATE (TRIASSIC)
PMc PMcl	CHERT AND LIMESTONE (PENNSYLVANIAN AND MISSISSIPPIAN)--Chiefly radiolarian chert. PMcl--Limestone
DOsl	SHALY LIMESTONE (DEVONIAN TO ORDOVICIAN)
DOld	LIMESTONE AND DOLOMITE (DEVONIAN TO ORDOVICIAN)
Pzc	CHERT AND PHYLLITE (EARLY PALEOZOIC)
PzpCq	QUARTZITE, GRIT, AND ARGILLITE (EARLY PALEOZOIC OR PRECAMBRIAN)
PzpCs	SHEARED GRIT, QUARTZITE, AND QUARTZ-MICA SCHIST (EARLY PALEOZOIC OR PRECAMBRIAN)
PzpCv	METAVOLCANIC ROCKS (EARLY PALEOZOIC OR PRECAMBRIAN)--Metarhyolite and dacite
PzpCc	CALC-SCHIST (EARLY PALEOZOIC OR PRECAMBRIAN)
PzpCp	PELITIC SCHIST (EARLY PALEOZOIC OR PRECAMBRIAN)

Contact--Includes approximately located, inferred, and indefinite

Fault--Dashed where approximately located, short dashed where inferred, dotted where concealed. U, upthrown side; D, downthrown side

Anticline--Showing direction of plunge

Syncline--Showing direction of plunge

Strike and dip of beds--May include overturned beds

Strike of vertical beds

Horizontal beds

Strike and dip of beds based on photo-interpretation or distant observation

Strike and dip of foliation

Zone of hornfels

SYMBOLS USED ON MAP A

- Arsenopyrite
- Cerussite
- Chalcopyrite
- Cinnabar
- Galena
- Gold
- Malachite
- Pyrite
- Sphalerite
- Stibnite
- Sample site--none of the above minerals identified

Amounts of the above minerals are less than 20 percent by volume of the nonmagnetic fraction

SYMBOLS USED ON MAP B

- Cassiterite
- Cyrtolite
- Monazite
- Powellite
- Scheelite
- Sample site--none of the above minerals identified

Amounts of the above minerals are less than 20 percent by volume of the nonmagnetic fraction

INTRODUCTION

This report and the accompanying maps summarize and interpret the distribution of ore-related minerals in the heavy-mineral fraction of stream-sediment samples collected in the Medfra quadrangle, Alaska. This is one of a series of maps and reports on geologic, geochemical, and geophysical studies that were conducted in the quadrangle as part of the Alaskan Mineral Resource Assessment Program (AMRAP) of the U.S. Geological Survey (Patton and others, 1980). The mineralogical studies were used to help delineate areas favorable for mineral deposits within the quadrangle and to define types of deposits that might be present in these areas.

An exploration geochemistry survey conducted in the Medfra quadrangle in 1978 and 1979 included the collection of 370 heavy-mineral-concentrate samples. Most of the samples were collected from channels of active first- or second-order streams with upstream catchment areas averaging about 9 km^2. The heavy-mineral-concentrate samples were collected by panning minus-2-mm stream sediment to remove most of the light-mineral fraction. The panned samples were sieved with a 20-mesh (0.8 mm) screen and the minus-20-mesh fraction was then passed through bromoform (specific gravity 2.86) to remove light-mineral grains not removed in the panning process. A nonmagnetic fraction of each sample was obtained using an isodynamic magnetic separator with a coil setting equivalent to 0.7 amperes and track settings equivalent to 5° forward slope and 10° side tilt. By using this magnetic-separation procedure, a relatively nonmagnetic fraction of each sample was obtained that was free of the diluent minerals, magnetic iron oxides, garnet, amphibole, pyroxene, epidote, and other high-iron/low-magnesium silicates. Elimination of these minerals from the concentrate samples reduces interference from variations in composition of non-ore-related minerals, permitting easier spectrographic detection of ore-related elements and facilitating visual identification of mineral grains.

A 5-mg split of finely pulverized sample material was analyzed using a semiquantitative, direct-current arc emission spectrographic method (Grimes and Marranzino, 1968). The analytical results for these samples are available in King and others (1980).

For this study, a split of the nonmagnetic heavy-mineral fraction of stream sediment was scanned visually using a binocular microscope and a shortwave ultra-violet lamp to help identify ore-related minerals. In most cases, the mineral grains could be identified from their physical properties, but X-ray diffraction analysis was used to confirm the presence of some mineral species. Sixteen ore-related minerals were identified in the 370 concentrate samples. The following is a listing of identified ore-related minerals, their chemical formulas, and the number of occurrences for each mineral: arsenopyrite, FeAsS (12); cerussite, $PbCO_3$ (2); chalcopyrite, $CuFeS_2$ (11); cinnabar, HgS (21); galena, PbS (12); gold, Au (10); malachite, $Cu_2CO_3(OH)_2$ (6); pyrite, FeS_2 (54); sphalerite, ZnS (19); stibnite, Sb_2S_3 (8); cassiterite, SnO_2 (139); cyrtolite (an altered form of zircon that can contain uranium, thorium, yttrium, and other rare-earth elements), $ZrSiO_4$ (3); monazite, (Ce,La,Nd,Th) PO_4 (20); powellite, Ca $(Mo,W)O_4$ (2); and scheelite, $CaWO_4$ (81). The distribution of the As-, Au-, Cu-, Hg-, Pb-, Sb-, and Zn-bearing minerals is shown on map A, and the distribution of the Mo-, Sn-, Th-, U-, W-, and rare-earth element-bearing minerals is shown on map B.

GEOLOGY

The following review of the geology of the quadrangle is excerpted from Patton and others (1980). Three distinct tectonostratigraphic terranes of pre-mid-Cretaceous rocks have been recognized in the Medfra quadrangle: the Nixon Fork, the Minchumina, and the Innoko. Each terrane forms a separate and stratigraphically distinct fault-bounded belt that cuts northeastward across the quadrangle. The Nixon Fork terrane is characterized by a thick section of early Paleozoic platform carbonate rocks overlying a Precambrian and earliest(?) Paleozoic age metamorphic complex composed of greenschist-facies pelitic schist, calc schist, and metavolcanic rocks locally faulted against the platform carbonate rocks in the north-central and northeastern parts of the quadrangle.

The Innoko terrane, located in the northwest corner of the quadrangle, is a succession of radiolarian chert and limestone turbidites of Mississippian and Pennsylvanian age; cherty tuff, crystal and lithic tuff, and volcanic breccia of Triassic and Early Jurassic(?) age; and volcanic graywacke and conglomerate of earliest Cretaceous age. These three units are thought to compose a tectonic package of island-arc and oceanic rocks that was thrust faulted (from the northwest) across a metamorphic complex (Patton and Moll, 1962). The metamorphic complex is exposed only at two isolated localities in creek beds along the western margin of the Medfra quadrangle, but is widely exposed in the adjoining Ophir quadrangle (Chapman and others, 1982). It is not certain that these metamorphic rocks are part of the same metamorphic complex underlying the Nixon Fork terrane.

The Minchumina terrane is exposed in a few groups of hills located in the Tanana-Kuskokwim lowlands in the southeastern part of the quadrangle. The East Fork Hills and the hills that border the lowlands on the northwest are composed chiefly of slightly schistose Ordovician to Devonian shaly limestone and chert. The Telida Mountains, in the eastern part of the quadrangle, are composed of an assemblage of quartzite, quartz-feldspar grit, and argillite that tentatively is assigned a Precambrian and early Paleozoic age on the basis of correlation with similar assemblages to the northeast in the Kantishna River and Livengood quadrangles (Chapman and others, 1971; 1975). The Slow Fork Hills, in the southeast corner of the quadrangle, consist of sheared grit, quartz, quartz-mica schist, and phyllite that are interpreted to be the metamorphic equivalent of the quartzite and grit beds of the Telida Mountains (Patton and others, 1980).

The Early and Late Cretaceous shallow-marine and fluvial sandstone, shale, and conglomerate of the Kuskokwim Group form a broad southwest-plunging syncline that unconformably overlies the Innoko and Nixon Fork terranes in the southwestern and west-central parts of the quadrangle. Late Cretaceous and early Tertiary volcanic and intrusive rocks locally overlie and intrude all three pre-mid-Cretaceous terranes and the Cretaceous sedimentary rocks of the Kuskokwim basin. The igneous rocks consist of (1) a large volcanic field composed of felsic flows, domes, and tuff units in the Sischu Mountains in the northeastern part of the quadrangle; (2) a large volcanic field composed of intermediate flows in the Nowitna River area in the northwestern part of the quadrangle; (3) felsic and intermediate sills, dikes, flows, and plugs in the upper Nixon Fork-Sulukna River area in the central part of the quadrangle; (4) granite and monzonite stocks that crop out within a broad and discontinuous east-west-trending belt that cuts across the center of the quadrangle; and (5) several circular volcanic-plutonic complexes of intermediate flows and stocks in the southwestern part of the quadrangle.

MINERAL OCCURRENCES

Mines, prospects, and mineral occurrences of the Medfra quadrangle are listed and located by Schwab and others (1981). Of the 35 mines and prospects listed, all but four represent lode- or placer-type gold deposits. Significant gold production was recorded from the Nixon Fork district in the southwestern part of the quadrangle. A gold placer on Colorado Creek along the west margin of the quadrangle was worked in the past. Schwab and others (1981) reported descriptive and geochemical data for 92 separate occurrences of sulfides and other indicators of mineralization that were located during geologic mapping and geochemical sampling of the bedrock units in the quadrangle between 1975 and 1979. Tourmaline is abundant in the Mystery and Telida Mountains, where it is associated with felsic subvolcanic and intrusive rocks. A small deposit of magnetite was discovered in a skarn zone near White Mountain Creek. Galena-bearing quartz veins were found at the head of the Susulatna River. A zinc-rich gossan is hosted by carbonate rocks on upper Soda Creek.

Schwab and others (1981) described 49 samples of bedrock that yielded anomalous geochemical values but displayed no visible signs of mineralization. Of particular interest are anomalous concentrations of Be, Hg, Mo, Pb, Sn, U, Y, and Zn in strongly radioactive uranium- and thorium-rich rhyolitic rocks in the Sischu Creek area in the northeast corner of the quadrangle (Miller and others, 1980).

Distribution of the Concentrate Minerals—Map A

Map A shows that the distribution of the As-, Cu-, Fe-, Hg-, Pb-, Sb-, and Zn-bearing minerals in concentrate samples is commonly associated with the Late Cretaceous and early Tertiary igneous rocks and related hornfels in the Kuskokwim basin and the Nixon Fork terrane. Concentrate samples also show that these minerals are distributed in isolated occurrences in the early Paleozoic platform carbonate rocks of the Nixon Fork terrane. Gold lode and placer deposits associated with quartz-monzonite stocks in the Nixon Fork mining area (T. 26 S., Rs. 21-22 E.) occur in the Nixon Fork terrane. The quartz monzonite stocks contain numerous small gold-bearing skarn deposits (Berg and Cobb, 1967). The Nixon Fork mining area produced about 40,000 to 60,000 oz of gold from the lode deposits. The ore consisted mainly of secondary Fe and Cu minerals, Au, and a little native Bi. The deposits have been extensively oxidized, thus releasing the gold from the chalcopyrite and pyrite. Gold, galena, cassiterite, malachite, and scheelite were found in concentrate samples collected from tributaries draining the Nixon Fork mining area. Although no chalcopyrite was detected in the concentrate samples, some malachite grains appeared to be pseudomorphs after chalcopyrite.

The carbonate rocks in the Nixon Fork terrane extend northeastward from the Nixon Fork mining area to the quadrangle boundary and are cut by numerous intersecting faults and breccia zones. South of the Mystery Mountains and Von Frank Mountain, the carbonate rocks are cut by small diabase and gabbro bodies and at least one altered felsic porphyry dike (Patton and others, 1982; Schwab and others, 1981). Schwab and others (1981) reported the presence of iron-oxide gossans in carbonate rocks containing as much as 35 percent Zn, 200 ppm Cd, 2.5 ppm Hg, 10 ppm Mo, 1 ppm Ag, and 0.05 ppm Au. Samples of chert conglomerate with hematite veinlets contain anomalous concentrations of As (200 ppm), Cu (150 ppm), Hg (0.7 ppm), Mo (50 ppm), Ni (200 ppm), and Zn (110 ppm). The distribution of cinnabar, chalcopyrite, malachite, pyrite, and sphalerite in concentrate samples collected from streams that drain the carbonate rocks delineates the extent of the gossan zone described by Schwab and others (1981). King and Tripp (1983) also enumerated anomalous concentrations of Cd, Cu, Pb, and Zn in stream-sediment, concentrate, and moss samples collected in this area. The correlation of the analytically detected ore-related elements in the various sample media and the geological environment in the carbonate-rich zones of the Nixon Fork terrane suggests the presence of areas favorable for metallic-mineral resources.

The carbonate rocks in the Nixon Fork terrane are overlain by a large volcanic field of felsic flows, domes, and tuff units in the Sischu Mountains in the northeastern part of the quadrangle. Concentrate samples collected from streams draining these volcanic rocks contain arsenopyrite, chalcopyrite, cinnabar, malachite, and pyrite. The distribution of the base-metal sulfides in concentrate samples correlates with anomalous concentrations of arsenic and copper in the nonmagnetic heavy-mineral concentrate samples collected by King and Tripp (1983). Some of these anomalous concentrations of minerals may indicate the location of areas favorable for the presence of base-metal deposits within the volcanic field.

Areas containing igneous rocks and related hornfels correlate well with the distribution of base-metal-bearing concentrate samples collected from streams in the Medfra quadrangle. The cluster of concentrate samples containing cinnabar, galena, sphalerite, and stibnite in the Cloudy Mountain area (T. 26 S., R. 16 E.) are particularly interesting. Cloudy Mountain is underlain by a volcanoplutonic complex and the nearby Ivy Creek drainage is underlain by hornfelsed Cretaceous sedimentary rocks. Aeromagnetic data suggest that the hornfelsed rock is underlain at shallow depth by an additional intrusive body (Patton and others, 1982). King and Tripp (1983) reported anomalous Hg, Pb, and Zn concentrations in stream-sediment samples, Ag, As, Au, Pb, Sb, and Zn anomalies in moderately magnetic to nonmagnetic heavy-mineral-concentrate samples, and Ag, As, Pb, and Zn anomalies in moss samples. The Cloudy Mountain area may be the northeastern extension of a wide belt of cinnabar-stibnite occurrences in southwestern Alaska that are localized mainly within the Kuskokwim Mountains (Cobb, 1970). The bedrock association of sedimentary hornfels and volcanoplutonic rocks with mineralogical and elemental suites also indicates the presence of precious- and base-metal-bearing deposits.

A cluster of concentrate samples containing arsenopyrite, chalcopyrite, cinnabar, galena, gold, pyrite, sphalerite, and stibnite is spatially associated with a Cretaceous to Tertiary granitic pluton located in the Sunshine Mountains (T. 24 S., R. 19 E.). The country rocks are altered to hornfels over a broad area, indicating that the granitic pluton may exist at shallow depth over a large area to the south (Patton and others, 1982). Schwab and others (1981) reported that the hornfelsic and sedimentary rocks contain anomalous concentrations of Ag, Au, Cu, Hg, and Zn, that quartz veins cutting the hornfels contain 3,000 ppm As and 0.3 ppm Au, and that the igneous rocks contain anomalous concentrations of As, Hg, and Pb. The mineralogical anomalies found in concentrate samples collected from streams draining the Sunshine Mountains indicate the presence of areas geochemically favorable for metallic mineral resources.

Concentrate samples collected from streams that drain an area in the Mystery Mountains (T. 23 S., R. 22 E.) contain arsenopyrite, cerussite, cinnabar, galena, and gold. Cretaceous sedimentary rocks in this area were altered to hornfels by numerous northwest-trending sills and plugs of highly altered rhyolite, dacite, and trachyandesite. The area is cut by northwest- and northeast-trending high-angle faults. There has been extensive tourmaline mineralization throughout the Mystery Mountain area, and chalcopyrite and malachite mineralization occurred in the Cottonwood Creek drainage area (Schwab and others, 1981). The distribution of the concentrate samples containing mineral anomalies correlates with the distribution of rocks that contain anomalous concentrations of As, Au, Cu, Hg, and Pb (Schwab and others, 1981). The malachite, arsenopyrite, gold, cinnabar, cerussite, and galena found in concentrate samples may have originated in sulfide-bearing hornfels, gossan zones in heavily oxidized quartz porphyry, zones of tourmalinization in sandstone hornfels, and sulfide-bearing zones in igneous rocks.

Concentrate samples containing cinnabar, galena, gold, pyrite, and sphalerite were collected from streams that drain an area containing monzonite (T. 22 S., R. 15 E.) and volcanoplutonic complexes (T. 23 S., R. 17 E.). The monzonite area encompasses the Cripple Creek Mountains. Volcanic and sedimentary rocks adjacent to the monzonite were altered to hornfels. The area of volcanoplutonic rocks contains numerous andesite dikes and small hypabyssal bodies that cut hornfelsed sedimentary rocks. The dikes and hypabyssal bodies are thought to coalesce into a large intrusive body at shallow depth (Patton and others, 1982).

Schwab and others (1981) described a quartz vein located on Wyoming Creek in the Cripple Creek Mountains that contains cinnabar and stibnite. The rocks that underlie the immediate vicinity of the Colorado Creek placer-mining area include greenstone, chlorite schist, and argillite, all of which contain disseminated pyrite. The hornfels of the Cripple Creek Mountains contain 30 ppm As, 110 ppm Cu, and 180 ppm Zn (Schwab and others, 1981). The distribution of pyrite and sphalerite in concentrate samples collected from the Cripple Creek Mountains correlates with the distribution of anomalous concentrations of As, Cu, and Zn in rock samples collected by Schwab and others (1981). In the area of the volcanoplutonic complexes, Schwab and others (1981) found galena in quartz veins, pyrite in sandstone hornfels, and analytically detected anomalous concentrations of Ag, As, Pb, Sb, and Zn in hornfels. The distribution of galena, pyrite, and sphalerite in concentrate samples collected from streams draining the volcanoplutonic rocks and associated hornfels correlates with the distribution of galena and pyrite and the anomalous concentrations of the base metals discussed by Schwab and others (1981). The ore-related minerals of the concentrate samples and the suite of elements found in anomalous concentrations in the rocks suggest that precious- and base-metal deposits may occur along the contacts of the hornfels and the monzonite and volcanoplutonic rocks.

The distribution of minerals in concentrate samples revealed widely scattered occurrences of arsenopyrite, chalcopyrite, cinnabar, galena, gold, pyrite, and sphalerite over a large area of a volcanic field of chiefly intermediate-composition flows in the vicinity of the Nowitna River in the northwestern part of the quadrangle. Schwab and others (1981) found disseminated sulfide minerals in an altered rhyolite tuff, anomalous concentrations of Pb (100 ppm), Cu (130 ppm), and Hg (0.26 ppm) in a cherty tuff, and anomalous concentrations of As and Hg in a sandstone. The distribution of cinnabar, chalcopyrite, galena, arsenopyrite, pyrite, and sphalerite in concentrate samples correlates with the distribution of sulfides and the anomalous concentrations of As, Cu, Hg, and Pb in the samples collected by Schwab and others (1981). The ore-related minerals found in the concentrate samples and the suite of elements found in anomalous concentrations in the rocks indicates the presence of precious- and base-metal deposits in the hornfelsed rocks.

A small cluster of concentrate samples that contained chalcopyrite, malachite, pyrite, and sphalerite were collected in the north-central part of the quadrangle (T. 19 S., R. 22 E.). The area is underlain by a Precambrian and earliest(?) Paleozoic metamorphic complex (Patton and others, 1980). The complex is composed of greenschist-facies pelitic schist, calc-schist, and metavolcanic rocks that may contain disseminated sulfide minerals.

Distribution of the Concentrate Minerals - Map B

One of the more striking mineral-distribution patterns is seen (map B) where cassiterite and scheelite found in concentrate samples are associated with virtually all of the Late Cretaceous and early Tertiary volcanic and intrusive rocks in the Medfra quadrangle. The cassiterite and scheelite are associated with (1) granite and monzonite stocks scattered throughout a broad east-west-trending belt that cuts across the center of the quadrangle; (2) felsic to intermediate-composition sills, dikes, flows, and plugs that crop out in the upper Nixon Fork-Sulukna River area (central part of the quadrangle); (3) several circular volcanic-plutonic complexes of intermediate-composition flows and stocks located in the southwestern part of the quadrangle; (4) a large volcanic field (more than 500 m thick) composed of felsic flows, domes, and tuff units that crop out in the Sischu Mountains (northeastern part of the quadrangle); and (5) a large volcanic field (more than 1,000 m thick) that consists of flows of intermediate composition in the Nowitna River area (northwestern part of the quadrangle). In addition to the cassiterite and scheelite, cyrtolite and monazite were found in concentrate samples collected from the granitic stocks of the Sunshine Mountains (T. 23 S., R. 20 E.), Von Frank Mountain (T. 22 S., R. 23 E.), and the Telida Mountains (T. 22 S., R. 29 E.). Powellite in concentrate samples collected from the Sunshine Mountains and an area in T. 21 S., R. 25 E., shows a spatial relationship to nearby granitic rocks.

The numerous small skarn deposits in the Nixon Fork mining area were found to contain gold; apparently they also contain scheelite and radioactive minerals, which is indicated by traces of tungsten- and uranium-bearing minerals found in dump material beside one of the shafts (Berg and Cobb, 1967). Concentrate samples collected from streams draining this area contain scheelite and cassiterite. Cassiterite and scheelite were also found in sluice-box concentrates collected on Ruby Creek (White and Stevens, 1953). The source of the cassiterite found in the concentrate samples is not known, although it appears that it is spatially associated with a quartz monzonite stock. However, Mertie (1936) did not list cassiterite as one of the constituent minerals of the quartz monzonite stock. Nekrasov (1971) characterized tin-bearing skarns as late-stage mineralization with a mineral suite that includes cassiterite, chalcopyrite, galena, and bismuthinite. Bismuth was found in stream-sediment samples and in the heavy-mineral-concentrate samples collected by King and Tripp (1983). Mertie (1936) reported that a small amount of native bismuth is present in lode ores and numerous bismuth nuggets are common in the stream placers. The distribution of scheelite in concentrate samples suggests that other undiscovered skarn deposits exist in the immediate area and in other areas of the carbonate belt.

Concentrate samples containing cassiterite and scheelite were collected from the large field of Late Cretaceous and early Tertiary rhyolite and dacite flows and domes that overlies the carbonate-belt rocks in the northeastern part of the quadrangle. One concentrate sample collected at T. 18 S., R. 30 E. contained monazite (?) - xenotime (?). The cassiterite found in concentrate samples may have been derived from fluorine-enriched systems within the volcanic rocks. Schwab and others (1981) reported anomalous concentrations of Sn (50 ppm) in rhyolite porphyry from several localities in this area. The presence of monazite-xenotime-like mineral in one concentrate sample collected from one site in this area may come from strongly radioactive uranium- and thorium-rich silicified volcanic rocks described by Miller and others (1980).

Occurrences of cassiterite and scheelite (in concentrate samples) are widely scattered throughout other areas of the carbonate-belt rocks to the southwest and northeast of the Nixon Fork mining area. Although there are no known monzonite bodies in the vicinity of the carbonate belt, small diabase and gabbro bodies, and at least one felsic-porphyry dike, are present in the area southeast of the Mystery Mountains (T. 23 S., R. 22 E.). Schwab and others (1981) reported the presence of iron-oxide gossans in carbonate rocks containing as much as 2.5 ppm Hg, 0.05 ppm Au, and 1 ppm Ag. Although gold was not found in the concentrate samples collected from this area, cinnabar was present in one sample (T. 25 S., R. 23 E.). The presence of scheelite and cassiterite in concentrate samples collected from streams that drain this part of the carbonate belt suggests that there may be other areas of tin- and tungsten-rich gold-bearing skarn deposits similar to the Nixon Fork deposit.

In the central part of the quadrangle, a large cluster of sites of concentrate samples that contain cassiterite and scheelite delineates most of the Mystery Mountains. (The geology of this area was described in the section concerning map A.) The distribution of gold and cassiterite in the concentrate samples correlates with that of gold and tin in samples collected by Schwab and others (1981). The source of the cassiterite may be the numerous felsic and intermediate-composition porphyry sills and plugs that intrude the terrigenous sediments. The distribution of the scheelite may indicate the presence of numerous small tungsten skarns associated with the hornfels.

Cassiterite and scheelite in concentrate samples from the upper Nixon Fork-Sulukna River area northeast of the Mystery Mountains probably comes from the granitic rocks and the felsic sills, dikes, flows, and plugs present in the area. The sedimentary rocks adjacent to both the granitic and volcanic rocks have been altered to hornfels. The presence of cassiterite and scheelite in concentrate samples collected from streams draining this hornfelsed rocks. The presence of gold, arsenopyrite, and cinnabar in concentrate samples collected from the hornfels of the Sunshine Mountains and the Mystery Mountains suggests that epithermal precious-metal deposits may be present. Base-metal deposits may be present in the area south of the Sunshine Mountains based on the presence of galena, chalcopyrite, pyrite, and sphalerite in concentrate samples collected in the area.

SUMMARY

The results of this mineralogical investigation of the heavy-mineral-concentrate fraction of stream sediment revealed a number of mineralogical anomalies that may reflect the presence of precious- and base-metal vein, porphyry, and tin lode deposits in the Medfra quadrangle.

Mineral suites discovered within the belt of carbonate rocks associated with the Nixon Fork district indicate the presence of other gold-bearing skarn deposits not yet found. Mineralogically favorable areas are best indicated by pyrite, malachite, cassiterite, and scheelite in concentrate samples. The carbonate-belt rocks that crop out in the central part of the quadrangle (where they are more extensively faulted and brecciated) may host strata-bound base-metal deposits, as suggested by the presence of pyrite, chalcopyrite, malachite, and sphalerite in concentrate samples. The presence of cassiterite, cinnabar, and scheelite in the concentrate samples indicates that the rocks of this same area may have undergone epithermal mineralization related to igneous intrusions at a later time.

The carbonate rocks overlain by felsic volcanic rocks in the northeastern part of the quadrangle may host uranium- and thorium-rich deposits, especially where a monazite-xenotime-like mineral was found in a single concentrate sample. The presence of cassiterite and scheelite in many of the concentrate samples suggests that the volcanic rocks contain zones of tin and tungsten enrichment. The presence of cassiterite, chalcopyrite, pyrite, and sphalerite content of concentrate samples suggests that base-metal veins may be widespread throughout the carbonate belt; the size, density, and the fungibility of economic grade of such veins are uncertain.

The data concerning the mineral content of the concentrate samples also indicate that rocks favorable for occurrences of metallic-mineral deposits may exist in the vicinity of the sedimentary hornfels adjacent to the Cretaceous to Tertiary granitic intrusions found in the quadrangle. Cassiterite and scheelite are commonly found in the concentrate samples collected from streams draining these hornfelsed rocks. The presence of gold, arsenopyrite, and cinnabar in concentrate samples collected from the hornfels of the Sunshine Mountains and the Mystery Mountains suggests that epithermal precious-metal deposits may be present. Base-metal deposits may be present in the area south of the Sunshine Mountains based on the presence of galena, chalcopyrite, pyrite, and sphalerite in concentrate samples collected in the area.

REFERENCES

Berg, H.C., and Cobb, E.H., 1967, Metalliferous lode deposits of Alaska: U.S. Geological Survey Bulletin 783.

Brown, J.S., 1926, The Nixon Fork country, *in* Mineral Resources of Alaska: Report on progress of investigations in 1924: U.S. Geological Survey Bulletin 783, p. 97-144.

Chapman, R.M., Weber, F.R., and Taber, Bond, 1971, Preliminary geologic map of the Livengood quadrangle, Alaska: U.S. Geological Survey Open-File Report, 2 sheets, scale 1:250,000.

Chapman, R.M., Yeend, W.E., and Patton, W.W., Jr., 1975, Preliminary reconnaissance map of the western half of the Kantishna River quadrangle, Alaska: U.S. Geological Survey Open-File Map 75-351, scale 1:250,000.

Chapman, R.M., Patton, W.W., Jr., and Moll, E.J., 1982, Preliminary summary of the geology in eastern part of Ophir quadrangle, *in* Coonrad, W.L., ed., The United States Geological Survey in Alaska: Accomplishments during 1980: U.S. Geological Survey Circular 844, p. 70-73.

Cobb, E.H., 1970, compiler, Antimony occurrences in Alaska: U.S. Geological Survey Mineral Investigations Resources Map MR-52.

Grimes, D. J., and Marranzino, A. P., 1968, Direct-current arc and alternating-current spark emission spectrographic field methods for the semiquantitative analysis of geologic materials: U.S. Geological Survey Circular 591, 6 p.

King, H.D., Risoli, D.A., Cooley, E.F., O'Leary, R.M., Speckman, W.A., Spiesman, D.L., Jr., and Galland, D.W., 1980, Final results and statistical summary of analyses of geochemical samples from the Medfra quadrangle, Alaska: U.S. Geological Survey Open-File Report 80-811, 134 p.

King, H.D., and Tripp, R.B., 1983, Multi-element maps showing the distribution and relative amounts of selected elements in four geochemical sampling media, Medfra quadrangle, Alaska: U.S. Geological Survey Open-File Report 80-811-M, 4 sheets.

Lindsey, D.A., and Shawe, D.R., 1982, Spor Mountain Be-F-U deposits, *in* Erickson, R.L., compiler, Characteristics of mineral deposit occurrences: U.S. Geological Survey Open-File Report 82-795, p. 67-69.

Mertie, J.B., Jr., 1936, Mineral deposits of the Ruby-Kuskokwim region, Alaska: U.S. Geological Survey Bulletin 864-C, p. 115-245.

Miller, T.P., Moll, E.J., and Patton, W.W., Jr., 1980, Uranium- and thorium-rich volcanic rocks of the Sischu Creek area, Medfra quadrangle, Alaska: U.S. Geological Survey Open-File Report 80-803, 9 p.

Nekrasov, I.Ya., 1971, Features of tin mineralization in carbonate deposits, as in eastern Siberia: International Geology Review, v. 13, p. 1532-1542.

Patton, W.W., Jr., Cady, J.W., and Moll, E.J., 1982, Aeromagnetic interpretation of the Medfra quadrangle, Alaska: U.S. Geological Survey Open-File Report 80-811-E, 14 p.

Patton, W.W., Jr., and Moll, E.J., 1962, Structural and stratigraphic section along a transect between the Alaska Range and Norton Sound, *in* Coonrad, W.L., ed., The United States Geological Survey in Alaska—Accomplishments during 1980: U.S. Geological Survey Circular 844, p. 76-78.

_____1983, Mineral-resource assessment of the Medfra quadrangle, Alaska: U.S. Geological Survey Open-File Report 80-811-G, 3 sheets, scale 1:250,000.

Patton, W.W., Jr., Moll, E.J., Dutro, J.T., Jr., Silberman, M.L., and Chapman, R.M., 1980, Preliminary geologic map of the Medfra quadrangle, Alaska: U.S. Geological Survey Open-File Report 80-811-A, 1 sheet, scale 1:250,000.

Patton, W.W., Jr., Moll, E.J., and King, H.D., 1984, The Alaskan Mineral Resources Assessment Program—Guide to information contained in the folio of geologic and mineral resource maps of the Medfra quadrangle, Alaska: U.S. Geological Survey Circular 928, 11 p.

Schwab, C.E., Patton, W.W., Jr., and Moll, E.J., 1981, Mineral occurrence map of the Medfra quadrangle, Alaska: U.S. Geological Survey Open-File Report 80-811-B, 2 sheets, 19 p.

Van Eeckhout, E.M., Warren, R.G., and Hill, D.E., 1979, Uranium hydrogeochemical and stream sediment reconnaissance of the Medfra and Mt. McKinley NTMS quadrangles, Alaska, including concentrations of fourty-three additional elements: Los Alamos Scientific Laboratory Informal Report LA-7381-MS, 210 p.

White, M.G., and Stevens, J.M., 1953, Reconnaissance for radioactive deposits in the Ruby-Poorman and Nixon Fork districts, west-central Alaska, 1949: U.S. Geological Survey circular 279, 19 p.

MAPS SHOWING DISTRIBUTION OF SELECTED MINERALS IN THE NONMAGNETIC HEAVY-MINERAL FRACTION OF STREAM-SEDIMENT SAMPLES, MEDFRA QUADRANGLE, ALASKA

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