DEPARTMENT OF THE INTERIOR
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SHEET 3 OF 3

Mineral Resources - Medfra Quadrangle, Alaska

MINERAL RESOURCES

Mines and prospects

Mining in the Medfra quadrangle has been limited to gold lode and placer deposits in the Nixon Fork district in the central part of the quadrangle and gold placer deposits in the Innoko district along the western margin of the quadrangle. At the time of these investigations active mining was confined to a single small placer operation on Colorado Creek in the Innoko district.

Gold Lode Deposits

Nixon Fork Mine--Between 1919 and 1960's the Nixon Fork Mine (Table 1, nos. 2, 3) had an estimated total gold production of between 40,000 and 60,000 oz from a gold-copper skarn deposit (Berg and Cobb, 1967). Most of the mining was carried out prior to 1933. Reed and Miller (1971) report some limited activity in 1960 and Bundtzen and others (1982) report that about 100 tons of high-grade ore was mined from the lode deposits in 1981 by the Mespelt and Almasy Mining Company, the present owners of the Nixon Fork Mine. The deposit occurs along the contact between a quartz monzonite-monzonite stock (TKm) and lower Paleozoic carbonate rocks (DOld). The following description of the deposit is summarized from Martin (1922), Brown (1926), Mertie (1936), and Herreid (1966): The ore occurs in marble within 30 m of the igneous contact. Ore minerals are chalcopyrite, pyrite, and minor bornite. Copper values range from 2 to 12 percent. In unoxidized ore the gold is bound up in pyrite and chalcopyrite; the oxidized ore is composed of limonite, quartz, malachite, azurite, and free gold. The ore generally occurs with skarn mineral assemblages including diopside, garnet, plagioclase, epidote, and apatite. Some ore-bearing rocks, however, contain sericite suggesting that ore was remobilized and concentrated during late-stage sericitic alteration. The occurrence of coarse lumps of magnetite in placer concentrates in Crystal Gulch, a short distance west of the monzonite stock at the Nixon Fork Mine (Brown, 1926), indicates that magnetite is also a skarn mineral.

Stone Mine--The Stone Mine, a small prospect located on Eagle Creek (Table 1, no. 5) 10 km southwest of the Nixon Fork Mine, was not visited by us in the field. According to White and Stevens (1953) the deposit occurs in a skarn zone near the contact of the lower Paleozoic carbonate rocks (DOld) and a small intrusive body (TKm) similar to the monzonite pluton at Nixon Fork Mine. No data are available on the extent of development work or on the amount of gold recovered.

Gold Placer Deposits

Nixon Fork District--An estimated 10,000 oz of placer gold has been recovered from the vicinity of the Nixon Fork Mine (Table 1, nos. 9-14) and from the vicinity of the Stone Mine lode deposit, 10 km southwest of the Nixon Fork Mine (Table 1, nos. 15, 16, and 34) (Eberlein and others, 1977). None of these placer deposits is being mined presently.

Innoko District--An active placer mine is located on Colorado Creek (Table 1, no. 35) along the western border of the quadrangle. Colorado Creek heads in a monzonite pluton (TKm) in the core of the Cripple Creek Mountains. The gold probably has its source in the contact zone around the pluton where the host rocks of Triassic-Jurassic tuffs and breccias (JꞦt) are cut by numerous small porphyry dikes. A 75-cm-thick vein of quartz, cinnabar, and stibnite is reported in the contact zone on Wyoming Creek a short distance east of Colorado Creek (Table 1, no. 1). Trace element analysis of the placer gold from Colorado Creek also yields high values for Hg (20,500 ppm) and Sb (450 ppm) (Warren Yeend, written commun., 1982).

Areas designated as favorable for the occurrence of undiscovered mineral deposits

Ten areas considered favorable for the occurrence of undiscovered mineral deposits have been delineated on the map and the criteria used in their selection described in Table 5. Where possible, specific mineral deposit types have been identified for each area. No attempt is made to weigh the "favorability" of the areas despite the fact that some contain known mineral deposits and others have very limited indicators of mineralization.

Criteria used to delineate areas as favorable for undiscovered mineral deposits include:

1. Favorable rock types, structures, and alteration.
2. Known mineral occurrences.
3. Geochemical anomalies in bedrock, stream sediment, heavy mineral concentrate and moss samples.
4. Occurrence of ore minerals in heavy mineral concentrates of stream sediments.
5. Aeromagnetic data suggesting possible mineralization.

Boundaries of the favorable areas have been drawn generally to conform to the mapped extent of favorable host rock units or hornfels zones.

We gratefully acknowledge the help and advice of B. L. Reed, D. A. Singer, H. D. King, M. L. Silberman, and S. E. Church in delineating areas favorable for the occurrence of undiscovered mineral deposits.

Table 5.--Favorable areas for the occurrence of undiscovered mineral deposits

Favorable areas	Type(s) of deposit(s) and criteria used to define areas
I	Beryllium-fluorite-uranium vein deposits (Spor Mountain type, Shawe, 1968) Criteria: (a) High radioactivity and anomalous Be and U in bedrock (168-171) (Miller and others, 1980). Fluorite observed in bedrock (Miller and others, 1980) (b) Favorable bedrock association (felsic volcanic rocks underlain by carbonate rocks) (c) Anomalous Sn, Y, Pb, Zn, Mo in bedrock (168-173) (d) Anomalous Pb, Au, Zn in stream sediments (e) Anomalous Mo and Sn in nonmagnetic heavy mineral concentrate samples (f) Chalcopyrite, pyrite identified in heavy mineral concentrates Precious metal deposits Criteria: (a) Favorable bedrock (felsic volcanic rocks with widespread silicification) (b) Anomalous As, Hg, U, Sb, Pb, Zn in bedrock (168-173) (c) Anomalous Cu, As in nonmagnetic heavy mineral concentrate samples (d) Anomalous Ag in moss (e) Arsenopyrite, cinnabar identified in heavy mineral concentrates
II	Skarn deposits (gold-copper) Criteria: (a) Known skarn deposits (2, 3, 5) (b) Favorable bedrock (carbonate rocks intruded by monzonite stocks (c) Aeromagnetic data indicate skarn zone mineralization may be more extensive in subsurface (Patton and others, 1982) (d) Anomalous Au, Cu, Ag, Zn, Sn in bedrock (e) Anomalous As, Ag, Au, Cu, Bi, Pb, Hg, Sn, Sb, Zn in stream sediments (f) Anomalous As, Ag, Au, Cu, Bi, Cd in moderately magnetic heavy mineral concentrates; Ag, Au, Cu, Bi, Mo, Pb in nonmagnetic heavy mineral concentrates (g) Anomalous As, Sn in moss (h) Gold, galena, malachite identified in heavy mineral concentrates
III	Skarn deposits (type uncertain) Criteria: (a) Known skarn deposit (60) (b) Favorable bedrock (carbonate rocks intruded by granite stock) (c) Carbonate rocks in area extensively sheared and dolomitized. Conodont color index indicates carbonate rock subjected to temperatures of at least 300°-400°C (written commun., J. E. Repetski and A. G. Harris, 1979). May be other intrusive bodies in subsurface. (d) Anomalous Ag, As, Au, Cu, Hg, Sb, Zn, Bi, Mo in rock samples from skarn zone (59, 61) (e) Anomalous Pb, Au from stream sediments (f) Anomalous Mo, Pb, Cu, As, W from moderately magnetic heavy mineral concentrates; W, Mo, Pb, Cd, As, Ag, Cu from nonmagnetic heavy mineral concentrates (g) Pyrite, arsenopyrite, galena identified in heavy mineral concentrates
IV	Strata-bound base metal deposits (Mississippian valley type) Criteria: (a) Favorable bedrock (reefy limestone and dolomite cut by many intersecting faults) (b) Strongly anomalous Zn in gossan (111) (c) Anomalous Zn, Pb, Hg, Cd, Sb, As, Ag, Ni, Mo in bedrock samples (111, 113, 114, 163) (d) Anomalous Zn, Pb in stream sediments (e) Anomalous Zn, Pb, Mo, Cu, W in moderately heavy mineral concentrates; Zn, As, W, Cu, Bi, Ag, Sn in nonmagnetic heavy mineral concentrates (f) Anomalous Zn, Cd, Pb in moss (g) Sphalerite, chalcopyrite, cinnabar, malachite, pyrite identified in heavy mineral concentrates
V	Porphyry tin deposits Criteria: (a) Abundant disseminated sulfides (chiefly pyrite) and tourmaline (75-106) (b) Favorable bedrock (terrigenous sediments intruded by numerous felsic and intermediate porphyry sills and plugs) (c) Widespread hornfels alteration and tourmalinization. Breccias of porphyry clast in tourmaline matrix suggest that tourmalinization accompanied hydrothermal brecciation. Local sericitization and silicification. (d) Presence of large positive aeromagnetic anomaly suggests intrusive rocks are more extensive in the subsurface. (e) Anomalous Sn, Cu, F, Ag, Pb, B, As, Sb, Hg, Bi in bedrock (77-104) (f) Anomalous Cu, Pb, Zn, Ag, Au, Bi in stream sediments (g) Anomalous Sn, Bi, As, Ag, Cu, Pb, Zn, Sb in moderately magnetic heavy mineral concentrates (h) Anomalous Sn, Bi, As, Ag, Cu, Pb, Cd, Zn, Au in nonmagnetic heavy mineral pan concentrates (i) Anomalous Sn, Ag, Cu, As, Zn, Pb, Cd in moss (j) Cerrusite, arsenopyrite, gold, galena identified in heavy mineral concentrates
VI	Deposit type uncertain Discussion: Significant geochemical anomalies and the occurrence of ore minerals in heavy mineral concentrates of stream sediments indicate that this area is mineralized but the deposit type is uncertain. Anomalous concentrations of mercury in bedrock and stream sediment samples suggest that the area could contain deposits of the epithermal precious metal type. Although the medium-grained texture of the Sunshine Mountain granite is not indicative of a near-surface environment, it is possible that later genetically unrelated epithermal mineralization has been superimposed on the Sunshine Mountain granite body. Anomalous tungsten values in bedrock and heavy mineral concentrate samples suggest the possibility of tungsten skarn deposits in calc-silicate hornfels around the periphery of the granite. Criteria: (a) Favorable bedrock association (granite pluton surrounded by broad zone of sedimentary hornfels. Carbonate-rich sedimentary host rocks locally altered to calc-silicate hornfels) (b) Anomalous Ag, Au, As, Cu, Hg, Pb, Zn, Bi, Sn, W, Mo, B, Be in bedrock (52, 53, 143-151) (c) Anomalous Cu, Zn, Hg, Sn, Pb, Au in stream sediments (d) Anomalous As, Cd, Cu, Bi, W in moderately magnetic heavy mineral concentrates; As, Au, Ag, Cu, Zn, Pb, W, Mo, Bi in nonmagnetic heavy mineral concentrates (e) Anomalous As and Zn in moss (f) Cinnabar, gold, arsenopyrite, pyrite, chalcopyrite, sphalerite identified in heavy mineral concentrates (g) Colors of gold reported from placers in the area but no production recorded
VII	Deposit type uncertain Discussion: Significant geochemical anomalies and quartz veins and sandstone with galena and pyrite suggest that the area is mineralized but the deposit type is uncertain. The possibilities include subvolcanic lead-silver, tin-silver, or lead-zinc-silver vein deposits. Criteria: (a) Galena in quartz veins (50) and pyrite in sandstone hornfels (48) (b) Favorable bedrock association (broad area of sedimentary hornfels intruded by numerous andesite dikes and small hypabyssal bodies (c) Anomalous Pb, Ag, Zn, Sb, Sn, As in bedrock (48, 50, 136, 137) (d) Anomalous Sn, Cu, Zn, Ag in stream sediments (e) Anomalous Sn, W, Bi, Ag, Zn, Pb, As in moderately magnetic heavy mineral concentrates; Sn, W, Bi, Pb in nonmagnetic heavy mineral concentrates (f) Anomalous Sn, Cu, Zn, Ag, As, Cd in moss (g) Galena, sphalerite, pyrite identified in heavy mineral concentrates
VIII	Epithermal precious-metal deposits Criteria: (a) Favorable bedrock (andesite flows overlain by rhyolite domes) (b) Evidence of argillic alteration, silicification, and hydrothermal brecciation in rhyolite dome (38) (Silberman and others, written commun., 1982) (c) Anomalous Hg, Mo, Pb in bedrock (37, 38, 128, 129) (d) Anomalous Ag, Sn in stream sediments (e) Anomalous Ag, As, Cu, Sn, W in moderately magnetic heavy mineral concentrates; Ag, As, Au, Cd, Cu, Mo, Sb, Sn, Zn in nonmagnetic heavy mineral concentrates (f) Anomalous Ag, Bi, Cd, Sn in moss (g) Gold, arsenopyrite, cinnabar, galena, sphalerite, chalcopyrite, pyrite identified in heavy mineral concentrates
IX	Precious or base metal deposits Criteria: (a) Favorable bedrock association (northeast-trending belt of sedimentary hornfels and associated volcanic and plutonic rocks) (b) Anomalous Sn, Pb, Zn, Hg, Cu in stream sediments (c) Anomalous Ag, Cu, Sn, Pb, Bi, W, Sb, As, Zn in moderately magnetic heavy mineral concentrates; Sb, Pb, Bi, Au, Sn, W, Ag, As, Zn in nonmagnetic heavy mineral concentrates (d) Anomalous Cu, As, Pb, Zn, Sn, Ag in moss (e) Stibnite, galena, cinnabar, arsenopyrite, gold, sphalerite, pyrite identified in heavy mineral concentrates
X	Lode tin deposits Criteria: (a) Favorable bedrock association (granite intruding quartzite, grit, argillite) (b) Widespread tourmaline in granite and associated sedimentary hornfels (120-124, 126) (c) Anomalous Sn, Ag, Bi, Cu, Mo, Pb, As, B in bedrock (120-126, 174) (d) Anomalous Ag, Sn in stream sediments (e) Anomalous Bi, Cd in moderately magnetic heavy mineral concentrates; Sn, Bi, Pb and W in nonmagnetic heavy mineral concentrates (f) Anomalous Sn, As, Ag, Cd in moss

Table 6.--Threshold values (in parts per million) for stream sediments, moss, and moderately magnetic and nonmagnetic fractions of heavy mineral concentrates

Table giving threshold values in parts per million. Element concentrations above or equal to these values are considered anomalous. Stream sediments values were derived from the minus 80 mesh fraction of sediment samples collected from active streams. The C-2 fraction is the moderately magnetic heavy mineral fraction of stream sediments. The C-3 fraction is the nonmagnetic heavy mineral fraction of stream sediments. Moss values were derived from aquatic bryophytes collected from stream channels beneath water level. Further information about sampling techniques and methods of analysis, as well as a map showing sample site locations, is available in King and others (1980). All analyses by semiquantitative spectrographic analyses unless otherwise noted. Symbols: # - atomic absorption; N.D. - not detected; N.A. - not analyzed; % - percent of total number of samples having anomalous values; * - all detected values considered anomalous; LLD = lower limit of determination in parentheses.

Analyzed material	Ag	As	Au		Bi	Cd	Cu	Mo	Pb	Sb	Sn	W	Zn		Hg
Sediment	0.5	*	*	*#	*	N.D.	150	N.D.	50	*	*	N.D.	200	$120^{\#}$	0.31
LLD	(.5)	(200)	(10)	(.05)#	(10)	(20)	(5)	(5)	(10)	(100)	(10)	(50)	(200)	(5)#	(.02)
%	1.6	0.4	0.4	$2.0^{\#}$	0.4	--	2.8	--	5.5	0.2	2.0	--	5.5	$4.7^{\#}$	2.9
Moss	2	300	N.D.		20	10	300	N.D.	50	N.D.	10	N.D.	2000	--	N.A.
LLD	(.1)	(200)	(2)		(1)	(1)	(1)	(5)	(1)	(50)	(5)	(50)	(100)		
%	5.3	7.0	--		0.5	6.3	2.8	--	3.5	--	5.5	--	0.8		--
C-2	1.5	500	*		*	*	500	50	700	*	200	*	1500		N.A.
LLD	(1.0)	(500)	(20)		(20)	(50)	(10)	(10)	(20)	(200)	(20)	(100)	(500)		
%	5.0	6.0	0.4		4.0	1.2	5.9	3.8	3.2	0.7	4.7	5.2	4.0		--
C-3	5	*	*		50	*	300	*	500	*	>1000	300	500		N.A.
LLD	(1.0)	(500)	(20)		(20)	(50)	(10)	(10)	(20)	(200)	(20)	(100)	(500)		
%	5.7	3.7	2.4		7.1	1.3	4.6	4.8	5.9	2.7	9.2	4.3	6.5		--

MINERAL FUEL RESOURCES

Petroleum

Lower Paleozoic Carbonate Rocks

The lower Paleozoic platform carbonate rocks (DOld) appear to have favorable reservoir and source bed characteristics for hydrocarbons. The sequence, which locally may be as much as 5,500 m thick, grades upward from Lower Ordovician supratidal deposits through a complex array of shallow shelf limestone facies that include reefoid masses in the Upper Ordovician and Middle Devonian (Dutro and Patton, 1982; Patton and others, 1980). Possible source beds composed of dark highly organic platy graptolite-bearing limestone and shale occur in the mid-Silurian. Solidified bituminous material ("dead oil") was noted in shallow-water "sabka" beds of Early Ordovician age at Novi Mountain (T. 17 S., R. 28 E.).

Although these carbonate rocks possess favorable source beds and reservoir characteristics, their thermal history as indicated by the color alteration of the conodonts suggests that the hydrocarbon potential may be limited to dry gas. No conodont color alteration index (CAI) below 2 was noted in any of the conodont samples collected from these carbonate rocks (Repetski, J. E., written communs., 1977, 1979; Repetski, J. E., and Harris, A. G., written commun., 1979). According to Epstein and others (1977), the upper thermal limit for oil is a CAI of 1.5. In the northeastern part of the carbonate belt CAIs range from 2 to 4 indicating that this part of the belt has been subjected to temperatures as high as 200° to 250°C. Although this is above the thermal cutoff for oil, it is below the thermal limit of 4.5 for dry gas. In the southwestern part of the belt CAIs range from 4 to 6 indicating that the carbonate rocks in this part of the belt reached temperatures of 200° to 400°C.

The platform carbonate rocks (DOld) are faulted against coeval deep water slightly metamorphosed shaly limestones (DOsl) along their southeastern margin (Patton and others, 1980). These deep-water deposits which underlie the low hills bordering the Kuskokwim River give CAIs as high as 6.5 indicating temperatures reached 350° to 500°C--well above the thermal limit for dry gas.

Upper Paleozoic-Mesozoic terrigenous clastic deposits

More than 4,000 m of terrigenous clastic deposits of Permian, Triassic, and Cretaceous age (ꞦPs, Kqc, Kss, Ksc, Ksu) are exposed in the central part of the quadrangle. The clastics are composed mainly of quartz, carbonate, and metamorphic rock debris derived from the underlying lower Paleozoic and Precambrian carbonate and metamorphic strata. They appear to have been deposited in a largely shallow marine and fluvial deltaic environment. Although the thickness and lithologic character of these deposits make them an attractive exploration target, their hydrocarbon potential appears unfavorable owing to the widespread occurrence of Late Cretaceous-early Tertiary volcanic and plutonic rocks. Large areas of these terrigenous clastic rocks are altered to hornfels and intruded by a myriad of small plutonic and subvolcanic bodies, many of which are too small to be shown on the geologic map.

Coal

Coal float is present in the Upper Cretaceous nonmarine sandstone and quartz-chert conglomerate unit (Ksc) in the Fossil Mountain syncline (Table 1, no. 47). Exposures of this unit are limited to resistant sandstone and conglomerate layers, so little is known about the thickness or abundance of the coal seams. Judging from the sparseness of the float, individual coal seams are probably less than 20 cm thick.

Brown (1926) quotes an unverified report of coal on Hosmer Creek (T. 24 S., R. 21 E.):

> "There is a great deal of conglomerate on lower Hosmer Creek. It makes a big hogback near the Nixon Fork. Behind this, up Hosmer Creek, is black shale, and at one place there is 6 inches (15 cm.) of coal in the shale."

Brown suggests that the coal occurs in a syncline of Upper Cretaceous nonmarine sandstone and quartz-chert conglomerate unit (Ksc) that crosses the middle course of Hosmer Creek.

Several lignitic coal seams less than 15 cm thick were noted in a 25-m-thick section of conglomerate, sandstone, and shale exposed in a cutbank on the Sethkokna River (Table 1, no. 118). These strata directly underlie volcanic rocks of the Sischu Mountains (TKs) and are dated by pollen as latest Cretaceous (Campanian-Maestrichtian).

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