Mineral Appraisal of Lands Adjacent to Mt. McKinley National Park, Alaska

Prepared for

United States Department of the Interior

Bureau of Mines

By

C. C. Hawley and Associates

C. C. Hawley and Associates, Inc.
Star Route A, Box 78D
Anchorage, Alaska 99507

(907) 344-6114

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16. Abstract

C. C. Hawley and Associates is a geological consultant firm of Anchorage, Alaska. The area described includes Mt. McKinley National Park and proposed extensions on all sides. Hawley and Associates had previously examined and explored mineral deposits and mineral trends in the study area and in adjacent lands. They also acquired much data from other firms. This was supplemented by intensive field investigations in the proposed additions. Field investigations within the present park boundaries were not permitted.

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FOREWORD

The Federal-State Land Use Planning Commission of Alaska requested the Alaska Field Operations Center of the Bureau of Mines to evaluate the mineral potential of land classified under Section 17(d)(2) of the Alaska Native Land Claims Settlement Act. Normal Bureau funds were augumented by special congressional appropriations. Time limitations and rigid personnel ceilings made it necessary to supplement Bureau of Mines work with studies by university personnel, private consultants and consulting firms.

This report was prepared by C. C. Hawley and Associates, a geological consultant firm of Anchorage, Alaska. The area described includes Mt. KcKinley National Park and proposed extensions on all sides. Hawley and Associates had previously examined and explored mineral deposits and mineral trends in the study area and in adjacent lands. They also acquired much data from other firms. This was supplemented by intensive field investigations in the proposed additions. Field investigations within the present park boundaries were forbidden. This report includes all data available from government and industry sources and the new data resulting from the field studies.

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INTRODUCTION

1.0 General

The Mount McKinley project, funded by U.S. Bureau of Mines contract no. J0166107, is one of a series of special U.S. Bureau of Mines studies done in order to appraise the mineral potential of lands in Alaska. The total land involved in the project was in excess of seven million acres, an area slightly larger than Maryland; project funds available totaled about $200,000.

A private industry type appraisal of a similar area would call for expenditures in excess of $1,000,000, and two or more seasons with full-time helicopter support.

Because of the short time available and scale of funding, the project was planned to essentially hit the high spots (excluding Mt. McKinley itself).

Regardless of limitation of funds and time, the contractor believes considerable progress was made toward appraisal of the area. Several factors contributed, including (1) concurrent U.S. Geological Survey studies of the Mt. McKinley area conducted by Dr. Bruce L. Reed and his associates, (2) study of the Kantishna area by T. L. Bundtzen of the State Survey (Bundtzen, Smith, and Tosdal, 1976), (3) availability of some industry information, (4) contractor experience in the area, and (5) good weather.

Because of possible conflicts between a private contractor and public agencies, the bulk of the new U.S. Geological Survey information was not available to this project. Nonetheless, Dr. Reed could and did furnish ideas about the geology, which significantly aided our study efforts, and it is believed that the melding of the material determined by our investigations and that of the U.S. and state geological surveys to be released in the near future, will allow a good first view of the mineral potential of the entire area. Undoubtedly there are many undiscovered deposits, but the discoveries made by us, the U. S. Geological Survey, and the State Division of Geological and Geophysical Surveys do indicate definite mineral favorable zones--some of which were not known or well understood before the very recent period of geologic studies.

1.1 Location, Geography, and Accessibility

The lands involved in this study are mainly in the Healy, Mt. McKinley, and Talkeetna 1:250,000 scale quadrangles in south-central Alaska surrounding Mt. McKinley National Park. Adjacent to the peak on its north, south, and west sides is a 3.8 million acre tract of land withdrawn under Section 17 (d) (2) of Public Law 92-203 for possible addition to the park. This (d) (2) area and the park are in turn enclosed in a 4.0 million acre region which has been considered for cooperative management between federal agencies and the State of Alaska. Both (d) (2) and Comanagement regions shown combined in fig. 1-1, and separated

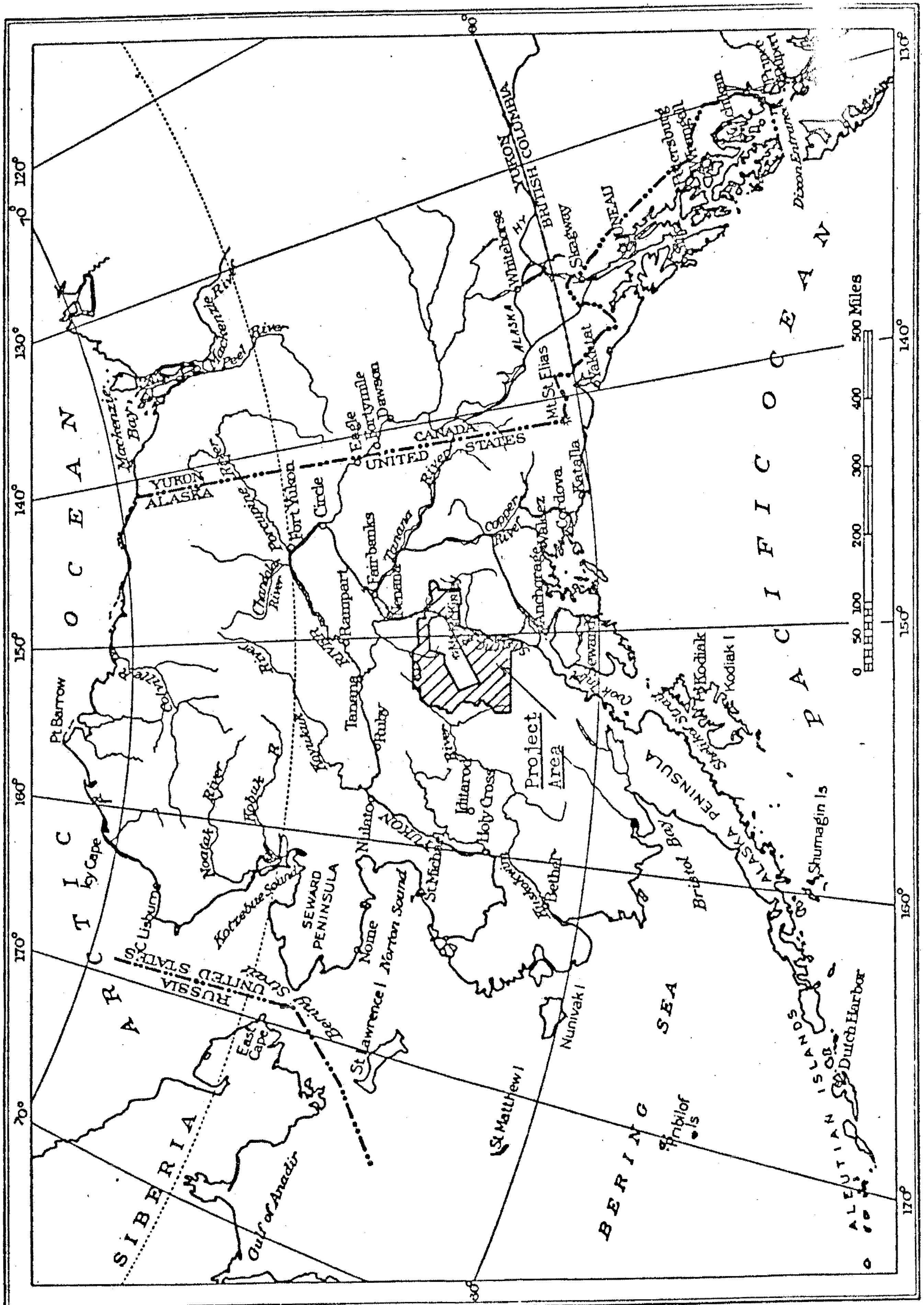


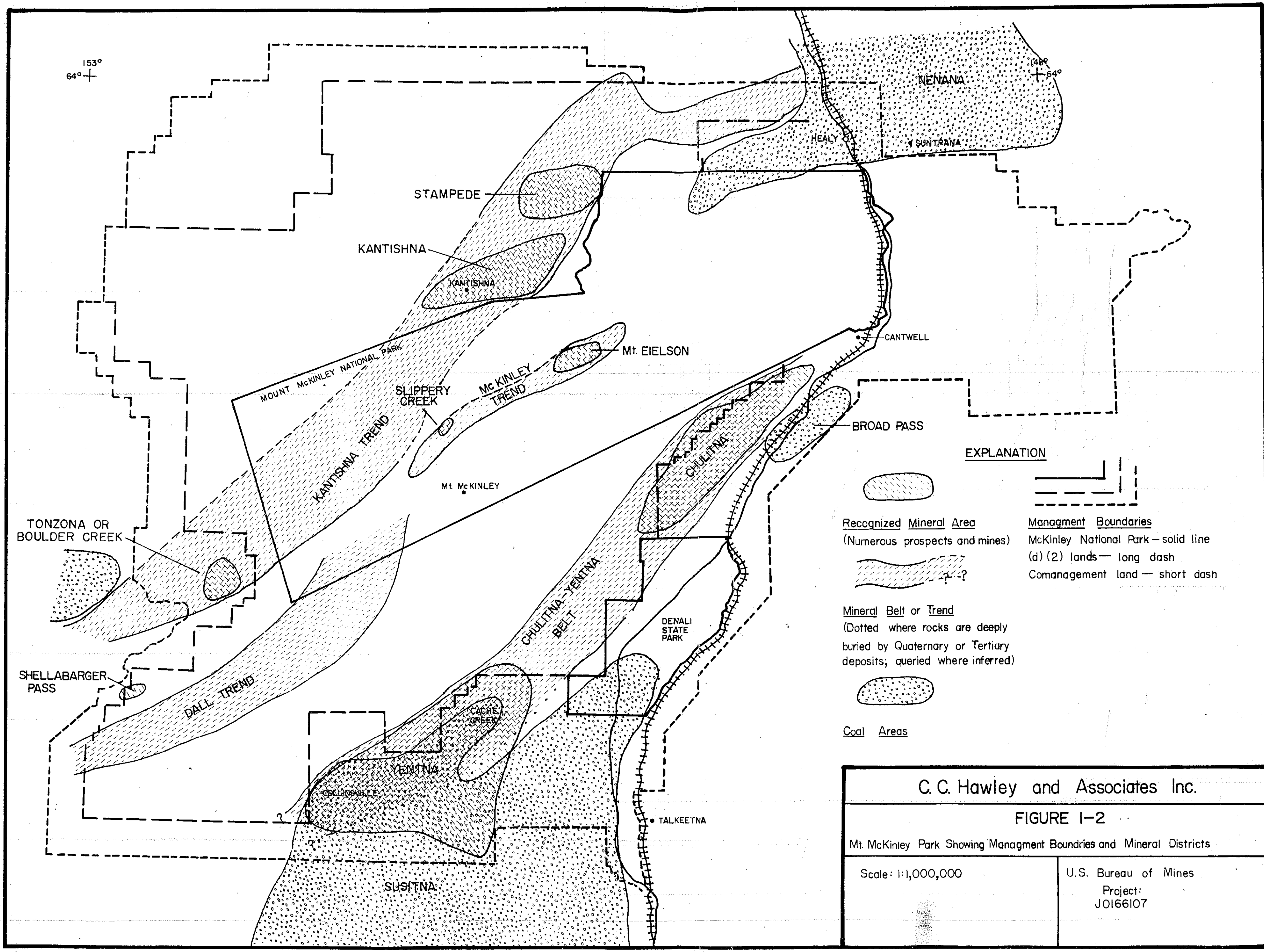
FIGURE 1-1 General Location of McKinley Project (USBM J0166107)

in fig. 1-2, contain mineralized districts, and potential mineral districts in unexplored areas.

This region expresses its tectonically active history in a great variety of scenery. The land ranges from the extremely rugged snow-capped mountains and glacier-filled valleys of the Alaska Range to the gentler slopes and broader valleys of the Kantishna, Peters, and Dutch Hills and other foothill ranges. It also includes lakes and wetlands on the northern flank of McKinley--where ancient moraines and outwash plains cover bedrock west of the Kantishna Hills west to near Castle Rocks, and north to near Lake Minchumina.

A mineralized region corresponding partly to the old Kantishna Mining District (fig. 1-2) and including several historic mining areas or mineral rich regions, is in the foothill region along the northern flank of the west-central Alaska Range just west of the Toklat River. Historic mining areas near Kantishna and Stampede are in the Kantishna Hills, a range of low mountains in the irregular reentrant in the north boundary of McKinley Park. Elevations in the generally rounded mountains range from about 1000 to 2000 feet in the major creeks to over 4000 feet along the ridges with Kankone Peak, the highest point at 4987 feet.

A blanket of tundra covers the Kantishna Hills at higher elevations and brush, locally very dense, grows along the slopes and in the valleys. There are also some good stands of timber at the lower elevations. The main access to the area is by a 90-mile gravel road through McKinley Park that connects to the



C. C. Hawley and Associates Inc.

FIGURE 1–2

Mt. McKinley Park Showing Managment Boundries and Mineral Districts

Scale: 1:1,000,000

U.S. Bureau of Mines
Project:
J0166107

Parks highway, a number of gravel air strips, and winter trails from the north and from the east near Healy. From Kantishna, dirt roads suitable for four-wheel drive vehicles extend about ten miles northeasterly into the hills. A winter haul road, used in the 1930s and 40s, extends from Stampede to the railroad, 56 miles to the east. Parts of this road were improved in 1960 by the state, but it is not used much by the local miners and is largely overgrown and in places sloughed.

The Chulitna area (fig. 1-2) is on the southeast flank of the west-central Alaska Range. It is southwest of Broad Pass and includes the western tributaries of the West Fork of the Chulitna River from the Bull River in the northeast to Partin Creek in the southwest. The area includes both lower hills with broad valleys, and steep, rugged mountains with large glaciers. Elevations range from 2000 feet in the major creek and river valleys to over 5000 feet on the ridges and over 6000 feet on the mountain peaks. It is part of a mineral belt or trend recognized by Hawley and Clark (1973).

Timberline in the Chulitna district is at about 3500 feet and brush is locally heavy. The area is an average distance of ten to twenty miles west of the Alaska Railroad and the Parks highway. The northern part of the area near the Golden Zone prospect was formerly accessible by a road that is now badly overgrown, and three of its main bridges are out. There are short gravel airstrips along the West Fork of the Chulitna River, at the Dunkle Coal mine north of the West Fork, and on ridges and gravel bars elsewhere. Further access is limited to trips on foot or a helicopter.

The Cache Creek, Collinsville, and Kahiltna areas comprise the main part of the Yentna district (fig. 1-2) and include the Dutch, Peters, and Little Peters Hills and Fairview Mountain. These hills are part of the foothill range along the southeastern flank of the west-central Alaska Range between the Tokositna and Yentna Rivers. The creeks from the northeast-southwest trending Dutch and Peters hills drain into the Kahiltna and Tokositna Rivers. The creeks from the Fairview Mountain area drain into the Kahiltna and Yentna Rivers. Relief is almost 3000 feet with elevations ranging from 2000 feet in the creeks to 3000 or 4000 feet on the ridges with the highest peak at 4699 feet. The vegetation is mostly tundra and brush. A 35-mile gravel road extends from the Parks highway to Petersville and dirt roads suitable for four-wheel drive vehicles lead to many of the tributaries of Peters and Cache Creeks.

The Dall trend (fig. 1-2) is within the Alaska Range. Its southeastern boundary extends from near the head of the Kahiltna Glacier southwestward to near the Kichatna River. Its northern limit is defined geologically by the McKinley strand of the Denali fault. It is a spectacular area of extremely rugged and steep mountains and abundant glaciers. Total relief is over 10,000 feet. Elevations range from 1000 feet in the major river valleys to over 6000 feet along the ridges with the highest peak, Mt. Russell, at 11,670 feet. The area is virtually barren of vegetation. Access to most of it is limited to helicopter or expeditions on foot. Nearby, though, there are a few lakes, including Chelatna and Midway, suitable for a fixed-wing aircraft on floats, and fixed-wing aircraft with wheels can land on some of the gravel bars of the Yentna River.

The Tonzona or Boulder Creek area (fig. 1-2) is located near the southwest corner of Mt. McKinley Park. Geologically, the Boulder Creek area coincides partly with a granite body enriched in tin and beryllium, but it is within an older metaliferous series of weakly--metamorphosed sedimentary and volcanic rocks of similar age to Kantishna rocks and inferred to be part of the same mineral trend. The creeks drain into the Tonzona River and the Swift Fork of the Kuskokwim River. This area is in steep, rugged mountains along the north slope of the Alaska Range. Elevations range from 2000 feet and 3000 feet in the creek bottoms to over 6000 feet along ridges with the highest peak in the area at 7905 feet. Scrub timber and brush cover the ground to around 3000 feet and tundra to around 4000 feet. Above 4000 feet the ground is generally bare. Access to the area is provided by two good gravel airstrips and several smaller bush airstrips. There is a dirt road suitable for a four-wheel drive vehicle from one of the airstrips to a base camp and cat trails from the camp to a couple of prospects. Further access to the area is limited to backpacking trips or a helicopter.

The geologic Minchumina basin, whose boundaries are imperfectly known, is in the lowland region generally northwest of Mt. McKinley Park. The land gently slopes north away from the Alaska Range toward Lake Minchumina. It is an area of very little relief with low, rolling hills. Elevations average under 1000 feet. The land is extremely wet and marshy. In this area, creeks and rivers often sink out of sight and tundra and low brush abound. Access is provided by an FAA-maintained airstrip at Lake Minchumina and various lakes suitable for a fixed-wing plane on floats.

1.2 Mining Activity

KANTISHNA AREA: Except for some of the extremely rugged country near Mt. McKinley, most of the McKinley region has been prospected on at least a limited scale, and mines have been developed in the Kantishna, Chulitna, and Yentna areas, with a substantial number of prospects found in the Mt. Eielson region in Mt. McKinley National Park and in the Boulder Creek or Tonzona area west of the park.

In 1903 the Wickersham party noted gold in the stream beds of the Kantishna Hills on their unsuccessful attempt to climb Mt. McKinley. In 1905 two separate parties of prospectors, Joe Dalton, with his partner Stiles, and Joe Quigley with Jack Horn, found gold in the Kantishna Hills and staked it. The news of these discoveries got out, and by late summer of 1905, the area was deluged with several thousand prospectors. They soon discovered that the rich ground was limited, and by 1906 only fifty people remained. The placers continued to be worked on a small scale with increased activity in the depression years prior to World War II, especially on Caribou Creek. Like most Alaska districts, mining decreased after the war and did not show any tendency to stabilize until the advent of a free market for gold. Activity has increased in recent years with the rising price of gold, and in 1976 there were about eleven placer operations ranging from small-scale mining using hand methods, to larger operations using heavy equipment and processing over 1000 yards per day.

It is estimated that between 45,000 and 50,000 ounces of gold have been produced from the placers in the Kantishna and Stampede areas. (Koschmann and Bergendahl, 1968; Cobb, 1974.)

Lode prospects were located soon after the placer deposits. Between 1904 and 1916 Capps (1919A) recognized more than sixteen lode prospects with 1376 feet of underground workings. By 1930 at least fifteen new prospects, and about 1112 feet of new underground workings were reported (Wells 1933).

From 1919 to 1923, at least 1435 tons of high-grade lead-silver ore was mined from Quigley Ridge and the Alpha mine respectively northeast and northwest of Kantishna. From 1939 to 1942 a gold-quartz lode deposit was mined at the Banjo mine; about 13,653 tons of ore containing 6,259.9 ounces of gold and 7,133.8 ounces of silver was mined from 1939 to 1941 (Bundtzen and others, 1976).

The most recent Kantishna production was in 1973 when a 35-ton/day flotation mill was installed and about 120 tons of low-grade lead-silver ore was mined from the Gold Dollar and processed. This brings the recorded total lead-silver ore production up to 1655 tons of ore containing 257,965 ounces of silver, 449 ounces of gold, and 504,760 pounds of lead (Bundtzen and others, 1976).

Antimony ore has been mined at various times beginning in 1905 and continuing until 1974 at the Stampede mine, Slate Creek mine, Last Chance Creek mine and on Eureka Creek. Most of the ore has come from the Stampede mine between 1937 and 1970. Total production has been about 4511 tons of high-grade antimony ore containing about 2,284.89 tons of antimony (Bundtzen and others, 1976).

MOUNT EIELSON AREA: The first claims on the Mt. Eielson lead-zinc deposit in Mt. McKinley National Park were staked in 1920 by J. B. and Fannie Quigley. More claims were staked later that year and the two following years. Since then, the claims have been allowed to lapse, have been restaked, and let lapse again. Outside of three short adits and many pits, there has been little development and no production (Moffit, 1932; Reed, 1933; Wahrhaftig and Gates, 1944; Muir, Thomas, and Sanford, 1947).

CHULITNA AREA: The first placer gold in the Chulitna area was discovered in 1907 by John Coffee on Bryn Mawr Creek. The first lode deposit, the Golden Zone, was discovered in 1909 (Capps, 1919B). In subsequent years there was much prospecting and more lode deposits were discovered and developed by pits, trenches, and underground workings. From 1911 to 1915 Frank and Lon Wells worked coal beds in the Dunkle area to use on their prospect on Costello Creek and other prospects in the basin of the West Fork of the Chulitna River. In 1929 the first coal prospecting permit was issued for production to meet local needs (Rutledge, 1948).

By 1930 the prospecting and mining activity in the area had slowed and only one claim filed assessment work in that year (Ross, 1933; Capps, 1919; Capps, 1933). In 1939 the coal prospecting permit was reissued and the Dunkle mine produced about 5000 tons during 1941 and 1942 (Rutledge, 1948). Also in 1941 and 1942 the Golden Zone mine produced 869 tons of concentrate from about 10,000 tons of ore containing 1581 ounces of gold, 8617 ounces of silver, 21 tons of copper, and 2970 pounds of lead (Mulligan, Warfield, and Wells, 1967). Since then there has only been further exploration.

YENTNA AREA: The Yentna area is mainly known for its placer deposits. Placer gold was first discovered in the Peters and Cache Creek areas in 1905 and in the Collinsville area in 1906 (Capps, 1913B). Further prospecting and mining was done and in 1916 a dredge was installed on Cache Creek and operated in subsequent years (Mertie, 1919). Mining continued with minor changes in the level of activity in the 1930s and early 1940s, with extensive mining during the later part of this period on Peters Creek. Mining continued on Cache Creek and in the Dollar Creek area, but most other operations stopped in the 1950s and 1960s, except for small-scale work on Bird, Cottonwood, and Willow Creeks (Renshaw, 1973). Mining activity increased again starting in 1974 and in 1976 in the Peters and Cache Creeks area there were at least eight placer operations ranging from small-scale mining using hand methods, to larger operations using heavy equipment. Total gold production from the area is estimated to be over 204,000 ounces, with a maximum of 10,788 ounces in 1922 (Hawley and Clark, 1968A).

Although essentially all production has been from placer mines in the Yentna district, there are around five or six lode prospects in the area which were probably located before 1940. They have been prospected by some pits and by short underground workings (Hawley and Clark, 1968A). Sometime in the late 1950s "Shorty" Bradley, a local placer miner, installed a ball mill and amalgamation cell on the Upper Bird Creek gold-scheelite prospect (Robson, 1974).

TONZONA OR BOULDER CREEK AREA: Between 1921 and 1923 Adolph and Charles Mespelt and F. B. Jiles and Ed Knudson discovered and worked on their prospects in the Purkey area. Activity in the area then ceased until 1947 when I. W. Purkeypile started to prospect. Since then the Purkey (changed from Purkeypile) family has acquired the claims and discovered the Hogback prospect (Maloney and Thomas, 1966). Since 1970 the discovery of rich tin ore at the prospect caused renewed activity, including a drilling program near the Jiles-Knudson prospect.

1.3 Previous Studies of Geology and Economic Potential

Although geologic studies have been made in the McKinley area since 1898 (Table 1-3), essentially all the work has been of reconnaissance nature, and few definitive studies have been made. Still, a picture of geologic framework has gradually emerged, and studies in progress by B. L. Reed, G. Bundtzen, Wyatt Gilbert, and University of Wisconsin Students and

Year of Study	Author of Report	Date of Report	Brief Description of Study
1898	G. H. Eldridge and Robert Muldrow	1900	Made surveys south and east of Mt. McKinley National Park along the Susitna, Chulitna, Jack and Nenana Rivers.
1898	Sgt. Wm. Yanert (Compilations of narratives . . . 1900)	1900	
1902	Brooks	1911B	First accurate survey in the McKinley region. Mapped topography and reconnaissance geology.
1906	Prindle	1907	Studied placer activity in the Kantishna and Bonnifield areas. Recognized major rock units.
1911	Capps	1913A,B	First systematic investigation in the Yentna area. Mapped topography and geology and described the placer deposits of the Kahiltna River Valley.
1913	Moffit and Pogue	1915	Mapped topography and reconnaissance geology from Broad Pass east to the West Fork Glacier.
1916	Capps	1919A	Examined lode deposits and placers in the Kantishna area. Mapped topography and geology along the north flank of the Alaska Range from the Nenana River west to the Muldrow Glacier and the Kantishna Hills.
1916	Overbeck	1918	Examined lode deposits near Nenana coal fields.
1917	Capps	1919B	Examined prospects in the basin of the West Fork of the Chulitna River, the Ohio Creek basin and the Broad Pass mining district. Mapped some geology.
1917	Mertie	1919	Studied placer mining in the Kahiltna River valley, including the Cache and Peters Creek area.

TABLE 1-3 SUMMARY OF GEOLOGIC WORK, MT. MCKINLEY AREA

(Table 1-3)

Year of Study	Author of Report	Date of Report	Brief Description of Study
1920-1923	Davis	1920, 1922, 1923	Examined lode deposits of the Kantishna area.
1923	Capps	1925	Studied the Yentna district.
1925	Capps	1927	Mapped geology along the northern flank of the Alaska Range between the Toklat River and the western edge of the Kantishna Hills.
1930	Capps	1933A	Worked in the Eastern part of Mt. McKinley National Park.
1930	Moffit	1932	Reported in detail on the Kantishna area.
1931	Wells	1933	Reported in detail on the Kantishna area.
1931	J. L. Reed	1933	Examined the lead-zinc deposits of Mount Eielson.
1931	Ross	1933	Detailed map of geology and mineral resources of the West Fork of the Chulitna area.
1932	Tuck	1934	Mapped topography and reconnaissance geology in the Curry district.
1941	White	1942	Mapped and examined the Stampede mine and the surrounding 25 square miles.
1942,43	Ebbley and Wright	1948	Studied the antimony deposit at the Stampede mine.
1943	Muir and Thomas and Wahrhaftig	1947 1944	Examined the lead-zinc deposits of Mount Eielson.
1943	Rutledge	1948	Examined the Dunkle Coal Mine.
1944	Barnes and others.	1951	Mapped Healy Creek from Sutrana eastward.

(Table 1-3)

Year of Study	Author of Report	Date of Report	Brief Description of Study
1945	Robinson and others	1955	Studied the radioactivity of the placers in the Yentna area.
1944-58	Wahrhaftig and others	1968,1969	Studied the schists of the Central Alaska Range and the Nenana coal field.
1947-51	Moxham and others	1959	Examined the Windy Creek area.
1950,1951	Mulligan and others	1967	Studied the Golden zone mine in the Chulitna area.
1950,59,64	Maloney and Thomas	1966	Examined the Purkey prospect.
1951,1952	Rutledge and others	1953	Study on the nonmetallic deposits along the railroad belt.
1960,1962	Seraphim	1961, 1962A,B	Examined the lode deposits in the Kantishna area.
?	J. L. Reed	1961	Summaried all available information on the Mt. McKinley quadrangle.
1961	Laird	1962A,B	Studied the Twin Creek mines property in the Collinsville area.
1961	Chadwick	1962	Examined the Purkeypile prospect.
1961,1962	Barnes	1966	Studied the geology and coal deposits of the Beluga-Yentna region.
?	Berg and Cobb	1967	Reported on the netalliferous lode deposits of the West Fork of the Chulitna River.
late 1960's and 1970's	B.L. Reed and Eberlein B.L. Reed and Elliot B.L. Reed and Lanphere	1972 1968 1969,72,73,74	Studied and mapped parts of the southern flank of the Alaskan Range. Described Shellabarger Pass copper-zinc deposits.

(Table 1-3)

Year o tudy	Author of Report	Date of Re t	Brief Description of Study
late 1960's and 1970's	Hawley	1971,72,73AB, 74	Extensive study and mapping in the Yentna and Chulitna areas.
	Hawley and Clark	1968A,B,1969, 73,74	
	Hawley and Clark and Benfer	1968	
	Hawley and others	1969	
	Clark and Hawley	1972	
1970	Stanley	1971	Examined the Purkey prospect.
1971	Bryant and others	1971	Detailed results from reconnaissance exploration program in the Upper Chulitna area by RAA.
1971	Cobb and Clark and Cobb	1972A,B 1972A,B	Compiled metallic mineral resource maps for the Mt. McKinley, Healy, Talkeetna and Talkeetna Mountains quadrangles.
1971	ADGGS	1973A,B,C	Aeromagnetic maps for the Healy, Talkeetna and Talkeetna Mountains quadrangles.
1972,73,74	Gutrath	1973,1974A,B	Examined the Collinsville area.
1972,73,74	Renshaw	1973,74,75	Examined in detail Peters Creek and its tributaries. Also worked in the Collinsville area.
1975	Chadwick	1975	Reported on the prospects in and around Mt. McKinley National Park, mainly in the Kantishna area.
1975	Bundtzen and others	1976	Examined mineral deposits and mapped in the Kantishna, Stampede and Chitsia areas.

faculty led by Campbell Craddock promise to resolve the main elements of the geologic picture. None of the area has received the type of detailed study formerly focused on mining districts in the Lower 48.

1.4 Description of This Project

Because of the time and funding constraints on this project, two main approaches were planned: (1) A semi-detailed examination of known mineralized areas by foot traverse, with detailed geological, geochemical, and geophysical studies of local mineralized areas; (2) A reconnaissance survey of the almost completely unknown southwest part of the area, with initial search for color anomalies by fixed-wing aircraft, and follow-up by helicopter of color anomalous areas, or areas of contact, suture type geology; (3) Local spot examinations of other areas.

In the semi-detailed approach, data was plotted on 1:24,000 scale enlargements of sections of 1:63,360 U.S. Geological Survey quadrangle maps. No attempt was made to systematically map geology, but rock types encountered were plotted and reconnaissance geological maps made in any area systematically examined for mineral potential.

Areas studied by this approach were:

1. Kantishna area
   - A. Kantishna mining area
   - B. Stampede mining area
   - C. Chitsia Mountain area
2. Tonzona or Boulder Creek Mining Area
3. Yentna District-Cache Creek area

4. Chulitna area

   A. Northern or Golden Zone-Bull River area
   B. Southern or Ohio Creek-Partin Creek-Coal Creek area

The most detailed studies were made in the Kantishna and Stampede areas, followed in order by Tonzona, and Cache Creek, and Ohio Creek areas. Economic data on the Yentna district were compiled from an exhaustive literature and field examination by Renshaw (1973,1974,1975). Data on the Golden Zone-Bull River was mainly after industry information or 1:6000 U.S. Geological Survey mapping.

In the reconnaissance survey, the most work was conducted in the Dall trend southwest of McKinley, but most of the south flank of the range was flown and mapped on 1:63,360 maps from fixed-wing aircraft.

In addition to the detailed ground studies and search for color anomalies from the air, radioactivity measurements were made from the air in the northwestern part of the Mt. McKinley quadrangle and locally on the ground in the Kantishna and Tonzona area.

Six people were assigned to the project; each had specific areas of responsibility--either in area or type of work. Field project chief was Carl D. Hale. Geoff Garcia was senior geologist. D. L. Hawley acted both as geologist and geophysicist, and Barbara Alaska Purdy was a project geologist. Georgia Bewley Hale worked both as a geologist and managed literature research and compilation of prospect data. Charlotte Kautzer worked as a field assistant and geochemical analyst, making analyses of soil and stream sediment samples by either Holman buffer or biquinoline copper complex field methods. The project was supervised generally by C. C. Hawley.

All samples collected by the project were also analyzed by Skyline Labs, Inc. at Anchorage or Denver by atomic absorption geochemical or semi-quantitative spectrographic techniques. Much of the data available to the project from private sources were transmitted to the Bureau of Mines in an interim report (C. C. Hawley and Associates, Inc., 1976).

1.5 Acknowledgments

Many people aided the project--either with geologic information, or with logistics support. Three people contributed most to our understanding of the complex geology of the area. These people were B. L. Reed of the U.S. Geological Survey, and Wyatt Gilbert and Tom Bundtzen of the Alaska Division of Geological and Geophysical Surveys.

In each of the mining areas, we had universal cooperation from the mine owners and prospectors. Specifically, in the Kantishna district, we would first of all like to acknowledge the Dean of Alaska Mining Engineers, Earl Pilgrim. Earl has done field work and mining in the Kantishna area since 1929. He operated the Stampede mine, and has made engineering reports on many of the mining properties in McKinley Park and in the Kantishna mining district. Mr. Pilgrim also furnished us accommodations at Stampede, Alaska. Others who helped us in

the Kantishna district include Jim Fuksa, Bud McClain, the Wieler brothers, and Sam and T. J. Koppenberg. In the Boulder Creek or Tonzona area, we stayed at Clark Engle's hunting camp and used other facilities furnished by David Purkey.

In the Yentna district four mine owners or operators furnished much of the detailed information. These people are Phil Brandl, Bob Young, John Jacobsen, and Ann Van Dolah. Compilations of existing engineering studies by Levake Renshaw (1974, 1975) were the main source of reserve and resource data for the placer gold deposits of the Yentna district.

D'Arcy Banister served as the U.S. Bureau of Mines coordinator for the project, and aided in the field investigations. Bob Larson flew the helicopter and occasionally fixed-wing and contributed to the success of the project in the rugged country around Mt. Dall.

CHAPTER 2

GEOLOGIC BACKGROUND

2.0 General

The Mt. McKinley area is an extremely complex area geologically. Rocks range from at least early Paleozoic and possibly Precambrian to middle Tertiary in age, and include all major classes of rock units--igneous, metamorphic and sedimentary. In particular, the older rocks have been highly folded and juxtaposed by major fault systems.

The Denali fault system essentially dissects the area and divides the area into two major geologic terranes. The basement rocks north of the fault are at least as old as lower-mid Paleozoic; the basement south of the fault is more likely Permian in age. Rocks on both sides of the fault are highly folded and both sequences were involved in major mountain building activities in Lat Cretaceous-Tertiary time.

Reed and Lanphere (1973) have recognized three periods of granitic intrusive activity, corresponding to Later Cretaceous, Early Tertiary and mid-Tertiary time. These periods of intrusive activity followed episodes of Paleozoic volcanism, including rhyolitic deposition in mid-Paleozoic time and basaltic volcanism in the Pennsylvanian and Permian. Subsequent to the early sedimentation, mountain building and plutonism, gentle warping accompanied and succeeded the development of local continental basins, which are locally the sites of coal deposits.

Correlating with the complex sedimentary, structural and igneous periods represented in the area are mineral deposits; it is clear that the McKinley area is strongly mineralized, and that there are concentrations of metallic mineral deposits which can be identified in mineral belts or trends.

2.1 Major Structural Relationships

The Denali Fault System has long been recognized as a major structural element in Alaska, essentially dividing an older terrane in northeastern Alaska--with an early Paleozoic-Precambrian basement--from a younger terrane south of the fault with a late Paleozoic basement (Richter and Jones, 1973).

In western Alaska, older Paleozoic basement is both north and south of the fault, and the break between Pennsylvanian-Permian and older basement in the McKinley region is on the south side of the fault (structural index map, fig. 2-1). These breaks, such as the one in eastern Alaska, appear to be--or nearly coincide with--ancient plate contacts. Such breaks and related deep fault zones appear to be fundamental to metallogeny.

The Denali fault has two main branches in the McKinley area (fig. 2-1) (Grantz, 1966). The McKinley Strand is the more recent structure, and it is not a fundamental break in the sense of dividing rocks with appreciably different basements. This structure has been active since middle Tertiary time with about 38 km of right lateral strike-slip motion movement in the last forty million years (Reed and Lanphere, 1974). The northern or Hines Creek strand is the older and more fundamental break; this strand has not been active in a major sense since pre-Tertiary time, as it is effectively buried in the McKinley area by the Paleocene Cantwell Formation which does not show evidence of major faulting.

The rocks north of the Hines Creek segment are of the Yukon Crystalline Terrane (Templeman-Kluitt, 1976) which is a complex group of weakly metamorphosed rocks of Precambrian (?)-Paleozoic age locally covered by Mesozoic or younger basin deposits. The Yukon Crystalline Terrane lies between the Denali-Shakwak fault systems and Tintina fault. It includes rocks previously mapped as Birch Creek Schist, Keevy Peak Formation, and Totatlanika Schist in the McKinley area. Templeman-Kluitt and others have postulated that both boundary faults (Denali and Tintina) show right lateral displacements of as much as 350-400 km. For example, the boundary between crystalline rocks and less metamorphosed rocks of similar age exposed about 25 miles north of Fairbanks and in the area near Lake Minchumina (fig. 2-1) may represent a 360 km displacement of rocks of the MacKenzie and Selwyn fold belts of the Yukon Territory.

In the McKinley area, the Yukon Crystalline Terrane (or Yukon Complex) occupies a nearly triangular area bounded on the south by the Hines Creek Strand, and on the north by a concealed fault postulated to lie between crystalline and noncrystalline Paleozoic rocks just east of Lake Minchumina. It thus underlies most of the northwest one-third of the McKinley area, and it contains at least two widely-mineralized units--the rhyolitic Totatlanika Schist and the slightly older carbonaceous shales and limestones of the Keevy Peak and Birch Creek.

The course of the Hines Creek Strand westward from near Healy is concealed by Cantwell Formation and its westward correlative is uncertain. It is postulated here, however, that it makes an abrupt southwestward bend near 151° west longitude, intersects the McKinley Strand of the fault, is displaced westerly 35-40 km and emerges on the south side of the McKinley Strand, as what is called here the Dall Fault, which is the south boundary of an extensive group of Paleozoic rocks exposed south of the present active strand of the Denali Fault system.

An alternative solution would be that the Hines Creek Strand continues southwestward to the Boulder Creek or Tonzona intrusion, and it is certain that an important fault does continue in this direction and was intruded by the Tonzona granite stock. In any event, the important fact is that an extensive tract of locally metalliferous Paleozoic rocks lies south of the "Denali Fault" (between the Dall Fault and McKinley Strand).

The area between the Hines Creek and McKinley strands contains rocks of middle and upper Paleozoic age, with units at least as old as Devonian extensively covered by the Cantwell Formation of Tertiary age. Rocks south of the Dall Fault and the McKinley Strand are dominantly middle-late Mesozoic graywacke-argillite, but a slice of Permian-Triassic oceanic crust (?) is faulted into this sequence in the Chulitna area (Clark, Clark and Hawley, 1972). These rocks, which include redbeds, limestone, basalt, and serpentine, are bounded on the east by a fault which appears to be part of a regional series of northeast-striking faults which are a fundamental control of mineralization in the Chulitna-Yentna belt (Hawley and Clark, 1973).

2.2 Rock Series of Economic Interest

Within the broad groups of igneous, metamorphic, and sedimentary rocks of the McKinley area (fig. 2-1), certain types are of specific significance to the economic geology, and include rock units like coal-bearing series and cement-quality limestone. They also contain marine sedimentary or volcanic layered rocks and igneous rocks which are characteristically enriched in certain trace elements.

Rocks which characteristically contain relatively high contents of trace elements are at many places metallized. For example, Triassic basalt units of east-central Alaska contain more copper than do most associated rocks, and they and their immediately overlying strata contain many copper deposits. Because of this and similar associations, abnormally metalliferous series are sought out in mineral evaluation programs. An attempt has been made here to identify such rocks, and they are plotted in generalized form in fig. 3-0.

Trace metal-rich series occur in the layered rock units in (1) all three major units of the Yukon Crystalline Terrane (Birch Creek Schist, Keevy Peak Formation, Totatlanika Schist),

(2) other lower-mid Paleozoic rocks, and (3) in the Upper Paleozoic-Triassic series best exposed in the upper Chulitna district; they also include at least three series of granitic rocks of Cretaceous-Tertiary age.

Cement quality limestone occurs locally in both the Devonian and Triassic rocks units. Important coal deposits are of Tertiary age, and are preserved in intermountane basins both north and south of the Denali Fault.

A. Paleozoic-Mesozoic Layered Series

Characteristically metalliferous series are found in the "Birch Creek," Keevy Peak, and Totatlanika sequence of the Yukon Crystalline Terrane, in carbonaceous shales of similar aged noncrystalline rocks, in the Triassic volcanics best exposed in the Chulitna belt, and in ophiolitic mafic units of several sequences. Certain other units like the Paleozoic limestone and limestone pebble-cobble conglomerate of the Dall Trend seem favorable for tactite metallization near intrusive bodies.

1. Yukon Crystalline Terrane--In most of the older reports (Prindle, 1907; Moffit, 1932) the rocks of the Kantishna district were referred generally to the Birch Creek Schist with some to the metavolcanic-rich Totatlanika series. More recent and detailed work, as by Wahrhaftig (1968, 69), Bundtzen, Smith, and Tosdal (1976) and work in progress by Robert Forbes, Wyatt Gilbert, and B. L. Reed near the area, and by Helen Foster and Florence Webber in other parts of the crystalline terrane shows that there is a large range in both rock types and metamorphic history of the Yukon Complex, and that, in particular, Birch Creek Schist, as originally defined, covers a great variety of rock types and ages. Nevertheless, schistose rocks of the Kantishna are familiar to the miners as Birch Creek, and it does

appear possible to make a crude subdivision of Kantishna stratigraphy into three units which are called here: Birch Creek Schist, Keevy Peak Formation, and Totatlanika Schist.

The Birch Creek Schist of the district is mainly a metasedimentary series originally deposited in near shore to marginally closed marine basins as feldspathic sandstone, carbonaceous limestones, and calcarous-argillaceous sandstones. These sedimentary units are now recrystallized limestones with varying carbon content, black graphitic phyllites, quartz-mica schists--some of which are garnetiferous, and calc-schists. Locally there are sericitic or feldspathic schists which could be rhyolitic volcanics; such units are minor in the Birch Creek--but are possibly of economic interest.

The schistose rocks and crystalline graphitic limestones form the core of the Kantishna mining area and persist northward in the district into the Stampede and Chitsia Mountain areas (figs. 4.1-A(1); 4.1-A(2), and 4.1-A(3)). Metalliferous series in the group are the carbonaceous limestones and graphitic or carbonaceous shales--which are enriched generally in silver, zinc, and molybdenum, and in felsic units which may be metarhyolites, enriched in zinc, uranium, and gold.

The Keevy Peak Series correlates generally (Bundtzen, 1977, communication) with typical Keevy Peak rocks of the Bonnifield district (Wahrhaftig, 1968 and 1970A,B,C and D). The series includes limestone argillites, phyllites, pebble conglomerates, and highly graphitic and pyritiferous black phyllites. It apparently overlies the Birch Creek in the Stampede mining area (fig. 4.1-A(2)), and increases in quantity relative to the Birch Creek lithology northward in the Kantishna district. Metal-rich units are gold (?), zinc, silver, and molybdenum bearing and are in the graphitic units.

The Totatlanika series overlies or intergrades with carbonaceous units of the Keevy Peak, and, as recognized by Wahrhaftig, is dominantly metarhyolite. Locally it contains fossiliferous limestone and was provisionally assigned to Mississippian by Wahrhaftig (1968), although the reference fossil is a wide ranging lower-mid Paleozoic form. The metarhyolities of the Chitsia Mountain area range from massive coarsely porphyritic or porphyroblastic metarhyolites to fine-grained felsic tuffs. The finer-grained series is locally metalliferous, and the entire unit has potential for stratiform volcanogenic deposits of base metals and gold. The Totatlanika predominates in the northern part of the Kantishna mining district.

2. Non-crystalline Lower-Mid Paleozoic Rocks--Geographically, argillites, cherts, and limey units of Paleozoic age are exposed northwest of the Yukon Complex, in the interval between the McKinley and Hines Creek segments of the Denali Fault, in the interval between the Dall Fault and western McKinley segment of the Denali Fault, and in a small area south of the McKinley Stra[illegible] in the Reindeer Hills.

The relation of these rock units to the rocks of the Yukon Complex is uncertain, but they are apparently partly contemporaneous.

Metalliferous series include carbonaceous argillites or shales exposed in the Tonzona area (figs. 4.2-C and 4.2-C(3)c) and in the southern part of the Dall Trend (fig. 4.1-C(3)). Devonian limestone within the series is locally of cement quality. Such units lie near the McKinley Strand of the Denali Fault in the Windy Pass, Foggy Pass, and northern Reindeer Hills areas (fig. 4.0-C).

Copper-bearing basaltic volcanics of Paleozoic age occur within the dominantly sedimentary series in the Shellabarger Pass area (4.1-D), and probably Cretaceous basalts are in the extreme western part of the McKinley area north of the McKinley Strand of the Denali Fault (figs. 4.0-B).

3. Upper Chulitna District--This district on the southeast flank of the Alaska Range is localized by a major northeast structural zone. Early studies, following mineral discoveries by John Coffee and the Wells brothers, by Capps (1919B) and Ross (1933) outlined a very complex zone of Permian-Triassic sedimentary, volcanic, and volcanoclastic rocks faulted against argillites of the Broad Pass region. The district was remapped by Hawley and Clark (1968,A-B, 1969, 1973, 1974), and a major serpentinite zone was found on the east side of the district, which was initially considered as a late intrusion. Subsequently, studies by the Clarks (Clark, Clark and Hawley, 1972) led to the more likely conclusion that the serpentinite was part of a late Paleozoic ophiolite sequence. Further studies by Wyatt Gilbert and the University of Wisconsin geologists have

clarified the sequence of rocks, and crossing the district from southeast to northwest, the general structural-stratigraphic sequence would be:

(1) Graywacke-argillite of Mesozoic age

(2) Major high-angle reverse fault

(3) Serpentinite-chert-argillite ophiolite unit of probable Upper Paleozoic age

(4) Volcaniclastic and sedimentary red bed series, with local limestones, of Permian and Lower Triassic age

(5) Limestone sequence grading upward into basaltic and andesitic (?) volcanoclastic-limestone sequence of Upper Triassic-Jurrasic (?) age

(6) Graywacke-argillite of Mesozoic age--at least partly Lower Cretaceous

Metalliferous series of the area include the basal serpentinite, which is rich in chromium and nickel, and the basaltic rocks of Upper Triassic-Jurassic (?) age which have high background amounts of copper.

B. Igneous Series

The entire McKinley area is within the arcuate zone of igneous batholiths and stocks of Mesozoic, Tertiary age that crudely parallel the north Pacific Rim. Work by Reed and Lanphere (1969, 1972, 1973, 1974) have shown that three major series of granitic intrusives of 1) Jurassic, 2) late Cretaceous and early Tertiary, and 3) middle Tertiary age characterize the central and southern Alaska Ranges. The major plutonic intrusive members of this series in the McKinley area are equivalent to the (1) Yentna-type granodiorite series of late

Cretaceous-early Tertiary age, the (2) McKinley-type granite series of early Tertiary age, and (3) the Foraker-McGonogil granodiorite of middle Tertiary age. The McKinley type intrusives are the most abundant.

Late Cretaceous-early Tertiary intrusives of the Upper Chulitna district are chemically similar to the above plutonic rocks, but several have hypabyssal--rather than plutonic characteristics--namely porphyritic textures and explosion or stoping breccias. Tentatively the quartz diorite of the Golden Zone type is considered to be hypabyssal equivalent of Yentna-type rocks, and the small tourmaline-granite plugs to the McKinley type.

Within McKinley Park, the northern Talkeetna Mountains, and in the Healy area, Tertiary granitic magmas broke through to the surface forming extensive volcanic fields of rhyolite domes, ash-flows, and tuffs. Gilbert and others (1976) have defined one such unit--the Teklanika Formation of early Tertiary age in McKinley National Park; Wahrhaftig (1970A, B, C)--and mapped others in the Bonnifield district.

Units of the Yentna-granodiorite group are about 65 million years old and form composite intrusives or clusters of small intrusive bodies which range from ultramafic-through mafic-to intermediate compositions, with pyroxenite, gabbro, biotite gabbro, and granodiorite represented. One very characteristic unit in the Dall Trend is a porphyritic granodiorite with chatoyant orthoclase phenocrysts. Based on occurrences reported by Reed and Elliott in 1968, and on geochemical work done on this project, the Yentna-type intrusives have gold, copper, and nickel mineralization. Recent U.S. Geological Survey work also confirms the gold-rich nature of Yentna-type mineralization (Bruce L. Reed, oral communication, 1976-77).

McKinley type intrusives are mainly biotite granite; they are light colored homogeneous bodies, that locally have tourmaline-muscovite facies. They form the majority of the intrusives in the area south of Mt. McKinley, the Tonzona intrusive in the Alaska Range, and probably the intrusives in the Castle Rocks and Lake Chilchukabena areas north of the range.

The McKinley-type intrusives have local enrichments of beryllium, tin, tungsten, and probably titanium and uranium, and locally give rise to mineral deposits containing tin, silver, beryllium, lead, zinc, and uranium. Like many areas of tin enrichment, it appears that tin-silver and related deposits are associated with parts of intrusives in cupolas or irregular contact zones, thus it is fairly apparent that the complete appraisal of the area for tin-type mineralization would include a very exhaustive search for minor areas of tin enrichment which might indicate buried cupolas.

The mid-Tertiary (35-38 million years old) series is represented mainly by the faulted Foraker-McGonogill body (Reed and Lanphere, 1974) which is granodioritic in composition. According to Reed (oral communication, 1977), this pluton shows local molybdenum-copper enriched facies, and is possibly the parent intrusive type for the numerous lead-zinc contact deposits of the Mt. McKinley National Park--like deposits at Mt. Eielson.

C. Tertiary Basin Deposits

Intermountane continental basins south of, in, and on the north flank of the Alaska Range contain large deposits of lignite and subbituminous coal. Most of the better deposits are outside the park or (d)(2) area, but major coal reserves of the Nenana field are in the co-management area.

The deposits on the north side of the Alaska Range are in the Nenana Coal Field, where the main coal-bearing units are the Healy Creek and Suntrana Formations. The formations are continental in origin and were deposited from late Oligocene through Miocene time. The most extensive deposits are in the Suntrana Formation (Wahrhaftig and others, 1969). Coal deposits south of the Alaska Range are in the Beluga-Yentna regions (Barnes, 1966). Coal-bearing of dominantly Miocene age (Wolfe, Hopkins, and Leopald, 1966) units have been correlated with the Kenai Formation. Within the Alaska Range in small intermontane basin are the coal deposits of the Chulitna district (Rutledge, 1948; Wahrhaftig, 1944) and the Broad Pass lignite deposit (Barnes and others, 1951).

Tertiary formations, host of the coal deposits, also contain deposits of clay (Cobb, 1951; Triplehorn, in press; Wahrhaftig and Black, 1958; and Waring, 1947) and perlite.

Although the Tertiary basin deposits are mostly valuable for their clay and coal, and possibly as sand and gravel deposits, there are some placer gold deposits which appear to be of Tertiary, rather than Pleistocene or recent origin. Tertiary placer gold deposits in the Yentna mining district occur at the base of a clay-rich Tertiary quartz-pebble conglomerate which formed on highly-weathered gold-bearing bedrock (Mertie, 1919).

2.3 Surficial Deposits

Deposits of sand and gravel, glacial boulders, and fine-grained silt cover much of the northwestern part of the area, and alluvial gravel deposits fill all the major river channels of the area. The deposits on the west side of the range include extensive morraines and outwash plains derived from Ice Age glaciation. They extend essentially from the northwest flank of the Alaska Range northwesterly to the hills near Lake Minchumina, with only local outliers like the Castle Rocks rising from the plain.

Locally the alluvial deposits are gold bearing and are significant placer deposits. The most extensive placer deposits of the region are in the Kantishna district on the north side of the range, and in the Yentna district on the southern side. In both districts several distinct periods of gold deposition can be recognized. In the Kantishna district the most extensive workings are in or at the base of recent alluvial deposits. However, there are extensive bench deposits which represent earlier periods of stream deposition. The same relation holds in the Yentna district, except there are also placer gold deposits of older age related to glacial or inter-glacial activity.

2.4 Regional Geophysics

Airborne magnetometer surveys have been made over the Talkeetna, Talkeetna Mountains and part of the Healy quadrangles (Alaska Division of Geological and Geophysical Surveys, 1972A, B, C).

The air magnetic surveys show three very large-scale patterns. The southeastern part of the area on the Talkeetna Mountains quadrangles and largely out of the area of this study, shows a very complex relatively high magnetic terrain, with most readings in excess of 5000 gammas--over a removed background field of about 56,000 gammas. The northernmost part of the area on the northern Healy quadrangle shows a relatively simple magnetic pattern of greater than 5000 gammas. This corresponds to the area of the Yukon complex. Between the highly irregular Talkeetna Mountains area and the even magnetic Healy area, is a broad area generally showing less than 5000 gamma magnetics, but local highs, which correspond to mafic volcanics or intrusive rocks with a high magnetic content. In the Dall trend small sharp magnetic highs correspond with Yentna type granodiorite intrusions or with ultramafic rocks. Both locally have mineral deposits. In general, a northeastern alignment within the intermediate terrain reflects basaltic units which also are relatively metal rich. Some of the magnetic lows of the Talkeetna quadrangle apparently correlate with Tertiary basins, but others may indicate relatively shallow concealed granitic rocks.

It appears that the magnetic surveys do indicate favorable zones for ore deposits, and the survey coverage of Healy needs to be completed and Mt. McKinley needs to be undertaken completely.

CHAPTER 3

ECONOMIC GEOLOGY

3.0 General

Metallic mineral deposits of a variety of types are scattered through the Mt. McKinley area, but are particularly concentrated in certain belts or trends associated with major structures and favorable layered rock sequences (fig. 3.0, in pocket). Distinctive mineral deposits also tend to occur with certain intrusive rock types which are widely distributed in the McKinley region, which itself lies on the generally arcuate chain of granitic batholiths paralleling the Pacific Rim.

More detailed work should serve to greatly refine the mineral provinces of the McKinley region, and probably could find trends not now recognized. But the belts defined here are reasonably established and can, in turn, be used to define areas where mineral deposits are more likely to occur.

3.1 Distribution-Provinces

Three major mineral belts or trends can be defined in the McKinley region: (1) The Kantishna belt, (2) The Dall Trend, and (3) The Chulitna-Yentna mineral belt (fig. 1-2). With the exception of the Dall Trend, which has become recognizable on the basis of work by this project and that of B. L. Reed, U.S. Geological Survey in 1974-76, the Kantishna and Chulitna belts have been previously recognized, although elements of their controls have been uncertain and their extent or correlation unrecognized.

The Kantishna trend is the western continuation of a major mineral province which lies on the southern part of the Yukon Complex and includes the Bonnifield District to the east; it may continue southwest to near Farewell. It conforms generally to a structurally interwoven series of weakly-metamorphosed sedimentary and volcanic units which comprise the Birch Creek-Keevy Peak-Totatlanika schistose series of late Precambrian (?), early-mid Paleozoic age.

Within the Mt. McKinley study area, the favorable rocks of the Kantishna trend can be followed westerly for about 50 miles from the Bonnifield area, thence southwest for 50 miles through the Chitsia-Stampede-Kantishna mining areas to a point near an arcuate northern bend of the McKinley River. From this point it is buried by younger sedimentary rocks for 40 miles, where it emerges near the Foraker River. From the Foraker it can be followed southwesterly at least to the boundary between the Talkeetna and McGrath quadrangles between the Denali Fault and front of the foothills.

The Dall Trend is named in the report for a east-northeast trending belt of deposits which has been traced northeasterly 45 miles from the Cathedral Spires to the Foraker pluton. It is localized along a major suture between Paleozoic and Mesozoic rocks.

The Chulitna-Yentna belt has been previously defined (Hawley and Clark, 1973, 1974), and coincides partly with an ancient plate (?) boundary where Permian-Triassic rocks are faulted against the Jurassic-Cretaceous series. It consists of a well-defined placer lode gold group of deposits in the Yentna district separated by a less well-mineralized zone, 30 miles long, from the Chulitna belt of lode deposits. Partly in the recognized belts--which have either a structural or stratigraphic control--and partly outside, are deposits affiliated with ultramafic igneous rocks, and deposits affiliated with three series of intrusive granitic rocks recognized by Reed and Lanphere (1973, 1974). In chronologic order, these consist of gold or gold-copper-silver-nickel deposits related to the intrusives of the Yentna series, tin-silver deposits of the McKinley series, and molybdenum-lead-zinc (copper) deposits of the Foraker series.

The Y e n t n a - associated deposits are limited to the Dall Trend, but gold deposits like the Golden Zone and Partin Creek are spatially related to quartz diorite porphyries similar in composition to some facies of the Yentna type.

McKinley-affiliated deposits are widely scattered. In addition to the deposits recognized in the Boulder Creek or Tonzona area, tin-silver bearing deposits affiliated with light-colored tourmaline granites are found at Coal Creek and Ohio Creek on the south side of the range. Strongly anomalous amounts of tin, tungsten, beryllium are also found in the Chilchukabena granite--also a tourmaline type. Light-colored plutons of the northern Talkeetna Mountains are probably also of this type.

3.2 Classification of Metallic Deposits

In general, the primary metallic deposits of the McKinley region can be classed into two categories by affiliation with igneous or sedimentary rocks, or into a third broad group of hydrothermal deposits (Table 3.2). In addition, there is a broad variety of secondary placer deposits.

The deposits of igneous affiliation are those in or directly associated with specific igneous rocks. The exact affiliation may be uncertain, but the association of deposits of tin-silver with the McKinley type intrusion, for example, is common enough that a genetic relation is apparent.

In general the igneous-affiliated deposits are disseminated or porphyry-like deposits within the intrusive or replacement deposits in favorable layered units near the intrusive.

Two terms are used throughout the text to describe the replacement deposits: Tactite is used for a dominantly silicated series consisting of garnet-wollastonite-epidote rich rocks developed in limey hosts. Skarn here is used for dominantly sulfide material--also in limey hosts. The skarns of the area are commonly composed of pyrrhotite with minor amounts of chalcopyrite and arsenopyrite. The skarns are widely scattered in the area, yet have enough common features, such as mineralogy, semi-concordant nature, and spatial relation to intrusives, to be recognized as a class. Some of the deposits which we consider as skarns related to plutonic igneous activity have been inferred by

TABLE 3-2

CLASSIFICATION OF REPRESENTATIVE TYPES OF DEPOSITS IN THE MT. MCKINLEY AREA

	Form or type	Examples
I. IGNEOUS AFFILIATED		
A. Plutonic		
1. Granitic	Disseminated	Ohio Creek
	Skarn	Tonzona, Ohio and Partin Creeks
	Tactite	Mt. Dall, Tonzona
2. Mafic-ultramafic	Podiform or Stratabound	Lacuna chromite
B. Hypabyssal		
1. Granitic	Pipe	Golden Zone
C. Volcanic		
1. Rhyolitic	Stratabound	Pb-Zn $BaSO_4$ occurrences Chitsia Mountain
2. Basaltic	Stratabound	Shellabarger Pass
II. SEDIMENTARY AFFILIATED		
1. Marine	Stratabound	Zinc-Silver deposits, Keevy Peak (?) Formation
III. HYDROTHERMAL		
	Vein	Most Kantishna deposits
	Disseminated	Copper deposits-volcanic hosts

others to be essentially volcanogenic stratabound deposits. Their association, however, with certain intrusions in context with cross-cutting alteration features argues convincingly for their epigenetic nature.

There are, however, undoubtedly stratiform deposits of both volcanic and sedimentary affiliation within the area. The Shellabarger Pass (Reed and Eberlein, 1972) copper-zinc deposits, and a small BaSO4--lead-zinc deposit near Chitsia Mountain--are examples of deposits with probable volcanic affinity.

No commercial grade metal deposits in sedimentary rocks have as yet been found, yet the association of zinc-silver-molybdenum in highly anomalous amounts in graphitic shales of Birch Creek (?)-Keevey Peak associations--or in Paleozoic black argillite of the Dall Trend--suggest that such deposits could exist.

The term hydrothermal is used here in a broad sense for those deposits which formed diagenetically to epigenetically in a variety of host rocks, primarily through the agency of hot metalliferous waters. In form many of these deposits are veins. Undoubtedly this class of deposits grades into the deposits of igneous affiliation, yet most of the vein deposits of the area are not affiliated with any igneous rock series, and it seems best in most cases to attribute their origin to hot brines which leached metalliferous sedimentary or volcanic rocks during either diagenesis or during a discrete epigenetic tectonic event.

The Kantishna veins are the main example of hydrothermal deposits. These exceedingly numerous deposits are in a belt crudely associated with a north-easterly trending arch formed in

Cretaceous or Tertiary time. The deposits, in general, show little igneous affiliation, but they are in a terrane which is strongly metalliferous. The shales and carbonaceous limestones of the Kantishna area are rich in zinc and silver--two common components of the vein deposits--suggesting a possible primary source of metals now found in vein deposits.

3.3 Non-metals and Industrial Minerals

Several types of non-metallic deposits have been considered for economic development in the Mt. McKinley region, including clay, limestone, and perlite. Thus far there has been no extensive production of non-metallics, although small amounts of clay have been mined. The limestone resource has been considered as a possible source of cement materials at intervals at least since 1940, and it is again receiving interest because of the possible construction of the Susitna dams and a new Alaska capitol.

Limestone deposits with at least some commercial attributes are found along the south flank of the Alaska Range in two groups: (1) Devonian limestones just north of the McKinley Strand of the Denali Fault at Windy and Foggy Passes in Mt. McKinley Park, and (2) north of the Nenana River just east of the Park (fig. 3.0).

Both Foggy and Windy deposits have been sampled, locally drilled, and documented in the literature (Moxham, Eckhart, and Cobb, 1959; Rutledge and others, 1953; and Waring, 1947).

Pure limestones of considerable volume also occur in the Triassic series of the Chulitna belt (fig. 3.0, fig. 4.2-A(1). The best known deposit is in upper Long Creek. Other non-metallic resources include clay (Cobb, 1951; Barnes and others, 1951) and argillite for light-weight aggregate.

3.4 Coal

The Mt. McKinley area (fig. 3.0) is on the southwest fringe of the major Nenana Coal Field (Wahrhaftig; 1973; Barnes and others, 1951), and on the northern edge of the major Susitna field (Barnes, 1966). It includes the smaller Costello Creek basin (Wahrhaftig, 1944), and the Broad Pass lignite deposit (Article 4, Barnes and others, 1951).

A coal discovery (Anchorage Times, March 1977) on the northwest side of the region is apparently in the series of basins, including Nenana on the north side of the range. It may indicate that the area is also flanked on the northwest by a major field.

Except on the Broad Pass field, coal is of subbituminous rank with high ash and water contents, extremely low sulfur, and Btu's in the 7500-9500 range. Coal of this quality is being produced at about 800,000 tons a year by Usibelli Coal Mine, Inc. from the Healy Creek and Lignite Creek areas on the northeast side of the region in the Nenana Field.

Preliminary work reported by Ode and Selvig (1944) indicates that the coal would be amenable to processing for gasification or liquification.

3.5 Geochemistry

About 1 0 0 0 rock, soil, or stream sediment samples were taken during this investigation and several thousand other geochemical analyses were available in government reports (Reed and

Elliott, 1958; Bundtzen, Smith and Tosdal, 1976) and in the Chulitna area from Resource Associates of Alaska, Inc., and other private sources. These data were used in assessing or following up mineral potential trends.

The geochemical analyses are not all directly comparable; some are done by semi-quantitative spectrographic methods, others by atomic-absorbtion. Based on the use of these or similar data in the area since 1966 by the senior author, the following numbers were considered to mark the base of anomalous concentrations in stream sediment samples, rock and soil.

	Parts Per Million
Copper	150
Lead	100
Zinc	300
Silver	1
Gold	.02
Molybdenum	10
Antimony	50
Tin	10

The above elements were the ones most commonly determined in many of the newly-collected samples; locally arsenic, beryllium, and other elements were determined and are reported if considered anomalous.

In general, the detailed maps of Chapter 4, samples have been assigned new map numbers starting from the left side of the maps and sweeping eastward through north-south groups corresponding to section or township and range.

CHAPTER 4

DESCRIPTION OF METALLIFEROUS DEPOSITS AND AREAS

4.0 General

The general distribution of rocks, samples, deposits, and the areas of more detailed maps are shown on three maps which effectively cover the project area and supplement--with greater detail--Figure 3.0. The maps based on enlargements of standard U.S. Geological Survey 1:250,000 series maps are:

Figure 4.0-A--1:125,000 enlargement of the Mt. McKinley quadrangle (see pocket).

Figure 4.0-B--1:125,000 enlargement of part of the Talkeetna quadrangle.

Figure 4.0-C--1:125,000 enlargement of parts of the Healy and Talkeetna Mountains quadrangles.

A. The Mt. McKinley Quadrangle Area. Deposits and mineral occurrence of this area are mainly those of the Kantishna district and those deposits in Mt. McKinley National Park. The Kantishna Mining District was broken into three main study areas corresponding to three main groups of known deposits--Kantishna-Stampede-and Chitsia Mountain--and new prospect-geologic maps were constructed at 1:24,000 or more detailed scales of parts of these areas. No new studies were made in the Park, and the deposits shown are those previously recognized.

The McKinley area map also shows the location of rock, soil, and stream sediment analysis collected in this project--or available in private or published form. (Locations in the detailed areas, such as Kantishna, are shown on larger scale maps). The results of analysis are shown in tabular form (table 4.0-A).

Part of the western McKinley quadrangle was flown with a scintillation counter at about 100 feet elevation. The areas included the Castle Rocks area, Lake Minchumina, and Lake Chilchukabena. The highest radioactivity was found in and near granite near Lake Chilchukabena; the same granite was found to be highly anomalous in tin, tungsten, and beryllium. It apparently has not been prospected.

B. The Talkeetna Quadrangle Area. The southwest continuation of the Kantishna trend, all the recognized Dall Trend, and the southern part of the Chulitna-Yentna belt are contained in the Talkeetna quadrangle (fig. 4.0-B, see pocket).

The Shellabarger Pass mineral area, and the Boulder Creek, Tonzona or Purkey mineral area are also included as are mineral occurrences associated with scattered intrusions of the McKinley type.

Also shown are the locations of rock, soil, and stream sediment samples collected by the U.S. Geological Survey (Reed and Elliott, 1968) (prefixed U or V) and this survey. All these samples are tabulated in Table 4.0-B.

TABLE 4.0-A

INDEX OF MINERAL DEPOSITS AND GEOCHEMICAL SAMPLES IN THE MT. MCKINLEY QUADRANGLEAREA, SHOWING RESULTS OF ANALYSES OF ANOMALOUS SAMPLES

MD = MINERAL DEPOSIT--SAMPLE TYPES: CH-3' = CHIP WITH LENGTH. GB = GRAB

GEOCHEMICAL SAMPLE TYPES: SS = STREAM SEDIMENT S = SOIL
P = PAN CONCENTRATE R = ROCK

MINERAL DEPOSITS IDENTIFIED BY LETTER SYMBOL ARE MAJOR DEPOSITS, OR DEPOSITS NOT IDENTIFIED IN MORE DETAILED MAPS OR TEXT SECTIONS.

MAP NO. OR SYMBOL	KARDEX NO.	REMARKS AND REFERENCES
A		ANTIMONY DEPOSIT SHOWN BY CAPPS (1933, P 1.4 VERY APPROXIMATE LOCATION
B	66-36,-128	STIBNER CLAIM (MOFFIT, 1933); ANTIMONY
C	66-37,-123	MERINGER CLAIM (MOFFIT, 1933, ANTIMONY AND MERCURY). RENAMED MINERAL MT. ANTIMONY CLAIMS (CHADWICK, 1976)
D	66-10	GREENBACK (SEE SECTION AND FIG. 4.1-B)
E	66-10	MAGNET AND OLD SOURDOUGH (SEE SECTION AND FIG. 4.1-B) (MOFFIT, 1933; CHADWICK, 1976)
F		CARLSON CREEK PROSPECT; COPPER, LEAD, AND ZINC IN SHEARED SEDIMENTARY ROCKS.
G	66-67	POSSIBLY TWIN HILLS PROSPECT OF MOFFIT (1933, P. 323). DISSEMINATED AND VEIN TYPE DEPOSITS. SPHALERITE, GALENA, MAGNETITE AND GOLD AND SILVER IN ASSAY QUANTITIES.
H		GOLD AND LEAD-SILVER BEARING LODE SHOWN BY CAPPS (1933, P1.4), ABOUT 1 MILE WEST OF MULDROW GLACIER.
I	66-2,-48(?) -126	MT. EIELSON AREA. LEAD-ZINC BEARING TACTITE (SEE SEC. 4.1-B)
J	66-5,-109,-110	SLATE CREEK ANTIMONY
K	66-77	BONNELL
L	66-125	EAGLES NEST OR DON ANTIMONY

TABLE 4.0-A (CONTINUED)

MAP NO. OR SYMBOL	KARDEX NO.	REMARKS AND REFERENCES
M		MINERALIZED FELSIC SCHIST
N	66-12,-125	ALPHA LODE
O		MINERALIZED FELSIC SCHIST
P	66-15, ETC.	LITTLE ANNIE LODE (IN QUIGLEY HILL GROUP)
Q		BANJO (RED TOP) LODE
R	66-11,-107	LAST CHANCE LODE
S	66-112	STAMPEDE ANTIMONY LODE
T		LITTLE CARIBOU LODE OCCURRENCE
U		MINERALIZED FELSIC SCHISTS
V		CHITSIA MOUNTAIN LODE OCCURRENCE

MAP NO. OR SYMBOL	FIELD NO. OR DEPOSIT NAME	MINERAL DEPOSIT OR GEOCHEMICAL TYPE	KARDEX NO.	RESULTS IN PARTS PER MILLION UNLESS INDICATED % OR OZ/TON						
				CU	PB	ZN	AG	AU	SB	OTHER OR REMARKS
1	215	S		–	–	–	.2	–	32	
2	216	S		–	–	–	–	–	30	
3	213	SS		–	–	275	< .2	–	–	7 U
4	214	SS		–	–	330	< .2	–	–	COARSE-GR.
5	275	R		<2	50	200	<1		–	20BE,10SN,/
6	276	R		<2	50	200	<1	–	–	15BE,10SN,
7	T248			105	15	235	< .2	–	–	FINE GRAIN
8	T249			30	5	110	< .2	–	–	
9	T246	R		25	–	–	–	–	–	105N
10	T247	S		185	20	185	.4	–	–	
11	T420	R		20	5	65	.4	–	–	
12	T421	R		5	5	80	< .2	–	–	
13	T422	S		45	5	85	< .2	–	–	<10SN; 8MO
14	T423	R		425	15	–	4.0	–	–	80MO NODULE
15	T424	S		105	50	225	.4	–	–	<10 IN GRAN.
15	T425	R		–	–	–	–	–	–	<10SN

TABLE 4.0 - B SAMPLE NUMBERS AND ANOMALOUS VALUES, TALKEETNA QUAD.

1	U191	SS	70	15	300	N	<.02				7Mo	
2	U192	SS										
3	U194	SS										
4	U193	SS										
5	U213	SS	70	15	300	N	<.02				5Mo	
6	U212	SS	30	30	300	N	<.02				5Mo	
7	U208	SS	100	15	700	N	<.02				7Mo	
8	U207	SS										
9	U209	SS										
10	U211	SS										
11	U210	SS										
12	U205	SS	150	15	N	N	<.02					
13	U206	SS	100	15	N	N	<.02					
14	U204	SS										
15	U203	SS										
16	U201	SS										
17	U202	SS	70	15	700	N	<.02				7Mo	100Ni
18	U199	SS										
19	U200	SS	70	20	300	N	<.02				7Mo	100Ni
20	U198	SS	150	15	700	N	<.02				7Mo	100Ni
21	U197	SS	150	15	200	N	<.02				3Mo	
22	U195	SS										
23	U196	SS										
24	U188	SS										
25	U187	SS	150	15	N	N	<.02				3Mo	
26	U186	SS	70	15	300	N	<.02					
27	U185	SS										
28	U184	SS										
29	U183	SS										
30	U182	SS	200	15	N	N	<.02					
31	U181	SS										
32	U180	SS										
33	U178	SS										
34	U179	SS										
35	U168	SS										
36	U177	SS	70	10	300	N	<.02				5Mo	150Ni
37	U176	SS										
38	U172	SS	50	15	300	N	<.02			150Cr	<10Mo	150Ni
39	U169	SS	70	10	500	N	<.02			150Cr	<10Mo	150Ni
40	U167	SS	50	30	300	N	<.02			70Cr	<10Mo	70Ni
41	U166	SS	70	[illegible]	300	N	<.02			70Cr	<10Mo	70Ni
42	U165	SS										
43	U164	SS										
44	U163	SS										
45	U162	SS										
12-B	U190	SS	70	20	700	1	<.02			70Cr	7Mo	[illegible]
12-C	U189	SS										

TABLE 4.0 - B SAMPLE NUMBERS AND ANOMALOUS VALUES, TALKEETNA QUAD.

46	U161	SS					
47	U160	SS					
48	U159	SS					
49	U158	SS					
50	U157	SS					
51	U156	SS					
52		SS					
53	U144	SS					
54	U145	SS					
55	U146	SS					
56	U174	SS					
57	U148	SS					
58	U149	SS					
59	U150	SS					
60	U151	SS					
61	U152	SS					
62	U232	SS					
63	U231	SS					
64	U233	SS					
65	U234	SS					
66	U235	SS					
67	U236	SS					
68	U230	SS					
69	U155	SS					
70	U154	SS					
71-A	U153	SS					
71-B	C418	R	60	30	20	< .2	-
72	C070	SS	115	15	180	-	-
73	C069	SS	90	15	205	-	-
74	C417	SS	60	30	160	.4	<.02
75	C416	SS	95	30	230	.4	<.02
76	U141	SS					
77	U140	SS					
78	U142	SS					
79	U143	SS					
80	C07	SS	90	30	125	< .2	<.02
81	C08	SS	45	25	150	< .2	<.02
82	C09	SS	55	45	235	< .2	<.02
83	C10	SS	30	35	295	<.2	<.02
84	C11	SS	45	30	165	< .2	<.02
85	C12	SS	50	55	175	.4	<.02
86	C13	SS	10	10	75	< .2	<.02
87	C14	SS	40	30	145	< .2	<.02
88	C15	SS	40	30	245	.2	<.02
89	C16	SS	45	20	185	< .2	<.02

TABLE 4.0 - B SAMPLE NUMBERS AND ANOMALOUS VALUES, TALKEETNA QUAD.

90	C17	SS	70	10	360	1.2	<.02	
91	C18	SS	40	30	255	0.2	<.02	
92	C19	SS	45	10	240	0.4	<.02	
93	U136	SS						
94	U135	SS						
95	U137	SS						
96	U133	SS						
97	U132	SS						
98	U131	SS						
99	U130	SS						
100	U129	SS						
101	U128	SS						
102	U127	SS						
103	U139	SS						
104	U122	SS	150	10	N	N	<.02	500Cr300Ni
105	U121	SS	20	100	0	<.5	<.02	150Cr
106	U120	SS						
107	U119	SS						
108	U118	SS						
109	U116	SS	150	20	N	N	<.02	100Ni
110	U117	SS						
111	U114	SS						
112	U115	SS						
113	U113	SS						
114	U111	SS						
115	U112	SS						
116	U110	SS						
117	U109	SS						
118	U107	SS						
119	U108	SS						
120	U106	SS						
121	U92	SS						
122	U91	SS						
123	U90	SS						
124	U89	SS						
125	U88	SS						
126	U87	SS						
127	U86	SS						
128	U73	SS						
129	U74	SS						
130	U75	SS						
131	U76	SS						
132	U78	SS						
133	U80	SS						
134	U79	SS						

TABLE 4.0 - B SAMPLE NUMBERS AND ANOMALOUS VALUES, TALKEETNA QUAD.

								XX		
135	U82	SS	150	20	N	N	<.02			
136	U83	SS								
137	U85	SS								
138	U84	SS								
139	U229	SS								
140	U228	SS								
141	U227	SS								
142	U225	SS								
143	U226	SS								
144	U224	SS								
145	U221	SS								
146	U223	SS	100	15	700	N	<.02			
147	U218	SS	70	15	300	N	<.02		5Mo	
148	U219	SS								
149	U259	SS	150	30	300	N	<.02		7Mo	
150	U258	SS	70	15	300	N	<.02	150Cr	3Mo	
151	C171	R	30	15	130	< .2	–		6W	<10SN
152	C172	S	85	45	215	.2	–			
153	C173	S	95	45	255	.6	–			
154-A	C176	R	10	15000	<200	20	.06	500AS200SBDIKERK		
155	C174	S	60	–	235	–	–			
156	C175	S	30	–	40	–	–			
157	C212	R	< 2	20	<200	<1	–			
158	C177	S	425	4600	500	9.4	<.02			<10Sn
159	C395	SS	10	75	40	<2	–			
160	C211	S	160	290	290	1.0	<.02			15Sn
161	C394	SS	45	110	200	<.2	N			
162	C3[illegible]	SS	45	65	305	< .2	<.02			
163	C3	R	270	5	55	< .2	<.02			
164	C3[illegible]	SS	105	145	330	< .2	<.02			
165	C39[illegible]	R	900	180	215	1.2	<.02			
166	C396	R	5	140	10	.4	<.02			
167	C397	SS	165	230	165	.4	<.02			
168	C398	SS	135	220	245	.6	<.02			
169	C399	SS	175	280	260	2.8	<.02			
170	C389	SS	220	195	405	.4	<.02			
171-A	C388	SS	240	160	500	.4	<.02			
171-B		R	135	40	1000	.2	<.02			
172	CM369	R	10	20	<200	<1.0				1000Ti<10Sn
173	CM368	SS	7	150	200	<1.0				500Ti<10Sn
174	U287	SS	70	20	300	N	<.02			
175	U288	SS								
176	U289	SS								
177	U290	SS								
178	U257	SS								

TABLE 4.0 - B SAMPLE NUMBERS AND ANOMALOUS VALUES, TALKEETNA QUAD.

179	U256	SS						
180	U255	SS						
181	U254	SS						
182	U253	SS						
183	U251	SS						
184	U250	SS						
185	U252	SS						
186	U249	SS						
187	U248	SS						
188	U247	SS						
189	U246	SS						
190	U245	SS	100	15	1500	N	<.02	150Ni
191	U244	SS						
192	U243	SS						
193	U239	SS	70	15	500	<1.0	<.02	
194	U238	SS						
195	U237	SS						
196	U242	SS						
197	U240	SS						
198	U241	SS						
199	C223	R	320	80	55	0.8	-	
200	C222	SS	120	45	350	0.6	-	
201	C221	S	70	15	75	<.2	0.03	
202	C220	SS	125	20	40	0.8	0.17	
203	C141	S	85	-	-	<0.2	0.05	7W <10Sn
204	C243	SS	40	15	75	<.2	.05	675Ni
205	C410	SS	30	10	50	< .2	-	
206	C411	SS	85	45	155	.4	.02	
207	C409	S	335	35	190	0.8	.04	
208	C408	S	160	20	115	<.2		
209	C407	SS	50	10	< 200	< 1		20 NI
210	C404	SS	50	10	< 200	< 1		30 NI
211	C405	S	200	20	< 200	1	.55	2000As,100W
212	C406	S	70	20	< 200	<1	.29	100W
213	C197	S	40	10	150	.2	<.02	<10Sn 2W
214	C196	R	200	10	300	<1	<.02	150Ni
215	C195	R	45	15	95	1.2	<.02	
216	C136	SS	30			< .2		<10Sn 4W
217	C276	S	75	25	185	.2	<.02	200Cr <.2Mo
218	C275	S	55	5	125	<.2	<.02	1200Cr <2Mo
219	C274	S	30	50	< 200	1		<10SN 2Mo
220	C273	S	75	25	105	< 2		<2Mo
221	C272	S	55	15	90	<.2	-	80CR<2Mo
222	C271	S	5	5	20	0.2	-	20CR<2Mo
223	C304	R	2400	15	10	.10	.6	60Cr 10Sn

TABLE 4.0 - B SAMPLE NUMBERS AND ANOMALOUS VALUES, TALKEETNA QUAD.

224	C268	S	150	40	280	0.6	<.02	400Cr 4Mo
225	C305	R	85	10	210	0.8		160Cr 6Mo
226	C267	S	155	25	200	<.2		140Cr 2Mo
227	C303	S	130	30	120	<.2	<.02	250Cr 2Mo
228	C269	S	135	85	175	.8	<.02	200Cr 2Mo
229	C270	S						
230	C307	S	100	15	100	<.2	<.02	300Cr <2Mo
231	C306	S						
232	C131	SS	45				<.02	400Cr 290Ni
233	C189	SS	120	25	170	<.2	<.02	800Cr 1000Ni
234	C129	R	1400		75	3.0	<.02	800Cr 1700Ni
235	C188	SS	40			<.2	<.02	1150Ni
236	C130	SS	30			<.2	<.02	525Cr 550Ni
237	C192	SS	55			<.2	<.02	1000Ni
238	C191	SS	45		260	<.2	<.10	320Ni
239	C180	R	150	15	<200	<.1	<.02	15Ni
240	C181	R	1250					6000Cr
241	C182	R	7	<10	<200			7000Cr [illegible]
242	C183	R	80	15	140	<.2	<.02	90Ni
243	C184	S	1500	20	150	2.0	<.02	600Ni
244	C187	S	150	10	200	<.2	<.02	300Cr
245	C190	S	250		60	1.2	<.02	
246	C132	S	10	95	110			
247	C185	S	35	65	390	.4	<.02	
	C186	R	15	<10	200	<1	<.02	<5Ni
248	C133	SS	35	5	100	< .2	<.02	2Mo
249	C134	SS	20	-	-	< .2	<.02	
250	C193	SS						
251	C135	SS	45	15	120	< .2	-	<10SN<2W
252	C277	S	65	45	125	.4	-	
253	C278	S	100	45	230	.8	<.02	
254	C279	S	50	20	160	< .2	-	
255	C280	S	45	20	110	< .2	-	
256	C281	S	50	30	145	< .2	-	
257	C282	S	25	105	175	1.0	<.02	
258	C283	S	25	15	75	< .2	-	
259	C284	S	20	15	75	< .2	-	
260	C285	S	65	40	125	.6	-	
261	C286	SS	40	20	125	< .2	-	
262	C287	SS	40	25	130	< .2	-	
263	C314	S	20	10	45	< .2	-	
264	C313	S	45	25	100	.2	-	
265	C312	S	10	10	45	< .2	-	
266	C311	S	15	20	45	.2	-	
267	C310	S	40	15	85	.2	-	
268	C309	S	25	30	100	< .2	-	

TABLE 4.0 - B SAMPLE NUMBERS AND ANOMALOUS VALUES, TALKEETNA QUAD.

269	C308	S	75	30	140	.2		
270	C199	R	105	–	225	.2		
271	C140	SS	25	5	95	< .2		<10SN<2W
272	C138	SS	80	10	115	<.2	<.02	500Cr
273	C119	S	105	25	180	.4		<10SN
274	C217	SS	LOST					
275	C477	R	70	–	–	–	<.02	<10SN
276	C455	SS	15	5	55	< .2	<.02	<10SN 2W
277	C456	SS	5	–	–	< .2	<.02	<10SN
278	C231	SS	20	–	–	< .2	<.02	
279	C120	SS	15	5	65	.2	<.02	<10SN <2W
280	C121	SS	15	5	50	< .2	–	<10SN
281	C122	SS	10	5	50	< .2	–	<10SN
282	C123	SS	20	10	65	< .2	–	<10SN
283	C124	SS	45	10	115	< .2	–	<10SN
284	C139	SS	15	10	65	< .2	<.02	<10SN <2W
285	C125	SS	55	30	170	.6	–	<10SN
286	C263	SS	15	5	80	< .2	<.02	<10SN <[illegible]W
287-A	C111	R	70	20	200	<1		10Sn 10Be
287-B	C110	S	15	5	60	< .2	<.02	<10SN <2W
288	C109	SS	20	10	60	< .2	–	<10SN 3W
289	C107	S	20	–	–	< .2	–	<10SN <2W
290	C264	S	55	10	120	< .2	<.02	<10SN 2W
291	C126	SS	5	5	40	< .2	–	<10SN <2W
292	C108	S	–	–	–	–	–	250W <10Sn
293	C265	S	40	–	–	–	–	<10SN 3W
294	C127	SS	25	5	35	< .2	–	<10SN <2W
295	C297	SS	5	10	95	< .2	–	
296	C296	SS	45	15	115	< .2	–	
297	C295	SS	15	10	120	< .2	–	
298	C294	SS	50	35	150	< .2	–	
299	C300	S	40	15	105	< .2	–	
300	C293	SS	30	15	170	.2	–	
301	C292	SS	5	5	55	< .2	–	
302	C128	SS	5	5	30	< .2	–	<10SN
303	C291	SS	5	10	100	< .2	–	
304	C290	S	5	15	105	< .2	–	
305	C288	S	30	20	125	< .2	–	
306	C289	S	35	15	75	< .2	–	
307	C137	R	2	15	<200	<1	<.02	10Be
308	C118	SS	< 5	5	25	< .2	<.02	<10SN <2W
309	C117	SS	5	5	25	< .2	–	<10SN <2W
310	C116	SS	5	< 5	5	< .2		<10SN <2W
311	C114	SS	60	15	145	< .2	–	<10SN 3W
312	C115	SS	50	15	140	< .2	–	<10SN

TABLE 4.0 - B SAMPLE NUMBERS AND ANOMALOUS VALUES, TALKEETNA QUAD.

									XX
313	C113	SS	50	20	130	< .2	–		
314	C112	SS	35	20	120	< .2	–		
315	C301	S	20	15	70	< .2	–		
316	C302	S	55	20	155	< .2	–		
317	C321	SS	10	–	90	–	–		<10SN 2Mo
318	C320	SS	5	–	110	–	–		<10SN <2Mo
319	C319	SS	5	–	60	–	–		<10SN <2Mo
320	C318	SS	30	15	120	< .2	<.02		<10SN
321	C317	S	10	15	5	<1	<.02		< 5NI
322	C316	S	< 5	5	55	<1	<.02		< 5NI
323	C315	S	5	40	15	1.4	<.02		
324	C402	SS	< 5	5	15	< .2	–		<10SN
325	C403	SS	5	5	15	< .2	–		<10SN
326	C401	S	55	25	150	.4	<.02		<10SN
327	C400	S	5	5	35	< .2	–		<10SN
328	C299	S	5	10	50	< .2	–		<10SN
329	C298	SS	< 5	5	30	< .2	–		<10SN
330	C451	R	15				<.2		10Sn
331	C450	S	7	15	<200	<1 –			< 5NI
332	C323	S	5	10	45	< .2	–		<10SN
333	C[illegible]	S	2	20	<200	<1			10SN <5NI
334	C3[illegible]	R	50	10	<200	<1			7000TI 15%FE <5NI
335	C325	R	20	15	<200	<1 –			10SN <5NI
336	C228	SS	< 5	35	–	< .2	–		<10SN
337	C329	S	15	20	<200	<1			<10SN <5NI
338	C452	S	55	–	–	< .2	<.02		<10SN
339	C229	SS	15	5	60	< .2	<.02		
340	C453	SS	25			<.2	<.02		10Sn
341	C230	SS	45	5	–	< .2	<.02		<10SN
342	C454	SS	5	–	–	< .2	<.02		<10SN
343	C419	R	40	5	85	2.2	–		
344	C88	R	30	10			<.02		1500Ni 300Cr
344B	C89	S	500	20	1350		<.02		4W
345	C719	S	310	35	770	2.0	.03		
346	C718	S	105	30	185	< .2	–		
347	C717	S	40	20	110	< .2	–		
348	C716	S	85	25	155	< .2	–		
349	C715	S	100	1500	<200	5	<.02		10Sn
350	C714	S	30	70	<200	<1	<.02		
351	C474	R	30	30	<200			< 2	3000Ba
352	C473	SS	2	10	<200	<1		24	5000Ti
353	C476	SS	15	20	<200	<1		11	1500Ti
354	C470	SS	10	–	–	< .2	<.02		
355	C469	S	30	–	–	.2	<.02		<10SN
356	C471	R	5	10	<200	<1	<.02		
357	C475	SS						2	

TABLE 4.0 - B SAMPLE NUMBERS AND ANOMALOUS VALUES, TALKEETNA QUAD.

(In Sample Type R=Rock, SS=Stream Sediment, S=Soil, PC=pan concentrate

Map No.	Field No.	Sample Type	Cu	Pb	Zn	Ag	Au	Other-
			(all results in Parts per Million)					
358	C472	SS	10	–	–	< .2	<.02	
359	C468	SS	80	–	–	< .2	<.02	<10SN
360	C87	S	450	4,000	2,000	12	<.02	
361	C86	S	10	–	60			<2Mo
362	C85	R	< 2	30	< 200	<1	–	300SR 1500Ti
363	C84	S	15	–	95			<2Mo
364	C83	R	15	–	–	–	<.02	300Ti
365	C82	R	20	15	–	–		500Ti
366	C81	SS	5	–	60	–		<2Mo
367	C80	SS	10	–	105	–		<2Mo
368	C78	SS	5	–	25	–		<2Mo
369	C79	SS	5	–	70	–		<2Mo
370	C77	SS	15	–	70	–		<2Mo
371	C75	SS	5	–	40	–		<2Mo
372	C76	SS	5	–	45	–		<2Mo
373	C74	SS	5	–	55	–		<2Mo
374	C73	S	15	–	95	–		<2Mo
375	C72	S	15	5	80	–		<2Mo
376	C713	S	70	20	190	< .2		
377	C712	S	75	15	120	< .2		
378	C711	S	85	5	85	< .2		
379	C709	S	225	5	155	.4	–	
380	C710	S	310	15	135	<.2	–	
*381	C227	S	105	20	145	.4	<.02	
*382	C225	S	100	10	195	< .2	–	
*383	C226	R	75	15	175	.8	–	
*384	C224	R	405	25	170	4.2	1.8	
385								
386								
387								
388								
389								
390								
391								
392								
393								
394								
395								
396								
397								
398								
399								
400								
401								
402								

* Out of place, In TKN C3

C. The Healy-Talkeetna Mountains Quadrangle Area. The Chulitna mineral belt, part of the Nenana coal field, and country essentially unsurveyed for minerals east of Mt. McKinley National Park, are in the Healy-Talkeetna Mountains map area (fig. 4.0-C). Considerable information is available in published or private reports on the area; and no extensive new reconnaissance was done.

TABLE 4.0-C

INDEX OF MINERAL DEPOSITS AND GEOCHEMICAL SAMPLES IN THE HEALY-TALKEETNA MTNS AREA, SHOWING RESULTS OF ANALYSES OF ANOMALOUS SAMPLES

(FIG. 4.0-C)

MD = MINERAL DEPOSIT--SAMPLE TYPES: CH-3' = CHIP WITH LENGTH. GB = GRAB

GEOCHEMICAL SAMPLE TYPES: SS = STREAM SEDIMENT S = SOIL
P = PAN CONCENTRATE R = ROCK

MINERAL DEPOSITS IDENTIFIED BY LETTER SYMBOL ARE MAJOR DEPOSITS, OR DEPOSITS NOT IDENTIFIED IN MORE DETAILED MAPS OR TEXT SECTIONS.

MAP NO. OR SYMBOL	KARDEX NO.	REMARKS AND REFERENCES
A		''COAL CREEK'' ZINC DEPOSIT (ADJACENT TO TIN-BEARING TOURMALINE GRANITE)
B		ELDRIDGE GLACIER OCCURRENCE, HAWLEY AND OTHERS (1969, TABLE 1, NO. 1) (COPPER TO 7.5 PERCENT)
C	67-168	PARTIN CREEK CLAIMS, ALSO WOOD-FENNIMORE. HAWLEY AND OTHERS (1969, TABLE 2; HAWLEY AND CLARK, 1974, P. 46)
D		READY CASH CLAIMS (AND CHULITNA MINING CORP.)
E		OHIO CREEK GREISEN
F	67-175	LONG CREEK (HAWLEY AND OTHERS, 1969, FIG. 7, TABLE 5)
G	67-14,-63,-130 -153,-155	GOLDEN ZONE, MAYFLOWER (67-6)
H		LOOKOUT MTN (HAWLEY AND OTHERS, 1969, FIG. 6, TABLE 5)
I	67-67	SILVER KING (HAWLEY AND CLARK, 1974, FIG. 6, P. 27-30)
J		DUNKLE COAL MINE
K		NIM (SNOOPY) CLAIMS. DISSEMINATED COPPER-MOLYBDENUM-GOLD. FIG. 4.2-A(1).
L		NIMBUS CLAIMS (HAWLEY AND OTHERS, 1969, FIG. 5, TABLE 5, SAMPLE NOS. 1B, 2B).
M		NIMROD CLAIMS (HAWLEY AND OTHERS, 1969, FIG. 5, TABLE 5, SAMPLE NOS. 3B-6B).
N		FOGGY PASS LIMESTONE DEPOSIT.

TABLE 4.0-C (CONTINUED)

MAP NO. OR SYMBOL	KARDEX NO.	REMARKS AND REFERENCES
O	67-86(?)	WINDY PASS LIMESTONE
P		PANORAMA MTN LIMESTONE
Q	67-122	LONG CREEK LIMESTONE

MAP NO. OR SYMBOL	FIELD NO. OR DEPOSIT NAME	MINERAL DEPOSIT OR GEOCHEMICAL TYPE	KARDEX NO.	RESULTS IN PARTS PER MILLION UNLESS INDICATED % OR OZ/TON						
				CU	PB	ZN	AG	AU	SB	OTHER OR REMARKS
1	H 14	SS		SAMPLE LOST						
2	13	SS		60	30	120	< 1	< .02		
3	12	SS		50	30	115	< .2	< .02		
4	11	SS		45	30	115	< .2	< .02		
5	10	SS		65	35	110	< .2	< .02		
6	9	SS		60	55	125	< .2	< .02		
7	8	SS		105	40	310	< .2	< .02		BDRK NOS.7-14
8	7	S		-	-	-	< .2	< .02		GOSSAN
9	2	S		150	40	300	< .2	< .02		SILIC.GRAPHITIC SCHIST
10	3	S		160	15	120	< .2	< .02	META-RHYOLITE	
11	1	S		25	20	115	< .2	< .02		DIABASE
12	4	S		150	20	80	< .2	< .02		DACITE PORPH.
13	5	S		55	80	55	< .2	< .02		
14	6	S		30	60	60	7.4	< .02		GRAPHITIC SCHIST

4.1 The (d()2) Withdrawal Area

Subject to Sec. 17(d)(2) of the Alaska Native Claims Settlement Act, a large area surrounding Mt. McKinley National Park was withdrawn from the public land laws and the mining and mineral leasing acts in March 1972. Mining could and has continued on existing claims, but no new claims can be staked. Deposits in this area, those in McKinley National Park, and those in adjacent regions, have been appraised for possible buyout (Chadwick, 1975) by the Park Service--or cooperative private or public groups.

The (d)(2) area, outlined in figure 1.2, includes essentially all of the Kantishna area, the Dall Trend described in this report, and the Shellabarger Pass area (Reed and Eberlein, 1972). It also contains mineralized rocks similar to those of the Boulder Creek or Tonzona area (described in sec. 4.2-C) and deposits of the northwest part of the previously recognized Chulitna belt (Hawley and Clark, 1974), specifically that part in uppermost Ohio Creek above Canyon Creek (described in sec. 4.2-A).

A. Kantishna District

The Kantishna District of this report coincides with a large part of a mineral-rich area first recognized in about 1906 (Prindle, 1907). As defined here, it is bounded on the south and east by Mt. McKinley National Park; the Kantishna area coincides geologically with an area of well-mineralized, low-grade metamorphic rocks.

The district has recorded production of gold, silver, lead, and antimony. Gold has been recovered principally from placer deposits, but one lode mine--the Banjo--produced a substantial amount of gold just prior to World War II. Silver and lead have been produced from several bonanza-grade deposits in essentially the same vein system as that of the Banjo. Antimony has been produced principally at Stampede and Slate Creek, with small lots at other localities. The Stampede mine is the second largest primary producer of antimony in the United States.

The district has been intermittently prospected and studied for more than 70 years, with principal contributors being, in chronological order, Prindle (1907-1911), Capps (1918, 1919), Moffit (1932), Wells (1933), White (1942), Seraphim (1962), Barker (1963), Chadwick (1975), and Bundtzen, Smith, and Tosdal (1976), Table 4.1-A.

To "understand" a district like Kantishna would take modern geologic mapping of metamorphic rocks and structural features at scales of 1:6,000-1:12,000, tens of thousands of feet of drilling, and miles of underground workings. Based on the grade and extent of mineralization, the district could be an important one, comparing in size to many of the underground mining districts of the Lower '48.

For descriptive purposes, the Kantishna area is divided into three geographic units. From southwest to northeast, these units are called the Kantishna mining area, the Stampede mining area, and Chitsia Mountain-Tekla Hills area. The Kantishna mining area contains most of the productive mines, with the notable exception of Stampede.

TABLE 4.1-A

ANNOTATED BIBLIOGRAPHY OF KANTISHNA DISTRICT

Prindle, L. M., 1907, The Bonnifield and Kantishna regions, Alaska: B 314-L, pp. 205-226.

____________, 1911, The Mount McKinley region, Alaska; with descriptions of the igneous rocks and of the Bonnifield and Kantishna districts: PP 70, pp. 136-154, 169-180.

Capps, S. R., 1918, Mineral resources of the Kantishna region, IN Mineral resources of Alaska - 1916: B 662, pp. 279-282. Short description of general geology and good claim by claim description of mining in area, mostly gold, lode, and placer.

____________, 1919, The Kantishna region, Alaska: B 687, 116pp.

Moffitt, F. H., 1932, The Kantishna district: B 836-D, pp. 301-339. Describes the roads, trails, geology, and mineral deposits. Describes antimony and other minerals in Stampede, Slate, Slippery, and Clearwater Creeks, the silver-lead deposit on Mt. Eielson, the prospects between Slipper Creek and Mt. Eielson, lode deposits between Friday and Eureka Creeks, lode deposits of Eldorado, Glen and Spruce Creeks, the placer mining in the area and coal occurrences.

Wells, F. G., 1933, Lode deposits of Eureka and vicinity, Kantishna district, Alaska: B 849-F, pp. 335-379. Describes 72 square miles (an area 6 miles by 13 miles at the west end of the Kantishna hills). Includes information on previous surveys, geography, geology, history of mining, character of ore deposits, and the mines and prospects in the area. Detailed information on tunnels of Red Top and Little Annie Claims (including assays and sketch maps), as well as assays from other claims.

White, D. E., 1942, Antimony deposits of the Stampede Creek area, Kantishna district, Alaska: B 936-N, pp. 331-348. General description of geology including 1"=50' map of underground workings, and 1"=2000' map of Stampede area. Discusses ore reserves.

Seraphim, R. H., 1961, Kantishna district: AK DGGS unpublished report MR-193-2, pp. 25.

Seraphim, R. H., November 1962, Kantishna, Moneta Porcupine Ltd., unpublished report, pp. 11. Discusses work done in 1962 mapping and sampling using a dozer. Discusses geochemistry done on Star and Martha Q., Friday, Polly Wonder, Little Annie and Gold Eagle and geology done on Red Top, Friday-Martha Q., Silver Pick-Little Maude, Little Annie-Little Annie No. 2, Gold Dollar-Gold Eagle and some other showings on Quigley Hill. Includes three geological maps, three geochemical maps, and assay plans with detailed geology on 40 scale of Red Top, Silver Pick-Little Maude, Gold-Dollar-Gold Eagle, Little Annie-Little Annie No. 2 claims.

Barker, F., 1963, Exploration for antimony deposits at Stampede Mine, Kantishna District, Alaska, IN Contributions to Economic Geology, Alaska: B 1155, pp. 10-17. Describes results of exploration program carried out from 1953-1956. Contains good summary of past work done. Gives main showings on drill holes. 1"=60' map showing drilling. 1"=1000' map showing trenching on Kobuk and Pearl Harbor claims.

Chadwick, R. H. W., Consulting Geologist, September, 1975, Gross mineral appraisal of Mt. McKinley National Park, Katmai National Monument, Proposed Lake Clark National Park: U.S. Department of the Interior, National Park Service, Western Region. Objective of appraisal was "to estimate the cost of acquisition of all mineral property interests by the National Park Service." Describes how this was done, discusses the properties and the general geology and description of Kantishna, Foggy Pass limestone deposit, Mt. Eielson zinc and Greenback claim. Includes information on each claim visited (including Kardex information).

Bundtzen, T. K., T. E. Smith, and R. M. Tosdal, 1976, Progress report: Geology and mineral deposits of the Kantishna Hills, Alaska: AK DGGS OF 98, 80 pp. Contains geological and geochemical maps (1"=1 mile scale) of Kantishna Hills. Location and analyses of 430 sediment samples and 78 veins. Best up to date description of the area. Describes previously unrecognized stratiform mineral occurrences (zinc, lead, barite) in Totatlanika Formation.

The rocks exposed in the Kantishna district are dominantly schistose and correspond to the Birch Creek, Keevy Peak, and Totatlanika Schists of the Healy area (Wahrhaftig, 1968). The southwestern or Kantishna area is underlain mainly by quartz-mica schists, generally correlated with the Birch Creek; the northern Stampede and Chitsia areas have Birch Creek rocks overlain (?) by Keevy Peak and Totatlanika-like rocks.

(1) Kantishna Mining Area (fig. 4.1-A(1), table 4.1-A(1)): A strongly mineralized area extends at least from Slate Creek, northeasterly through the Quigley Hill area, to near Kankone Peak, a distance of about 20 miles. It is developed in Birch Creek-type rocks, and is centered axially on an upwarped structure termed the Kantishna "anticline."

The map of the area (fig. 4.1-A(1)) shows the location of samples collected in this investigation, and where mapped, the geology. It also shows the approximate location of patented claims, and the approximate linear extent of placer claims along major streams. It is meant to be used with table 4.1-A(1), which is a combined index and compilation of analyses. In this table, all field numbers, unless otherwise prefixed, are M, as M224,225. Field numbers prefixed as B, as Map. No. 68, Field No. B, are prospect numbers from the report by Bundtzen, Smith, and Tosdal (1976, Table 1). In some cases the Alaska State Division of Geological and Geophysical Survey card (Kardex) numbers are given in the table, and the approximate location of prospects only known from the state files are given on fig. 4.1-A(1), as KX 66-64, --5, -100, -87, -48, all on Willow Creek in the southeast part of the Kantishna area.

TABLE 4.1-A.(1) INDEX OF MINERAL DEPOSITS AND GEOCHEMICAL SAMPLES IN THE KANTISHNA AREA, SHOWING RESULTS OF ANALYSES OF ANOMALOUS SAMPLES

MD=Mineral Deposit--Sample types: Ch-3'=Chip with length
Gb=Grab

Geochemical sample types: SS=Stream sediment S=Soil
P=Pan concentrate R=Rock

Map No. or Symbol	Field No. or Deposit Name	Mineral Deposit or Geochemical Type	Kardex No. Prefix KX-66 on all	Results in parts per million unless indicated % or oz/ton						
				Cu	Pb	Zn	Ag	Au	Sb	Other or Remarks
1	M224	SS		20	50	465	<.2	-	50	Nos 1-16 Upper
2	225	SS		40	45	230	<.2	-	60	Slate Creek Area
3	223	SS		10	30	160	<.2	-	120	
4	221	S		-	-	-	.4	3.6	660	
5	222	S		-	-	-	<.2	<.02	30	
6	220	SS		-	-	-	-	<.02	18	
7	372	SS		55	45	165	<.2	-	760	
8	217	R		-	-	-	<.2	<.02	65	
9	219	S		-	-	-	.2	-	55	On fault gouge
10	218	S		-	-	-	-	-	5	
11	216	S		-	-	-	-	-	30	
12	226	S		Lost	Sample					
13	227	SS		-	-	-	-	-	65	
14	228	S		-	-	-	-	<.02	26	
15	371	R	109-110	-	-	-	.2	-	92,000	Ch 10' Slate Ck /Mine
16	215	R		-	-	-	.2	-	32	
17	524	SS		20	95	235	.4	-	70	
18	444	S		15	20	75	<.2	<.02		
19	445	S		320	30	60	<.2	<.02		
20	B3	MD		No Assay Information						Quartz & Pyrite
21	B2	MD		No Assay Information						Stibnite & Quartz
22	572	S		60	50	195	-	-	9	
23	554	S		10	30	-	.2	-	145	
24	553	S		15	145	-	.6	-	190	
25	552	S		20	50	-	<.2	-	270	
26	454	S		10	70	125	1.4	-	48	
27	455	S		15	430	195	5.6	-	1700	
28	551	S		45	80	-	<.2	-	38	
29	550	S		60	125	-	1.6	-	150	
30	453	SS		25	60	305	.4	-	40	
31	415	R		160	255	575	12	-	-	20Mo
32	456	S	41,22,	10	50	180	.8	-	270	.05Hg
33A	522	Ch-2'	125	540	12%	18.5%	460	-	2650	B = Bonnell
33B	523	Ch-3'		70	2.85%	10.0%	110	.05	670	
34A	561	S		-	-	-	3.2	-	300	

Results in parts per million unless indicated % or oz/ton

1/ Bundtzen Loc. No. 6; 3-20' stibnite vein; N30W,35° NE strike and dip, as much as 3' massive stibnite.

Map No. or Symbol	Field No. or Deposit Name	Mineral Deposit or Geochemical Type	Kardex No. Prefix 66	Cu	Pb	Zn	Ag	Au	Sb	Other or Remarks
C { 34B	459	R 1/		-	< 5	-	55	-	6800	.15Hg } C. Eagles Nest
34C	460	R		-	45	-	26	-	190	.11Hg
35	450	S		15	85	70	< .2	-	32	
36	451	S		20	55	125	.4	-	40	
37	452	S		25	60	215	.4	-	38	
38A	457	S		10	140	185	4.2	< .02	375	
38B	508	SS		220	65	205	< .2	< .02	-	
39	505	SS		350	90	50	.6	< .02	-	
40	506	S		545	50	30	< .2	< .02	-	
41	507	R		345	1650	635	11.0	< .02	-	
42	407	S		285	20	25	.4	-	-	
43A	405	S		450	10	35	3.4	-	-	
43B	406	R		1200	45	20	.6	-	-	
44	404	S		180	25	40	1.4	-	-	
45	403	S		320	40	50	.4	-	-	
46	402	S		480	30	95	.2	-	-	
47	401	S		55	320	580	2.4	-	-	
48	503	S		-	30	90	< .2	-	-	
D-ALPHA { 49	502	S	125	70	255	145	.8	< .02	-	} D. ALPHA
50	504	S	125	-	25	85	< .2	< .02	-	
51	400	R	125	2350	65000	18500	440	.20	8600	
52	500	R	125	800	11500	7500	320	-	2950	
53	501	R	125	5000	185000	46500	800	.22	27800	
54	446	SS		30	60	85	.4	< .02		
55	T61B	R		-	-	-	8.4	1.2	-	
56	T062	R		-	-	-	< .2	.16	-	
57A	T059	S		-	-	-	.6	.42	-	
57B	T060	R		-	15	35	50.0	.03	10800	
58	T058	R		-	-	-	1.6	.16	-	
59	T055	R		-	120000	1950	480	1.2	-	
60	T056	R		-	3800	2650	110	2.4	-	
61	T057	R		-	5000	3550	75	1.7	1300	
62	T054	SS		25	45	170	< .2	< .02	-	
63	351	S		50	50	95	< .2	-	-	
64	352	S		550	50	925	< .2	-	-	Metarhyolite (?)
65	353	S		300	135	465	.2	-	-	Metarhyolite (?)
66	458	S		50	35	115	< .2	< .02	-	
67	521			5	15	55	< .2	< .02	-	Limestone
68	B11			-	100	500	4.4	-	-	Stratabound in/
69	B12			No Assay Information						Qtz-Sid-Py-Gn Vein

TABLE 4.1-A (1) CONTINUATION SHEET

Map No. or Symbol	Field No. or Deposit Name	Mineral Deposit or Geochemical Type	Kardex No. Prefix 66	Results in parts per million unless indicated % or oz/ton						
				Cu	Pb	Zn	Ag	Au	Sb	Other or Remarks
70	T063	R		10	50	<200	< 1	–	–	15,1000 Mn
71	355	SS		35	30	145	.4	< .02	–	
72	549	SS		10	15	85	< .2	< .02	50	
73	548	SS		25	25	120	< .2	< .02	44	
74	528	S		10	15	65	8.4	.03	–	
75	416	S		–	800	600	8.0	.11	–	Graphitic schist
76	417	R		650	11500	16500	290	1.1	640	Tail-/qtz veined
77	529	R-	Gb	175	75	180	.80	.32	–	ings/Vein Mat.
78	413	R		–	345	425	10	15	–	.64ppm Hg
79	204	R		5	50	100	0.8	–	–	Aplite; 2w
80	T051	S		–	10	55	.2	–	–	
81	T050	R		–	505	315	2.8	< .02	–	Caved Pit
82	T052	S		–	95	175	0.4	–	–	Reddish Soil
83	442	S		10	5	15	19	.40	–	
84	443	S		5	50	45	1.6	2.5	–	
85	597	S		35	10500	29500	8.6	< .02	1700	
86	478	S		25	40	85	–	1.4	–	
87	447	S		60	3300	5200	< 26	1.2	1400	
88	462	R		5	30	–	< .2	–	280	Carbonate vein/
89	461	S		20	10	–	.6	–	16	stibnite
90	356	R		–	10	5	.6	1.4	–	
91	354	S		30	35	80	2.8	3.1	–	Qtz vein float
92	574	S		10	55	165	1.2	0.09	–	Old pits
93	575	S		–	170	–	1.6	0.09	–	Old pits/trench
94	568	S		50	165	1800	1.2	–	–	Soil in caved/
95	200	SS		70	1,750	700	42	.33	–	
96	201	SS		35	50	125	.6	.04	–	50w Gold Dollar
97	203	R		–	–	–	.4	< .02	–	Graphitic Schist
98	" 357	MD	15	3200	1800	2.7%	1600	2.8	1900	Ch-3'
99	" 358	MD	15	175	1300	550	17	2.0	125	Ch-1'
100	" 359	MD	15	1800	900	550	375	15.0	1450	Ch-1.5'
101	" 360	MD	15	185	265	2.65%	8.4	.27	75	Ch-3'
102	" 361	MD	15	200	2600	1600	50	12.0	110	Ch-2.8'
103	" 362	MD	15	200	3600	2500	95	6.5	140	Ch-1'
104	" 447	MD	15	600	9750	8350	150	2.4	–	Ch-2.5'
105	" 448	MD	15	1200	500	3700	70	1.8	–	Ch-8'
106	" 449	MD	15	435	800	6150	8.8	11.6	–	Ch-1.8'
107	202	R		–	–	–	.4	< .02	–	50W
107A	B24	MD		1000	15.11%	–	73.4	& .32	oz/t	Bundtzen; Golden
108	567	S		25	115	125	< .2	< .02	–	Eagle

Map No. or Symbol	Field No. or Deposit Name	Mineral Deposit or Geochemical Type	Kardex No. Prefix 66	Results in parts per million unless indicated % or oz/ton						
				Cu	Pb	Zn	Ag	Au	Sb	Other or Remarks
109	467	S		30	50	-	< .2	-	46	
110	465	R		13500	500000	52000	1150	<.02	8800	
111	466	S		40	35	-	.4	-	-	
112	468	R		465	27500	11500	50	-	3500	
113	471	S		30	130	180	.2	-	-	.06Hg
114	469	R		1000	50000	86300	1500	<.02	5400	32.0Hg
115	470	S		40	650	515	1.4	-	-	.095Hg
116	509	R		2450	750	100	2.0	-	-	
117	205	R		5	35	60	.2	.30	-	
118	206	R		15	20	50	< .2	<.02	-	Pyritic
119	207	R		5	25	40	< 2	<.02		
120	564	PC		70	>10,000	200	20	-	-	<50w;<10Sn
(C) 121	T064	R		69000	92500	2400	2.0	-	-	<2W
122	208	SS		30	150	260	.2	.02	-	
123	M277	R		5	15	-	5.6	.5	-	Float
124	510	R		-	35	300	1.0	0.1	-	Tailings;0.06Hg
125	514	R		-	3500	575	18	.09	-	
126	512	R		-	55	160	.4	.05	-	
127	511	R		-	575	900	5.6	1.2	-	
128	513	R		-	30	2,650	.4	.08	-	Wells 1933
129	B17	MD		-	22.0%	-	284.02	oz/t	-	Martha Q Claim;/
130	B21	MD		-	1-10%	-	89-144	oz/t	-	Silver Pick Clai
131	463	R		1,200	2,850	1,400	480	4.6	1,200	Silver Pick Clai
132	B20	MD		-	3.73	-	16.44&	.36	oz/t	Seraphim1961/1.1H
133	B21	MD		Silver	Pick	Claim				Silver Pick Clai
134	472	R		650	1000	535	320	24.0	-	
135	475	S		-	-	-	5.2	.10	-	4W
136	476	S		80	275	400	12.0	4.2	-	
137	565	R		205	180	805	20.0	.16	17	
138	566	R		85	130	115	3.4	1.9	-	
139	354	S		30	35	80	2.8	3.1	-	Waterlevel Pros.
140	B14	MD	-91	Trace	2,700	100	.92	oz/t	51.5%	Qtz-Stibnite vei
141	596	SS		35	25	140	.4	.05	-	<2W
142	B42	MD		No assay	information					Qtz-Aspy vein
143		MD								
144	B22	MD	-124							Little Annie
145	414	S		900	10	-	-	-	-	
146	T053	S		470	50	70	<.2	<.02	-	
147	473	R		50	1,050	170	4.0	<.02	-	<2W
148	B29	MD	Pennsylvania	Keystone				.86 oz/t		Davis, 1922

Map No. or Symbol	Field No. or Deposit Name	Mineral Deposit or Geochemical Type	Kardex No. PREFIX 66	Results in parts per million unless indicated % or oz/ton						
				Cu	Pb	Zn	Ag	Au	Sb	Other or Remarks
149	B25	MD		–	300	200	.22OZ/T	TR.	TR.	BUNDTZEN (1976)
150	B26	MD		–	200	200	TR.	TR.	TR.	" "
151	B35	MD		NO ASSAY INFORMATION						
152	B32	MD	-32	5,200	22,200	60,000	43.13	–	–	BUNDTZEN (1976)
153		MD		NO ASSAY INFORMATION						VEIN
154		MD		NO ASSAY INFORMATION						VEIN
155	536	SS		25	20	90	< .2	<.02	–	
156	147	SS		25	40	95	<.2	<.02	–	
157	149	SS		40	30	160	<.2	<.02	–	
158	300	SS		35	30	130	<.2	<.02	–	
159	148	S		40	35	95	<.2	<.02	–	
160	301	S		40	35	200	.2	.03	–	
161	302	SS		10	20	95	<.2	<.02	–	
162	303	SS		10	30	180	.2	<.02	–	
163	304	SS		30	40	165	<.2	<.02	–	
164	305	SS		35	40	165	<.2	<.02	–	
165	306	SS		35	50	245	<.2	<.02	–	
166	307	S		35	20	120	<.2	<.02	–	
167	308	S		25	120	125	1.0	<.02	14	<2Mo
168	411	S		80	50	210	0.6	–	–	
169	410	S		115	115	740	1.6	.02	–	
170	515	R		–	220	120	3.2	.17	–	
171	516	S		–	20	30	.2	.05	–	
172	517	R		–	120	100	1.6	.16	–	PIT
173	309	S		30	105	45	2.4	3.6	17	<2Mo PROSPECT
174	B41			NO ASSAY INFORMATION						
175	310	S		25	5	180	<.2	<.02	–	
176	409	R		15	30	135	–	–	–	
177	518	R		–	245	210	0.6	<.02	–	0.06 Hg
178	519	R		–	235	515	–	–	19	0.03 Hg
179	437	S		60	900	155	1.0	.08	–	
180	438	S		40	900	80	2.6	.06	–	
181	439	S		90	50	200	.4	<.02	–	
182	440	S		65	175	315	1.4	<.02	–	
183	441	S		150	110	455	1.4	<.02	–	
184	412	SS		30	45	265	–	–	–	
185	423	SS		35	25	140	.2	.10	–	
185	B50	MD	11,-107	100	300	TR.	.03OZ/T	TR.	36.4%	LAST CHANCE
186	177	R		–	30	160	.8	4.9	1800	
187	178	R		5	15	145	<.2	–	135	

Map No. or Symbol	Field No. or Deposit Name	Mineral Deposit or Geochemical Type	Kardex No. PREFIX 66	Results in parts per million unless indicated % or oz/ton						Other or Remarks
				Cu	Pb	Zn	Ag	Au	Sb	
188	179	R		650	15	135	110	2.6	340	
189	180	R		10	20	85	.6	4.0	560	
190	181	R		5	15	15	.4	.70	260	
191	537	SS		50	25	125	<.2	< .02	–	
192	538	SS		80	30	130	<.2	< .02	–	
193	539	SS		40	15	100	<.2	< .02	–	
194	540	SS		45	15	80	<.2	< .02	–	
195	541	SS		30	15	100	<.2	< .02	–	
196	542	SS		30	20	125	<.2	< .02	–	
197	543	SS		50	25	120	<.2	< .02	–	
198	544	SS		30	20	125	<.2	< .02	–	
199	545	SS		40	30	145	<.2	< .02	–	
200	546	SS		35	30	320	<.2	< .04	–	
201	547	SS		25	30	115	<.2	< .02	–	
202	429	SS		50	30	195	1.6	–	–	
203	430	SS		–	90	295	1.2	–	–	
204	431	SS		–	25	295	.4	–	–	ORGANIC
205	432	SS		–	40	265	.6	–	–	
206	433	SS		–	20	280	.2	–	–	
207	434	SS		–	25	260	.2	–	–	
208	435	R		–	100	185	.2	–	–	
209	436	R		165	18000	180	60.0	.3	–	ALTERED QTZITE
210	B43	MD		200	TR.	300	.02OZ/T	–	–	BUNDTZEN; 100Mo
211	182	SS		30	45	165	.2	< .02	–	
212	183	SS		40	35	145	<.2	< .02	–	
213	424	S		50	40	140	<.2	< .02	–	
214	184	S		80	40	100	<.2	–	290	
215	133	S		20	265	420	1.2	.15	–	
216	134	R		55	650	1650	12.0	.05	–	
217	B44	MD		MINERALIZED SEE BUNDTZEN (1976, P.45)						
218	425	R		–	35000	15000	100	4.5	2800	.89Hg
219	426	S		15	130	265	.8	<.02		
220	427	S		30	45	135	.4	–	–	
221	428	R		15	1050	360	8.8	–	–	
222	186	S		240	40	120	.6	–	10	
223	187	S		110	5	105	–	–	22	
224	534	SS		35	130	175	.8	.13	–	
225	B45	MD		–	–	–	.9OZ/T	–	–	BUNDTZEN, 1976
226	B46	MD		–	7,100	1,400	1.36	& .08OZ/T	.74%	" "
227	B51A	MD		–	–	–	–	–	–	

TABLE 4.1-A(1) CONTINUATION SHEET

Map No. or Symbol	Field No. or Deposit Name	Mineral Deposit or Geochemical Type	Kardex No. PREFIX 66	Results in parts per million unless indicated % or oz/ton						
				Cu	Pb	Zn	Ag	Au	Sb	Other or Remarks
228	B51	MD		400						
229	132	S		15	15	65	.2	.19	–	
230	B48	MD					3-16OZ/T			BUNDTZEN
231	533	R		–	1,500	1,050	26	.92	–	IN B48 CLAIM GRP
232	532	S		40	30	140	< .2	<.02	–	MASS.QTZ VEIN
233	531	S		20	45	90	< .2	<.02	–	
234	130	S		5	20	40	< .2	<.02	–	
235	421	S		10	30	55	.4	.12	–	
236	129	S		65	50	100	< .2	<.02	–	
237	530	S		115	40	185	<.2	<.02	–	
238	128	S		70	35	90	.2	<.02	–	
239	B52	MD		21,600	900	39,800	.97OZ/T	TR.	–	BUNDTZEN, HIGRADE
240	535	S		–	600	500	13	.71	–	TRENCH
241	188	R		55	305	155	.6	<.02	90	
242	139	S		–	90	90	3.2	.51	–	
242A	B56	MD		–	460	–	–	7.6	–	
243	138	S		485	10500	7,000	90	1.2	–	
244	137	S		675	14,500	21,000	120	.47	–	
245	135	SS		40	40	125	.4	.05	–	
246	136	SS		95	210	410	.6	.02	–	
247	174	SS		50	55	135	.6	.02	–	HIHOLMANBUFFER
248	175	SS		80	75	250	.4	.30	–	
249	170	R		10	120	85	1.0	.03	–	QTZ VEIN
250	B54	MD		–	–	–	.45OZ/T	–	2,300	BUNDTZEN
251	171	SS		40	55	145	.2	–	–	
252	420	S		–	2,600	650	26	.10	20	
253	173	SS		40	60	175	.4	.03	–	
254	419	S		–	700	700	14.0	.38	35	
255	B53	MD		NO ASSAY INFORMATION						
256	169	SS		40	30	160	< .2	<.02	–	
257	168	R		–	30	25	.2	<.02	–	
258	418	SS		–	45	180	< .2	–	4	
259	172	SS		30	30	195	< .2	.03	–	
260	189	S		45	25	85	< .2	<.02	–	
261	190	S		40	80	130	.2	<.02	–	
262	191	R-G		45	25	60	< .2	<.02	–	Pyritic quartzi
263	B57	MD		NO ASSAY INFORMATION						
264	140	S		5	70	85	1.4	.95	–	
265	141	S		50	25	35	.2	.10	–	
266	B56A	MD-G		TRACE	TRACE	TRACE	.28	.01-.22 OZ/T		

Map No. or Symbol	Field No. or Deposit Name	Mineral Deposit or Geochemical Type	Kardex No. PREFIX 66	Results in parts per million unless indicated % or oz/ton						
				Cu	Pb	Zn	Ag	Au	Sb	Other or Remarks
267	142	S		95	65	155	.2	<.02	–	
268	143	S		15	40	125	.8	.10	–	
269	144	S		45	60	110	< .2	.02	–	
270	145	S		40	40	170	.2	<.02	–	
271	422	PC		20	200	< 200	2.0	–	–	7000Ti, 500Sn, 100Ni, 20%Fe
272	195	MD-G		340	85000	1450	340	9.9	1250	1' QTZ-ASPY VEIN
273	194	S		50	160	315	.2	< .02	–	
274	B59	MD		NO ASSAY INFORMATION						
275	193	R		320	350	17000	3.4	< .02	–	GOSSAN LAYER IN GRAPHITIC SCHIST
276	192	R		25	40	65	< .2	<.02	–	
277	B58			NO ASSAY INFORMATION						
278	75 AST 1681			–	1050	240	1.7	–	–	
279	146	S		30	25	110	< .2	<.02	–	
280	176	R		–	5	110	< .2	<.02	–	
281	75 AST 2023	MD		–	6800	6000	31.0	–	–	
282	B60	MD		300	14300	–	3.2	7.7	–	
283	196	S		40	170	95	.2	< .04	–	
284	344	S		–	5	80	< .2	–	–	
285	343	S		–	35	135	< .2	–	–	
286	342	S		–	35	130	< .2	–	–	
287	345	SS		–	15	110	< .2	–	–	
288	346	SS		–	35	180	< .2	–	–	
289	198	S		–	–	95	< .2	< .02	<	
290	B62	MD		–	4700	1400	–	–	32	8.5Mg
291	B61	MD		1.02%	–	–	1.9	–	–	
292	197	S		25	20	55	< .2	< .02	–	
293	75 AST 68	MD		1250	–	–	3.4	–	–	
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a. Geologic setting--The Birch Creek Schist of the Kantishna mining area consists mainly of quartz-feldspar-mica or quartz-mica schist, and subordinately of carbonate-rich schist, schistose limestone, locally graphitic, and graphitic schist. The subordinate units crop out mainly along the crest of the northeasterly-trending Kantishna "anticline." Bundtzen, Smith, and Tosdal (1976) mapped amphibolitic greenschist units, particularly on the north flank of the area.

The structure of the area is apparently simple; that of an open, nearly symmetrical anticlinal form, locally crossfaulted and warped. The apparent simplicity is confirmed to some extent by stratigraphic relations with the carbonate-rich facies exposed mainly in the apparently upfolded core, and by near parallelism between bedding and schistosity. Bundtzen, Smith, and Tosdal (1976) also, however, described sheared serpentinite zones near the schistosity, and other evidence of strong bedding or low-angle slippage, and Morrison (1968) described small-scale structures which imply multiple deformation. On the basis of present knowledge, the structure can be explained as (1) relatively simple, locally modified by thrusts in tight folds, or (2) that the area has been multiply deformed, perhaps with an early recumbent fold, thrust fault style, which was up-arched in Cretaceous-early Tertiary time. If multiple deformation is assumed, the first order control of at least the vein-type mineralization appears to be the later deformation, folding and faulting, not the complex, possibly isoclinal, early folding.

There is little evidence of an igneous association of most of the mineralization in the district. A mineralized quartz porphyry crops out at the Bonnell prospect, a second, very small intrusive is in Friday Creek; limy rocks are converted to tactite on Iron Dome, but a general sparcity of igneous rocks or indirect evidence of igneous activity is the rule.

b. Economic geology--Three main types of vein deposits have been recognized by most geologists in the district: (1) gold-bearing quartz veins, (2) silver-lead bearing veins, and (3) antimony-rich veins. Both types 1 and 2 are rich in arsenic, and both contain antimony, with antimony apparently increasing in class 2. Stibnite is the main mineral of the type 3 veins.

Two subclasses of the silver-lead bearing veins have also been recognized--galena-sphalerite veins with silver in the 5-20 oz/ton range, and galena-sulfosalt veins which contain tetrahedrite, jamesonite, argentite, ruby and native silver with silver ranging upward from 50 to more than 1,000 oz/ton.

District type zoning has also been suggested at Kantishna (as by Bundtzen, Smith and Tosdal, 1976). In a zoning scheme, gold-bearing veins predominate in the northeast axial part of the area, with silver-bearing veins in the southwest axial region. Antimony veins appear to overlap, but judged by some of the better occurrences, like Eagle's Nest, Slate Creek, and Last Chance, the best antimony deposits may be peripheral to the main area of silver-lead and gold-bearing veins.

Most of the mine workings are caved and surface trenches sloughed, but based on some outcrops, published data, and geochemistry, mineral structures range from one foot or less in width and 50 to 100 feet long, to zones in excess of 30 feet wide, by more than 2,000 feet long. Known shoots of bonanza grade ore are on the order of 50 to 500 tons in size.

Most of the deposits previously identified in the Kantishna area are of vein type, but high metal contents in certain strata and minor stratiform mineral occurrences suggest that the area has potential for stratabound deposits; and also the possibility that stratabound sources may be the source of at least part of the metals now contained in veins. Graphitic schists interlayered with limy units in Eldorado Creek and in Quigley ridge have unusually high metal content: graphitic schist, apparently not mineralized, at location 69A in Eldorado Creek contains, in ppm, 160 copper, 255 lead, 575 zinc, 12 silver, and 20 molybdenum; graphitic schist (loc. 75) with apparently unmineralized quartz veins 2,000 feet northwest of Kantishna, contains, in ppm, 800 lead, 600 zinc, 8.0 silver, and 0.11 gold. Gray phyllite and ferricrete from the phyllite in a cliff just north of Kantishna is strongly anomalous in gold and silver (samples 83-84, table 4.1-A(1)).

Stratabound deposits in carbonate rocks in Eldorado Creek were reported by Bundtzen, Smith and Tosdal (1976) at their localities 8 and 11--respectively 37 and 68 on fig. 4.1-A(1). A stratiform gossan layer 1' thick and exposed for 20 feet along strike was found at location 275; gossany soil material at this location contained 1.7 percent zinc and 3.4 ppm silver. The gossan is in graphitic limestone schist. Mineralized felsic schists occur southwest of the Alpha mine (sample locations 40-43) in a road cut southwest of Wickersham Dome (locations 145-146), and about a mile north of Kantishna airstrip (locations 63-64) on the east side of Moose Creek. At the Alpha mine and Wickersham localities, chalcopyrite is disseminated in schist, and the schist contains sparse 6" - 1' sulfide-rich layers. The Wickersham Dome schist has limited exposure, and may be faulted off near the Divide between Friday Creek and a southward-flowing tributary. The Alpha occurrence is notably pyritic and anomalous in copper for 2000 feet, and soil samples collected up to 1000 feet east of the pyritic outcrops (nos. 44-46) are anomalous in copper. The felsic schist, possibly metarhyolite, exposed north of Kantishna airfield contains anomalous copper and zinc.

The mineralized felsic schist exposed southwest of the Alpha mine is about on strike with the Alpha vein, and is probably the gossan referred to by Bundtzen, Smith, and Tosdal (1976, p. 29). It is believed, however, to be a separate stratiform occurrence not directly related to the Alpha vein. Besides differing in stratabound versus cross-cutting occurrence, the schist is characterized by copper and silver, rather than lead, zinc, silver of the Alpha vein.

Another "stratabound" occurrence, not examined in this survey, is the Lloyd prospect mentioned by

Bundtzen, Smith and Tosdal (1976, no. 52, table 4). Chalcopyrite, sphalerite, and magnetite are in a three- to ten-foot thick layer, described as "apparently a pre-metamorphic sulfide occurrence with bands of sulfides folded with country rock."

Erosion of the exposed or similar veins has produced placer deposits in most of the creeks on both sides of the Kantishna antiform (fig. 4.1-A(1). It is difficult to assess such deposits without drilling or trenching and little work was done on placers. The approximate extent of claims is shown, and on upper Caribou Creek, left-limit bench deposits were obvious enough that they were sketched on fig. 4.1-A(1).

We concur with Chadwick (1976) that the size of valley systems and grades determined by mining in progress indicates that lower Caribou and Moose could have extensive deposits, and that the tributaries like Glen have low yardage, but very rich deposits. The valley bottom placers have been extensively mined in Friday and Eureka Creeks, and large reserves are, hence, not possible. Small benches and alluvial placers may prove very satisfactory for one or two-man operations.

c. Major lode deposits--The main lode deposits recognized in the area include Slate Creek (Sb), Bonnell (Pb-Zn-Ag), Alpha (Ag-Au-Pb), Quigley Hill properties, including Red Top, Little Annie, and Gold Dollar (Ag-Pb), Banjo and Jupiter Mars (Au-Ag), and Last Chance (Sb). Information on these and a few other prospects is summarized in map form in the following illustrations. With the exception of the Quigley Hill area (Seraphim, 1962), maps are tape-compass maps made during the 1976 investigation:

Map	Property	Remarks
Fig. 4.1-A(1)-1	Slate Creek	
4.1-A(1)-2	Bonnell	
4.1-A(1)-2	Alpha	
4.1-A(1)-3	Quigley Hill properties (with Gold Dollar)	(Seraphim)
4.1-A(1)-4	Banjo-Jupiter Mars	
4.1-A(1)-5	Last Chance	

SLATE CREEK ANTIMONY MINE

A deposit exposed at the surface and in shallow workings in upper Slate Creek has produced about 625 tons of antimony ore with about 45 percent antimony content (Bundtzen, Smith, and Tosdal, 1976, p. 27-28). The deposit was first located in 1904-05, and was explored by a tunnel 97' long driven in 1915 and 1916. About 125 tons of hand-picked ore were produced from stoping near the portal of this adit, including 37 tons of 58 percent ore shipped by Earl Pilgrim in 1942 (Ebbley and Wright, 1948). Ernest Maurer produced about 160 tons of 47 percent ore in 1943 and 1944 from the old workings, and a 63-foot long drift about 16 feet lower than the early tunnel. The balance of production has come from an open cut excavated over the old drift adits in the 1970s.

The property has been reached by a now inaccessible road up Eldorado and Slate Creek, by trail from a good airstrip

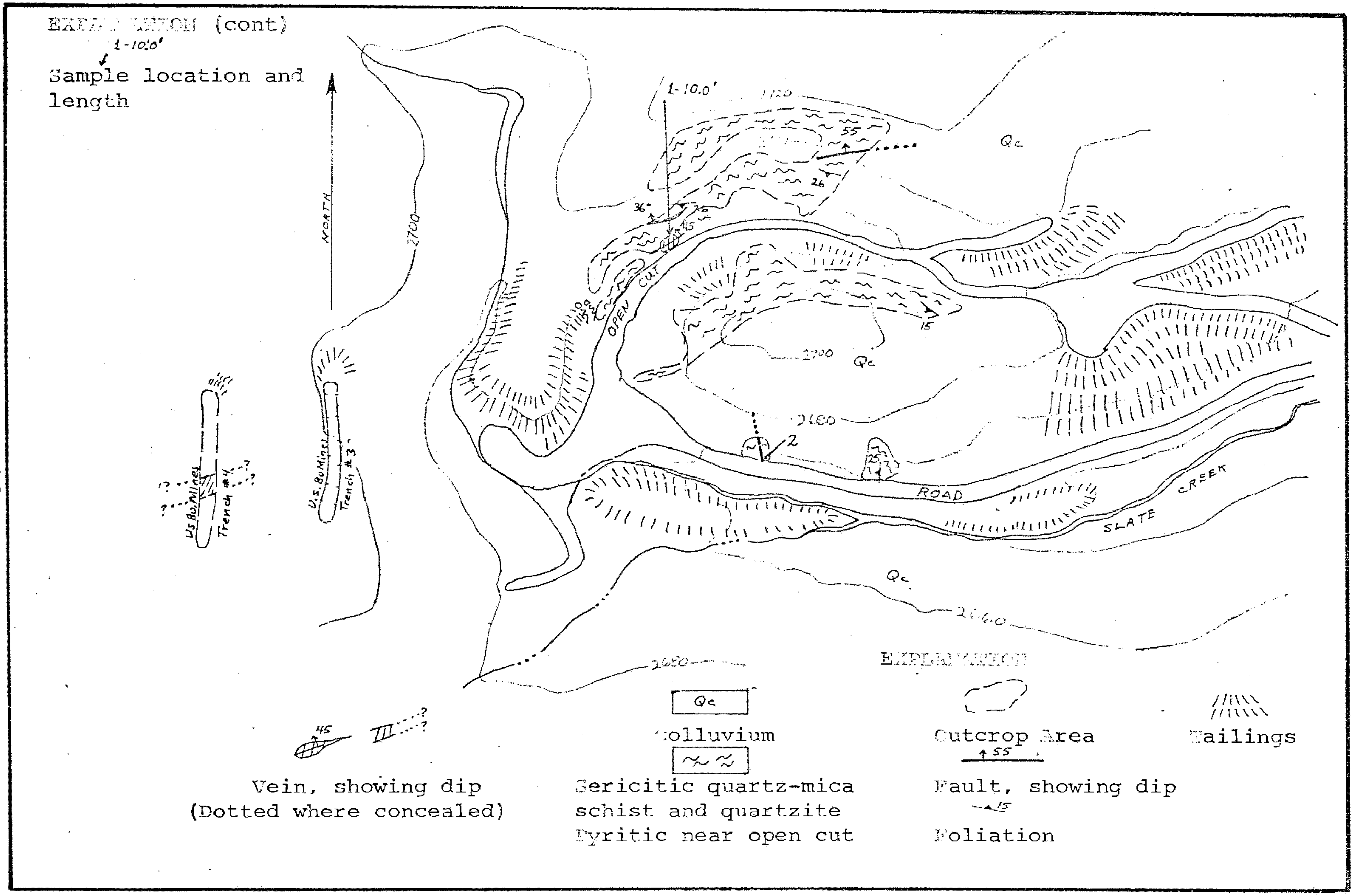


FIGURE 4.1-A(1)-1--SLATE CREEK
Scale: 1"=100-ft: = 20-ft

Tape and compass sketch by C. D. Hale and Geoff Garcia, 19 about one mile southwest of the prospect, and along the ridge top by cat trail from a ridge that starts just south of the Slate Creek-Eldorado Creek intersection. This latter route is preferable for surface access.

The ore deposit itself is pod-like in character, but lies in or near a northeast-striking fault structure. It has been explored by both private individuals and, in 1942, by the U.S. Bureau of Mines, who excavated five trenches across the trend of the deposit and drilled eight vertical churn holes. The 63-foot drift was driven on an ore trend found in trenches 1 and 2 from the bottom of trench no. 2. The exact relations of the original ore-showing are not decipherable within the 1970 bulldozer cut; as described by Ebbley and Wright (1948, p. 22), they were:

> The Slate Creek antimony deposit lies within a shear zone 40 feet wide . . . . The most pronounced line of demarcation between the shear zone and the enclosing quartzite schist is seen on the southeast or hanging wall side. Here a strong fissure striking N50°E and dipping steeply to the southeast, forms a definite break with the country rock.
>
> The ore body proper . . . has a maximum width of 26 to 28 feet where exposed in trench 2. The mineable part of the vein consists of a reticulated stockwork of quartz, high-grade ribs of stibnite, zones of stibnite boulders enclosed by decomposed schist, and horses of almost barren decomposed schist, all thoroughly intermixed. Although generally speaking the ribs of high-grade stibnite parallel the strike of the main shear zone, in some cases it appeared that these ribs were of low dip and divergent from the strike of the main fissure.

The results of Bureau trenching indicated an ore zone at least 100 feet long and up to 28 feet thick; churn drilling indicated that antimony-bearing material with more than two percent antimony content continued downward to 50 feet below trench no. 2 and grades above one percent to 25 feet below trench no. 1. The material indicated has been mostly removed by open-cut mining (fig. 4.2-A(1)-1) and the only ore showings are small (less than one foot), high-grade veins and a 10-foot sheared zone at the site of our sample no. 1, which assays 9.2 percent antimony. Bureau of Mines drilling and drifting by Ernie Maurer in 1943 apparently substantiates a steep dip for the ore zones, which partly conflicts with relations observed in trenches.

The prospect and nearby area does appear to have potential for continued antimony production, but mainly because of other indications of mineralization. Antimony-bearing material occurs in black, mucky gossan in Bureau of Mines trench no. 4 (fig. 4.1-A(1)-1) about 300 feet west of the open-cut, and in other nearby trenches (not shown). Anomalous amounts of antimony are contained in soils and stream sediments and rock samples in uppermost Slate Creek and in the southflowing drainage about one mile west of the head of Slate Creek (sample nos. 1-16, fig. 4.1-A(1) and table 4.1-A(1)).

In order to outline the potential, this one- to two-mile square area should be mapped and soil sampled in detail, and favorable zones should be further tested by excavation and drilling. This work could be accomplished along with needed clean-up operations at the existing mine site.

BONNELL PROSPECT

The Bonnell or Neversweat prospect is on the south side of Eldorado Creek about two and a half miles southwest of Kantishna, and is accessible by a four-wheel drive road which follows Eldorado Creek. The Bonnell is not known to have been productive, but is well mineralized and is the main prospect in the Kantishna area showing a spatial relation to an igneous pluton--a light-colored quartz porphyry which crosses Eldorado Creek near the prospect.

The prospect is opened in a series of short adits which are mostly caved; the uppermost adit is open and was mapped as representative of the mineralization type (fig. 4.1-A(1)-2).

The mapped adit is mainly in mica-schist cut at the face by two intersecting dikes of quartz porphyry. Veins of massive galena-sphalerite and quartz with scattered galena-sphalerite are in both the schist, locally parallel to schistosity, and quartz porphyry. The veins in schist pinch and swell along strike, but are up to at least three-feet thick. An 18-inch to 2-foot thick vein is in the quartz porphyry and parallels the strike and dip of the main dike. A two-foot sample of this vein contained about 30 percent combined lead and zinc and about 13.5 oz silver per ton.

Mineralized material found on dumps from other short adits is similar in character--rich in massive galena and reddish sphalerite. Stibnite and sulfosalts, including boulangerite, jamesonite, and tetrahedrite are locally present.

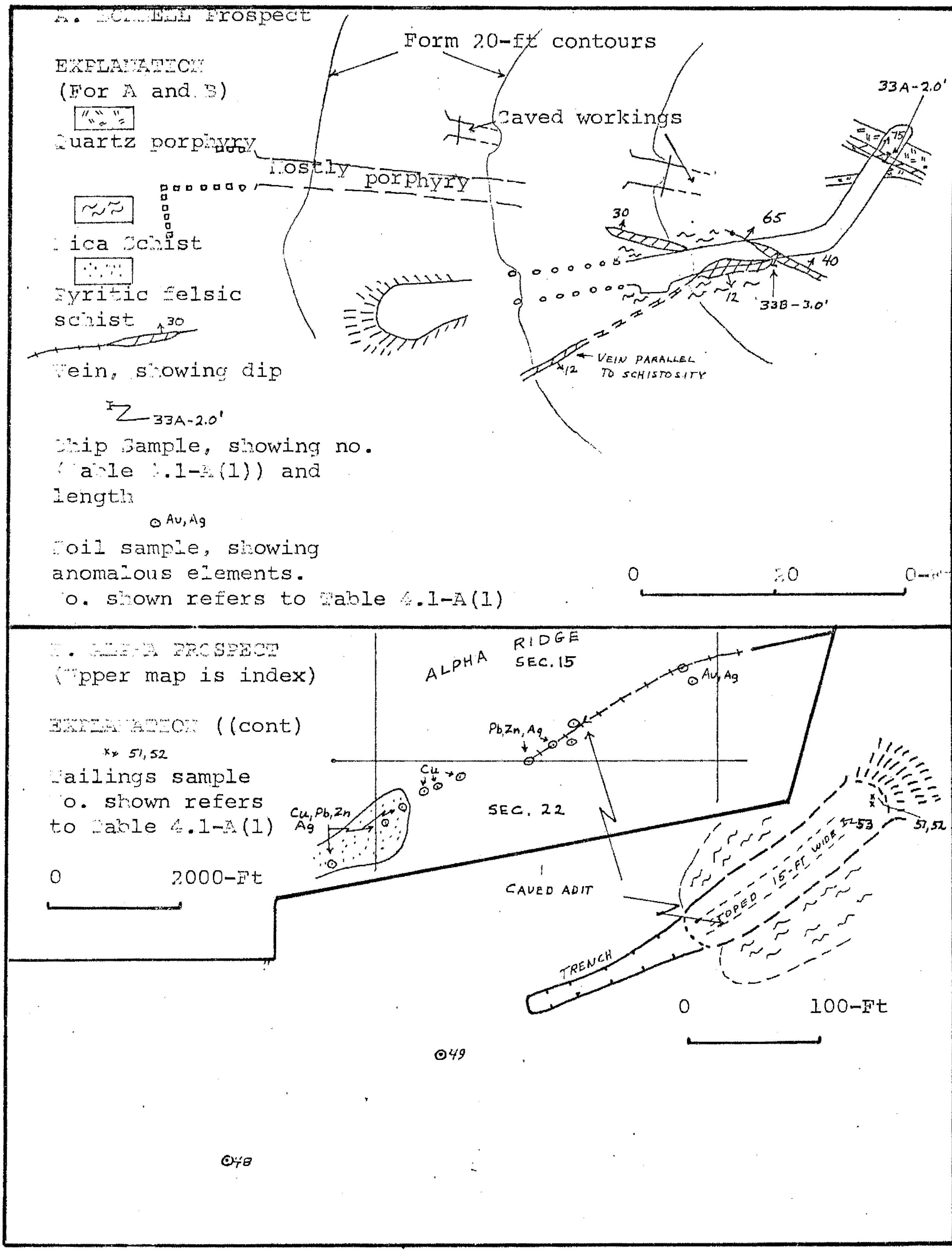


FIGURE 4.1-A(1)- 2--SKETCH MAPS OF THE BONNELL(A) and ALPHA (B) PROSPECTS

The prospect has not been productive because of relatively low silver content, but it could produce mill-type ore. If it is assumed that all silver is bound in galena, a lead concentrate would contain about 80 oz silver per ton.

The extent of mineralization is uncertain, but could be fairly extensive. The vertical extent shown at the adits is about 150 feet. More speculatively, relatively high amounts of silver, lead, and antimony shown in soil and stream sediment samples collected near the 5000-foot long quartz porphyry plug suggests the possibility of similar veins in about a one-half square mile area.

ALPHA MINE

The Alpha Mine owned by Jim Fuksa and associates was a producer of small amounts of high-grade silver ore in 1921, with a recorded production of ten tons which averaged 200 oz silver and 2.5 oz gold per ton.

The mine was developed by an adit, now caved, and is on a ten-foot wide vein which strikes N60-70E^{o}, which can be traced or reasonably projected by geochemical anomalies 3000 feet in the southeast part of sec. 15. Further, geologic mapping suggests that the vein passes into a fault to the northeast, and it projects toward a mineralized felsic schist to the southwest (figs. 4.1-A(1) and 4.1-A(1)-2.

Vein minerals reported include galena, jamesonite, stibnite, sphalerite, siderite, pyrite, and arsenopyrite, with minor amounts of tetrahedrite and boulangerite.

Two grab samples and one chip sample of vein material were metal-rich (nos. 51-53, table 4.1-A(1). One sample of partly oxidized material assayed about 23oz/ton silver and 18.5 percent lead. The structure needs extensive prospecting, especially to determine its eastern and western extent.

THE QUIGLEY HILL PROPERTIES (fig. 4.1-A(1)-3)

Several veins exposed on a ridge east of Moose Creek and between Eureka and Friday Creeks have produced small amounts of high-grade silver ore, with the most coming from the Little Annie, Gold Dollar, Red Top, and Galena veins from 1919-1923 and in 1973. Reported total production of the group is about 1,647 tons of ore, which contained about 254,089 ounces of silver--or an average grade of slightly more than 150 oz/ton silver (after Bundtzen, Smith and Tosdal, 1976, table 1).

Except for minor hand picking of dump material, the last attempt at underground mining on the Quigley Hill properties was at the Gold Dollar mine in 1973. About 120 tons was mined and some was milled in a newly-constructed mill at the Red Top. A sketch longitudinal section plan and vein sections of this work are shown in the insert on fig. 4.1-A(1)-3.

The country rocks are mainly quartzitic schist (including meta graywacke), quartz-mica schist, with minor limestone and calc-schist and graphitic schists. Exposures vary from good on ridge crests, to essentially nil on the sides of the valleys. Outcrop areas shown (fig. 4.1-A(1)-3) are generalized from detailed mapping by Seraphim and others (1961, 1962A). The ridge is near the crest of the Kantishna antiform (fig. 4.1-A(1)).

The mineral deposits are generally east-northeast striking, steeply dipping veins from less than 1 to as much as 27-feet thick (Little Annie); a subordinate vein set strikes northeast, and a vein or fault set (not shown) probably also strikes north-northwest. At most places the veins consist of quartz, siderite, galena, pyrite, and some sphalerite, and have not been mineable. Locally, perhaps at vein intersections or near north-northwest cross faults (Bundtzen, Smith and Tosdal, 1976; oral commun. Leo MarkAnthony, 1976), they contain bonanza silver sulfosalt ores which have proved mineable.

These deposits have been explored by tunnels or drifts measured in hundreds of feet long at the Red Top, Gold Dollar, and Little Annie, and by trenches and pits and short adits and shallow shafts on most of the claims. Most of the workings and all major workings are caved and inaccessible, but Seraphim's work documents recent exploration activity near the Red Top and older U.S. Geological Survey reports have good descriptions of the Little Annie and Red Top (notably Wells, 1933). There has been essentially no drilling and little geophysics; an unsuccessful attempt was made in 1976 to pick up the Little Annie vein by VLF-EM. Possibly self-potential methods would be as effective as any technique in tracing the veins.

The extent of ore in depth thus remains untested. The bonanza shoots mined thus far are probably more likely hypogene than supergene, as indicated by the abundance of primary sulfosalts in the rich ore.

Of the known veins, Red Top, Gold Dollar-Golden Eagle, Little Annie, Silver Peak, Galena, Frances, Little Maud, and probably Water Level and Sulfide have horizontal continuity measured at least in hundreds of feet and deserve further exploration.

Veins in the southeast part of the area, including those on the Pennsylvania and Pittsburg, appear to be gold-quartz veins similar to those exploited at the Banjo mine.

BANJO-JUPITER MARS

The Banjo or Red Top mine has been the most productive underground mine in the district. From 1939-1941 the mine produced about 13,653 tons of ore with an average grade of about 0.46 oz/ton gold, and 0.52 oz/ton silver, with small amounts of, in decreasing order, lead, arsenic, and zinc. The workings are completely caved in 1976, although they reportedly were open in 1960. The mine closed due to World War II and reportedly has reserves blocked out to the extent of several thousand tons. Judged from adit orientation, the Banjo vein strikes northeasterly, and could continue eastward beyond the present workings through a tundra-covered saddle (fig. 4.1-A(1)-4).

The Banjo prospect was visited in 1929 by E. R. Pilgrim (1929B) and was described as a quartz-rich vein more than twelve feet across, with minor galena, occasional sphalerite, and at

TABLE 4.1-A(1)-4

INDEX OF MINERAL DEPOSITS AND GEOCHEMICAL SAMPLES IN THE BANJO-JUPITER MARS AREA, SHOWING RESULTS OF ANALYSES OF ANOMALOUS SAMPLES

MD = MINERAL DEPOSIT--SAMPLE TYPES: CH-3' = CHIP WITH LENGTH. GB = GRAB

GEOCHEMICAL SAMPLE TYPES: SS = STREAM SEDIMENT S = SOIL
P = PAN CONCENTRATE R = ROCK

MAP NO. OR SYMBOL	FIELD NO. OR DEPOSIT NAME	MINERAL DEPOSIT OR GEOCHEMICAL TYPE	KARDEX NO.	RESULTS IN PARTS PER MILLION UNLESS INDICATED % OR OZ/TON						
				CU	PB	ZN	AG	AU	SB	OTHER OR REMARKS
1	M509	MD-GB		–	2,450	750	100	2.0	–	TAILINGS
2	576	S		15	15	100	< .2	< .02	–	<2W
3	584	S		5	15	20	< .2	< .02	–	7W
4	585	S		40	20	150	< .2	< .02	–	<2W
5	586	S		20	5	90	< .2	.03	–	<2W
6	587	S		60	30	185	< .2	< .02	–	<2W
7	588	S		5	10	85	< .2	< .02	–	4W
8	580	S		40	135	210	< .2	< .02	–	<2W
9	579	S		40	90	195	< .2	< .04	–	<2W
10	578	S		30	90	205	< .2	< .02	–	<2W
11	577	S		30	45	165	1.2	< .02	–	<2W
12	581	S		30	50	140	.4	< .02	–	<2W
13	582	S		15	35	140	< .2	< .02	–	<2W
14	583	S		20	25	115	.2	< .02	–	<2W
15	311	S		35	200	125	2.4	< .02	–	
16	312	S		30	140	115	1.0	.03	–	
17	313	S		25	100	95	.4	.03	–	
18	314	S		20	200	200	1.2	.05	–	
19	315	S		30	225	165	2.4	.02	–	
20	316	S		35	180	515	2.0	.04	–	
21	317	S		30	515	315	4.4	.03	–	
22	318	S		40	750	270	11.0	.26	–	
23	319	S		25	260	230	2.0	.04	–	
24	320	S		35	750	700	12.0	.02	–	
25	321	S		160	9,000	4500	75.0	.18	–	
26	322	S		50	1,350	575	11.0	.10	–	
27	323	S		60	1,150	375	120.0	.04	–	
28	324	S		45	40	145	.2	< .02	–	
29	598	S		65	35	135	1.4	< .02	–	
30	325	S		75	40	130	.2	< .02	–	
31	599	S		55	45	135	.2	< .02	–	
32	326	S		40	45	125	< .2	< .02	–	
33	350	S		55	55	145	.2	.19	–	
34	327	S		70	30	215	2.2	< .02	–	
35	328	S		50	95	215	2.8	.03	–	

TABLE 4.1-A(1)-4 (CONTINUATION SHEET)

MAP NO. OR SYMBOL	FIELD NO. OR DEPOSIT NAME	MINERAL DEPOSIT OR GEOCHEMICAL TYPE	KARDEX NO.	RESULTS IN PARTS PER MILLION UNLESS INDICATED % OR OZ/TON						
				CU	PB	ZN	AG	AU	SB	OTHER OR REMARKS
36	329	S		70	110	370	1.0	< .02	–	
37	330	S		130	250	1050	9.0	.15	–	
38	331	S		25	130	265	1.6	.03	–	
39	334	S		75	1100	605	16.0	.23	–	
40	335	S		100	3900	800	22.0	.26	–	
41	336	S		30	90	175	.4	< .02	–	
42	337	S		30	30	130	.2	< .02	–	
43	338	S		20	65	95	.8	< .02	–	
44	339	S		25	60	365	.6	< .02	–	
45	340	S		15	35	150	.4	< .02	–	
46	341	S		5	50	150	1.2	< .02	–	
47	332	S		405	25000	3100	13.0	6.4	–	TAKEN FROM TRENCH BTM
48	333	S		60	565	1050	.4	.22	–	NEAR PIT;
49	525	MD-CH	3'	2,500	22500	4600	260.0	5.5	600	RED SOIL
50	526	MD-CH	4'	950	16000	1800	100.0	1.6	345	
51	527	MD-CH	3'	290	230	1800	1.2	.15	32	
52	205	S		5	35	60	.2	.30	–	SOIL IN BULL
53	206	S		15	20	50	< .2	.02	–	DOZER CUT
54	207	S		5	25	40	< .2	< .02	–	" "

some places, scheelite. As estimated from a sketch made by Pilgrim, the vein strikes about N35E, dips steeply southeast, and has a carbonaceous schist hanging wall. Representative samples cut by Pilgrim assayed from 0.04-0.66 oz/ton gold, 0.20-27.20 oz/ton silver, and 0-2.1 percent lead; a three-foot sample also assayed .43 percent WO_3.

The strike measured by Pilgrim is consistent with trend of workings on a steeply dipping vein. Soil and colluvium is fairly deep in the saddle northeast of the mine workings, but some soil samples close to the projected path of the vein are anomalous in gold, lead, or silver (fig. 4.1-A(1)-4; table 4.1-A(1)-4).

Several hundred feet south of the Banjo is another gold-quartz lode, the Jupiter-Mars, which is on 4 claims--from north to south, Chlorine, Jupiter-Mars, Chloride, Waterloo--covering a major lode zone. The prospect is opened by a short adit and trenches. The vein system strikes east-northeast and dips steeply. Old reports state that the vein was lost in the face of the short adit. The soil geochemistry (fig. 4.1-A(1)-4; table 4.1-A(1)-4) done near the prospect indicates, however, that the vein zone itself continues at least 2,000 feet to the east. The anomalous zone is about 200 feet across and is characteristically enriched in lead, zinc, silver, as well as gold.

The Jupiter-Mars prospect was visited and sampled by E. R. Pilgrim in 1929 (1929B). Channel samples collected by Pilgrim in the adit respectively 33 feet and 90 feet from the portal assayed 0.09 oz/ton gold, 2.00 oz/ton silver, and 1 percent lead over

5.6 feet and 0.21 oz/ton gold, 8.6 oz/ton silver, and 1.6 percent lead over 10 feet, or generally comparable with samples 49-51 on fig. 4.1-A(1)-4.

Based on the surface trends, the Banjo and Jupiter-Mars could intersect in upper Lucky Gulch.

The gold-bearing area which extends eastward from about the Pittsburg through the Jupiter-Mars-Banjo area into upper Glen and Spruce Creek is extensive, has relatively continuous large veins and deserves more detailed study.

LAST CHANCE LODE

The Last Chance property is in Last Chance Creek just above Caribou Creek. Short adits, shallow shafts, and trenches (fig. 4.1-A(1)-5) develop a northeast striking vein, which is about 2 to 6-feet thick, consisting of quartz, sheared and altered country rock, and stibnite and jamesonite(?) bearing sulfide material. According to Bundtzen, Smith and Tosdal (1975) the mine has produced about 75 tons of high-grade antimony concentrates.

Much of the vein material has been removed by mining from the exposed parts of the vein; three samples of vein material left in the shallow workings show presence of gold in the 0.08-.15 oz/ton range with silver and antimony.

d. Other deposits or prospects--Data on the Slate Creek, Quigley Hill and other well-known occurrences

EXPLANATION

Country rocks are mainly chlorite schist

1↙ 4-4.0'

Sample location, shows length

ANALYSES

	Pb	Zn	Au	Ag	Sb
	(all in ppm)				
1.	30	160	4.9	0.8	1800
2.	15	145	<0.02	<0.2	135
3.	15	135	2.6	110	340
4.	20	85	4.0	0.6	560

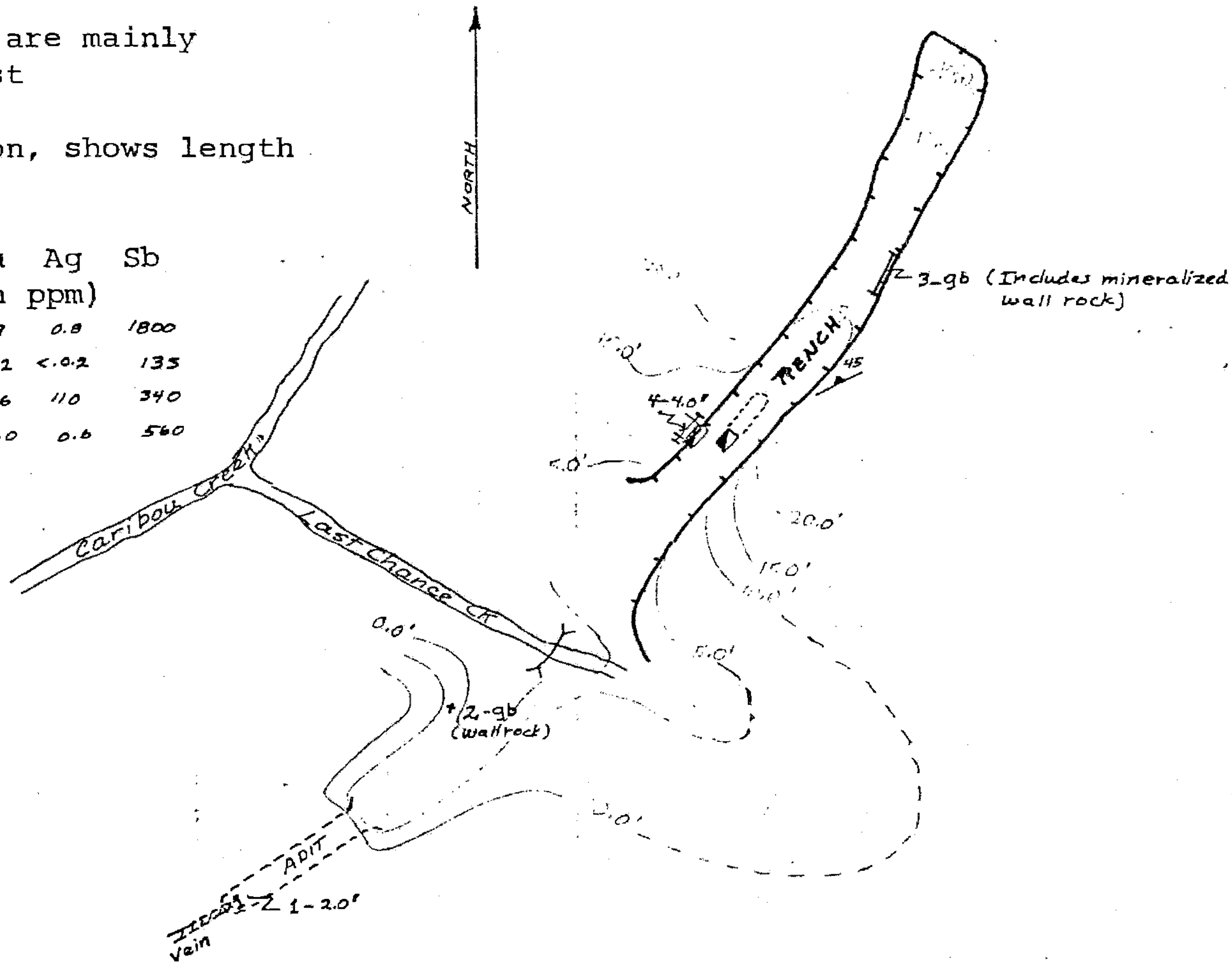


FIGURE 4.1-A(1)-5.--Sketch Map of the Last Chance Prospect
Scale: 1" = 10-ft Sketch contours= 5-ft interval

and all occurrences found or reported is summarized on field data sheets which are compiled in a separate open-file report. Many appear to deserve more thorough prospecting.

The listing in the open-file report parallels the order given in fig. 4.1-A(1).

(2) Stampede Mining Area (fig. 4.1-A(2); table 4.1-A(2): The Stampede mining area of this report extends from Canyon Creek on the south to about Martin Creek on the north, and from the Clearwater Fork on the east to the headwaters of Canyon Creek on the west. Placer gold has been mined, in decreasing order of production, from Little Moose, Crooked Creek, Stampede, and Bearpaw Creeks. The main recognized mineral resource is, however, the Stampede mine, the second largest antimony mine in the United States. Geochemical anomalies and geologic occurrence suggests, also, that stratiform deposits containing zinc, lead, silver, and molybdenum could exist in association with graphitic schists and carbonaceous limestones.

The entire area of fig. 4.1-A(2) was not studied systematically. Some new work was done near the Stampede mine and near the occurrences and anomalies reported by Bundtzen, Smith, and Tosdal in 1976--hereafter referred to as Bundtzen (1976).

a. Geologic setting--The Stampede area, like the Kantishna Mining Area, is predominantly underlain by metasedimentary schists which are warped into open northeast-trending folds--perhaps superposed on older tightly-folded metamorphic structures. It differs from the Kantishna mining area in having graphitic, carbonate-rich, and conglomerate schistose facies which are tentatively correlated with Keevy Peak unit of Wahrhaftig (1968), in addition to dominant quartz-mica schists assigned to the Birch Creek. Igneous rocks are sparsely distributed. A premineral andesite occurs at the Stampede mine, and tactite bodies suggestive of nearby intrusives occur at mineral localities D and 90 (fig. 4.1-A(2)), and metarhyolite forms two masses within the sequence mapped as Keevy Peak in the Crooked Creek area.

Rocks tentatively assigned to the Keevy Peak crop out south of Stampede mine and in the lower Little Caribou-Marten Creek area. This sequence includes phyllite, stretched pebble conglomerate, marble, carbonaceous limestone and calc-schist, and graphitic schist. Graphitic schist possibly part of this sequence, is downfaulted (?) into Birch Creek Schist at the divide between Little Moose and a south flowing tributary of the North Fork of Canyon Creek. The graphitic schist in this area is highly pyritic, and springs flowing from the schist form ferruginous deposits which locally are preserved as limonitic ferricrete.

Graphitic schists and carbonate rich rocks not separated from Birch Creek in mapping are also exposed in upper Canyon Creek and the upper part of the North Fork of Canyon Creek. This area was not visited and contacts of graphitic and limy units shown on fig. 4.1-A(2) were derived from Bundtzen's map.

Mapping was generally not in enough detail to distinguish small faults. Besides the Stampede fault, which strikes northeast, a major lineament, probably along a northeast-striking fault, forms the approximate south boundary of the Keevy Peak terrane of the Little Caribou-Martin Creek area.

b. Geochemistry--About 200 samples were collected in the Stampede area of which about 150 are tabulated in reference to the general map of the area in table 4.1-A(2). These samples and samples collected by Bundtzen, Smith, and Tosdal (1976) indicate several anomalous areas, including Antim bench mark area, Canyon Creek, and the Little Caribou area. Sample nos. 1-18 were collected to resolve an anomaly reported by Bundtzen west of Antim bench mark. The results suggest an association of zinc with graphitic schist.

Graphitic schist crops out near the common corner of secs. 2, 3, 10 and 11, and a stream sediment sample and red spring deposit below this outcrop are enriched in zinc (the spring sample indicates almost 0.5 percent zinc). Zinc enriched samples in the area of upper Canyon Creek are mainly from Bundtzen; their distribution suggests a source in limy-graphitic schist terrane of upper Canyon Creek. Of the soil samples collected on graphitic schist near the north fork of Canyon Creek area, only a few (nos. 37, 55-59) are slightly anomalous--enriched in lead. Very likely zinc is being and has been leached from these highly pyritic rocks and is not precipitated at or near the exposures. (Zinc was detected at

TABLE 4.1-A(2)

INDEX OF MINERAL DEPOSITS AND GEOCHEMICAL SAMPLES IN THE S T A M P E D E AREA, SHOWING RESULTS OF ANALYSES OF ANOMALOUS SAMPLES

MD = MINERAL DEPOSIT--SAMPLE TYPES: CH-3' = CHIP WITH LENGTH. GB = GRAB

GEOCHEMICAL SAMPLE TYPES: SS = STREAM SEDIMENT S = SOIL
P = PAN CONCENTRATE R = ROCK

MAP NO. OR SYMBOL	FIELD NO. OR DEPOSIT NAME	MINERAL DEPOSIT OR GEOCHEMICAL TYPE	KARDEX NO.	RESULTS IN PARTS PER MILLION UNLESS INDICATED % OR OZ/TON						
				Cu	Pb	Zn	Ag	Au	Sb	Other or Remarks
1	M366	SS		35	15	265	< .2		8	
2	494	SS		25	15	125	< .2		6	
3	495	SS		20	15	115	< .2		20	
4	493	S*		20	15	4750	< .2		12	*SPRING
5	492	SS		45	20	160	< .2		17	DEPOSIT
6	491	SS		85	20	530	.8		–	
7	490	SS		65	15	100	< .2		10	
8	489	SS		45	25	315	< .2		–	
9	488	SS		80	20	270	< .2		–	
10	483	R		230	25	1500	< 2	< .02	7	Ferricrete
11	484	SS		110	25	260	< .2	–	–	25 Holman
12	483	S		305	40	205	< .2	< .02	–	Buffer
13	486	SS		55	15	180	< .2			
14	487	SS		25	20	115	< .2			
15	482	S		75	35	–	.4	< .02	5	
16	481	S		125	25	120	< .2		13	
17	480	S		30	20	70	< .2			
18	479	S		30	30	105	< .2		7	
19	620	RAT SPRING		55	55	180	< .2			
20	496	R		20	25	55	< .2	< .02	34	
21	367	S		65	–	130	< .2	< .02	–	<2Mo
22	621	R		100	–	165	–	–	–	Ferricrete
23	50	R		–	15	55	–	< .02	2	<2Mo
24	51	P		20	< 10	<200	1	–	<100	Ti=>10,000;
25	53	SS		–	15	120	< .2			<2Mo2 color
26	52	SS		50	25	520	< .2	< .02	9	
26A	54	SS		–	20	90	< .2	< .02		<2Mo
27	56	SS		–	20	55	< .2			<2Mo
28	57	SS		–	30	455	< .2			<2Mo
29	58	SS		–	35	90	.2			<2Mo
30	74	R		–	15	75			2	<2Mo
31	622	SS		45	–	185				
32	623	R		35	–	115				Ferricrete
33	624	SS		40	35	145	< .2			25 Holman
34	625	SS		35	35	145	< .2			Buffer

TABLE 4.1-A(2) (CONTINUATION SHEET)

MAP NO. OR SYMBOL	FIELD NO. OR DEPOSIT NAME	MINERAL DEPO-SIT OR GEO-CHEMICAL TYPE	KARDEX NO.	RESULTS IN PARTS PER MILLION UNLESS INDICATED % OR OZ/TON						
				Cu	Pb	Zn	Ag	Au	Sb	Other or Remarks
35	626	SS		55	55	70	< .2	< .2		
36	627	R		55	–	180				
37	628	S		10	55	50	< .2			
38	629	SS		30	55	85	< .2			
39	M066	S		–	20	50	–	–	–	
40	M070	SS		–	20	80				<2Mo
41	071	SS		–	25	130	< .2			<2Mo
42	069	SS		–	25	155	< .2			<2Mo
43	068	SS		–	30	465	< .2			<2Mo
44	067	SS		–	30	145	< .2			<2Mo
45	064	SS		–	25	130	.2			<2Mo
46	063	SS		–	30	300	< .2			<2Mo
47	062	SS		–	40	135	< .2			<2Mo
48	061	SS		–	35	480	< .2			<2Mo
49	060	SS		–	30	90	.4			<2Mo
50	059	SS		–	35	320	< .2			<2Mo
51	072	SS		–	20	70	< .2			<2Mo
52	707	SS		–	25	145	< .2	–	13	
53	709	SS		–	30	360	< .2	< .02	10	
54	708	SS		–	25	215	< .2	< .02	6	
55	633	S		30	35	65	< .2	–		
56	632	S		10	35	175	< .2	–		<2Mo
57	631	S		15	30	70	< .2	–		
58	634	S		55	70	100	.8	–		
59	630	S		35	70	70	.2	–		
60	079	S		–	35	50	< .2	–		<2Mo
61	078	S		–	25	90	< .2	–		
61A	077	S		–	20	110	< .2	–		<2Mo
61B	076	S		–	20	65	< .2	–		<2Mo
61C	704	R		–	–	–	5.6		2700	LITTLE CARI-
61D	705	S		–	345	430	< .2	.30	95	BOU PROSPECT
62	347	SS		150	65	1150	< .2	RED PRECIPITATE /AREA		
63	348	SS		30	–	110	< .2			
64	349	SS		SAMPLE LOST						
65		MD		NO ASSAY INFORMATION						
66	199			–	–	60	< .2	< .02		
66A		MD	BUNDTZEN	64 –					64%	VEIN < 1'TH
67	251	R		215	95	1000	2.4	.1		
68	254	S		85	20	170	< .2			
69	250			SAMPLE LOST						
70	252	R		–	–	5	.2	< .02		
71	253	R		315	20	520	4.0	< .02		
72	84	S		–	30	85	< .2			<2Mo
73	85	R		< 2	10	< 200	< 1			FELSITE DIK
74	83	S		–	20	110	< .2			<2Mo
75	82	S		–	15	150	< .2			<2Mo
76	81	R		–	5	75	.2			<2Mo

TABLE 4.1-A(2) (CONTINUATION SHEET)

MAP NO. OR SYMBOL	FIELD NO. OR DEPOSIT NAME	MINERAL DEPOSIT OR GEOCHEMICAL TYPE	KARDEX NO.	RESULTS IN PARTS PER MILLION UNLESS INDICATED % OR OZ/TON						
				CU	PB	ZN	AG	AU	SB	OTHER OR REMARKS
77	80	S		–	5	20	< .2			<2Mo
78	44	S		70	55	70	< .2		< 156	<2Mo
79	45	S		60	30	180	< .2		11	<2Mo
80	46	R		10	20	40	< .2		< 1	<2Mo
81	47	S		25	30	80	< .2		< 1	<2Mo
82	119	SS		35	25	210	< .2	< .02	9	<2Mo
83	120	SS		30	20	100	< .2	< .02	10	<2Mo
84	117	SS		60	50	165			5	
85	48	S		55	90	220	< .2		2	<2Mo
86	116	SS		LOST	SAMPLE					
87	115	SS		20	20	100				4W
88	114	S		LOST	SAMPLE					
89				LOST	SAMPLE					
90				LOST	SAMPLE					
91	042	S		35	20	90	< .2		5	<2Mo
92	043	S		20	15	140	< .2		< 1	<2Mo
93	101	R		10	25	35	–		5	2Mo
94	124	R		5	10	15	< .2	< .04	3	<2Mo
95	125	SS		15	30	105	< .2	< .02	2	<2Mo
96	123	SS		25	10	130	< .2	< .02		2Mo
97	122	R		25	10	85	< .2	< .02	< 1	<2Mo
98	121	SS		15	15	80	< .2	< .02	2	<2Mo
99	100	S		10	15	115			3	SW;20% BA
100	113	S		20	15	100			18	
C		MD								
101	013	S		–	–	90	< .2		1	SOIL LINE
102	014	S		–	–	120	< .2		12	
103	015	S		–	–	75	< .2		5	
104	016	S		–	–	250	.2		4	
105	017	S		–	–	90	< .2		9	
106	018	S		–	–	80	< .2		11	
107	019	S		–	–	80	< .2		12	
108	020	S		–	–	60	< .2		5	
109	021	S				85	< .2		5	
110	022	S				85	< .2		3	
111	023	S				75	< .2		3	
112	024	S				95	.4		24	
113	025	S				80	< .2		160	
114	031	S			5	5	.4	< .02	42	<2Mo
115	110	S		35	15	85			22	
116	109	S		45	15	70			22	
117	108	S		55	10	20			110	
118	107	S		45	5	20			90	
119	106	S		30	10	115			50	
120	111	S		25	40	55	< .2		13	
121	105	S		50	10	145			160	
122	104	S		65	60	225	3.8		36	42Mo

GRAPHITIC SCHIE

TABLE 4.1-A(2) (CONTINUATION SHEET)

MAP NO. OR SYMBOL	FIELD NO. OR DEPOSIT NAME	MINERAL DEPOSIT OR GEO-CHEMICAL TYPE	KARDEX NO.	RESULTS IN PARTS PER MILLION UNLESS INDICATED % OR OZ/TON						
				CU	PB	ZN	AG	AU	SB	OTHER OR REMARKS
123	103	S		30	25	100			1	
124	MD									
125	102	S		40	15	220	< .2		3	<2Mo
126	151	S		–	10	100	< .2		14	<2Mo
127	152	S								
128	153	S		–	20	140	< .2		24	<2Mo
129	154	S		–	40	255	.6		46	10Mo
130	155	S		–	15	60	3.8		7	2Mo GRAPHI
131	156	S		–	20	110	2.4		16	10Mo TIC
132	157	S		–	20	110	< .2		9	SCHIST
133	158	S		–	20	115	< .2		–	<2Mo
134	159	S		–	45	140	< .2		2	<2Mo
135	160	S		–	30	70	< .2		4	<2Mo
136	161	S		–	45	100	< .2		4	<2Mo
137	162	S		–	15	65	< .2		6	<2Mo
138	163	S		–	20	530	< .2		5	<2Mo
139	164	S		–	10	20	< .2		5	<2Mo
140	165	S		–	10	35	< .2		5	<2Mo
141	166	S		–	15	70	.2		5	<2Mo
142	167	S		40	90	140	< .2		1	<2Mo
143	(NO 143)									
144	086	SS		–	15	70	< .2		1	<2Mo
145	040	S		20	20	60	< .2		2	
146	041	S		10	25	85	< .2		4	<2Mo
147	087	SS		0	35	45	< .2		2	
148	126	SS		25	10	140	< .2	< .02	4	<2Mo
* 149	127	MD R	BARITE VEIN	10	40	70	< .2	< .02	3	<2Mo;<2W,17
150				–	30	205	< .2			2W;0.5% BA
151										
* 149	= BUNDTZEN NO. 67									

anomalous levels by Bundtzen in sec. 8 in the drainage below our area of detailed sampling.)

Soils collected in a traverse across the Stampede fault and adjacent country rocks are locally anomalous in trace metals. Sample nos. 117, 118, and 121 are relatively rich in antimony and are in or near the south extension of the Stampede fault. Sample nos. 122, 129-131 are enriched in at least one of the elements Ag, Mo, Zn; they were collected from soils developed on graphitic schist. A siliceous schist (no. 67) collected in the Keevy Peak sequence near Crooked Creek is anomalous in trace elements (copper, lead, zinc, silver, and gold).

Samples anomalous in zinc also occur in the upper part of the south fork of Crooked Creek. The source of this anomaly is uncertain. A strong zinc anomaly in the west fork of Little Moose Creek (locality 62) probably has its source in graphitic schist.

c. Mineral deposits--Types of mineral deposits recognized in the Stampede area include nearly monomineralic antimony (stibnite)veins, iron-copper-antimony bearing tactite deposits, a barite vein, and placer deposits of gold.

The major deposits of antimony are at the Stampede mine. Stibnite also occurs at locality 66A, in the Little Caribou area (locality D-1), and in the Ridge group patented claims (locality C). Details of stibnite occurrence are given in section "d" on the Stampede mine. A low-grade copper-iron (magnetite) tactite was discovered by Bundtzen between Little Caribou Creek and the south fork (unnamed) of

Crooked Creek. The occurrence is apparently stratiform in limy and calc-schists of Birch Creek type.

d. Stampede Mine (fig. 4.1-A(2)-d (1 &2)--The Stampede antimony mine is the second largest lode mine in the Kantishna district, following the Banjo gold mine, and is also the second largest lode producer of antimony in the United States. It is on Stampede Creek about two and a half miles above the Clearwater, and 120 miles from Fairbanks. Access is by winter trail to near Healy, and by air on a 4000-foot gravel runway on the Clearwater. The mine was investigated during its most productive period in 1941 by White (1942) and in 1943 by Ebbley and Wright (1948), and during a DMEA supported exploration program in 1953 by C. L. Sainsbury, Gordon Herreid, Robert Chapman, and Fred Barker (Barker, 1963). Nearly all workings are caved. This report collates the previous studies and reports on some new mapping, and geochemical and geophysical studies done during 1976.

Geologically, there is good reason to assume new reserves can be found at Stampede. The ore bodies are in veins in the footwall of the Stampede fault; they evidently rake easterly, possibly within a quartzitic schist unit of the Birch Creek Schist. Most previous exploration work has been based on gaining greater depth on the complex vein system below the old workings. It is believed that future work should be centered northeast of the existing workings, along the apparent rake of the ore trend.

Reserves of antimony ore also lie in the old workings, primarily in unmined high-grade zones in the so-called Nesse Winze ore body, in the Mooney ore body, and in low-grade (10-15% Sb) parts of previously high-graded veins.

The Stampede antimony mine is now owned and was operated during its most productive years by E. R. Pilgrim, who has been associated closely with the mine since 1936. Total recorded production, which is believed nearly complete, is of 3,594.5 tons of ore (or concentrates) which contained about 3,700,000 pounds of metallic antimony. About 150 tons of high-grade ore were mined prior to 1937, but the major period of production was 1937-1941 when 2388.6 tons of ore were mined. Production from 1937 through 1943 totaled 2,638 tons with an average grade of 53.44 percent Sb. About 121.35 tons of ore containing about 56 percent Sb were shipped in 1970, following smaller production in 1964, 1965, and 1969.

The property consists of 14 claims, 10 lode and 4 placers, of which 8 lode and 4 placer claims are shown on fig. 4.1-A(2)-d(1). The claims are patented or patent applied for.

Geologic setting: The Stampede mine is in the footwall of a northeast-striking, southeast dipping shear zone (the Stampede fault) which locally subparallels a contact between Birch Creek Schist and Keevy Peak unit (fig. 4.1-A(2). The mine is also near the crest of a gentle east-trending upwarp (Stampede Warp) recognized by White (1942) as the Stampede anticline. The ore lies in steep to low-angle south-dipping veins which junction with the Stampede fault to the southeast. Steep, weakly-mineralized fissures of northwest strike, offset both the productive vein system and the Stampede fault.

Ore deposits: The ore at Stampede consists of high-grade masses of nearly mono-mineralic coarse-stibnite which grades into quartz-stibnite veins or stibnite-bearing shear zones. High-grade stibnite attained a width of about 26 feet in an outcropping body (fig. 4.1-A(2)-d(2)); lower grade veins ranged from a foot or less to about 30' wide Stibnite is the dominant metallic mineral of the ore and in some cases constitutes over 90 percent of the vein material. Arsenopyrite and pyrite are present in small amounts, and red-brown sphalerite was noticed disseminated in outcrops of the Kobuk lode. There is apparently a general gradation downward and laterally from massive coarsely crystalline stibnite to a finer-grained aggregate of quartz, stibnite, and sericite (Ebbley and Wright, 1948), although relatively thin streaks of high-grade stibnite (from 2 inches to about 1 foot thick) may persist on the hanging walls of low-grade or disseminated-type ore zones.

Ore controls are not completely known, but some ore shoots are in the northeast vein set near the intersection with cross-cutting weakly-mineralized northwest fissures. And, as recognized by White (1942) and others subsequently, ore is essentially confined to a relatively competent quartzitic schist, and is not present in micaceous schists. Outcrops at the Kobuk lode (inset fig. 4.1-A(2)-d(2)) illustrate this type of lithologic control.

The veins are locally expressed geochemically, and may be picked up by soil sampling, as can be inferred from the south soil line across the Stampede vein in fig. 4.1-A(2)-d(1). Thick colluvium, however, precludes effectiveness of this technique in many places. An electromagnetic geophysical technique (VLF-EM) was tried with essentially indifferent success. A massive steep planar conductor should be expressed as a cross-over in dip angle, changing from, in this case, W- to E-dip, over ore. There is a change in dip angle over the Stampede vein, but it also is subparallel to a topographic change--which in the particular case, should have a similar effect as a south-dipping ore zone. More detailed work would be required to prove or disprove the technique. It appears that ordinary prospecting techniques, such as tracing stibnite float and trenching, have not been exhausted in the area.

Mine workings: As in many vein deposits, workings at the Stampede mine are a complex series of drifts, cross-cuts, and connecting shafts and raises (fig. 4.1-A(2)-d(2)). In general and from west to east, they consist of a Main Shaft and Glory Hole workings near the discovery outcrop, an Upper Tunnel at 2190 feet, and a main or Lower Tunnel at 2035 feet, which respectively developed ore at generally lower levels going eastward.

The so-called DMEA drift, nearly barren, does extend westerly from the Main Tunnel below the Glory Hole workings. The Neese Winze and Emil Winze were sunk from the Upper Tunnel, and ore in the Emil Winze was developed on so-called 50- and 100-foot levels below the Upper Tunnel. The Libby (not shown) and Mooney intermediate levels were developed on the Stampede vein above the Main or Lower Tunnel. Each of these series of workings was driven to develop a more or less discrete ore body.

<u>Ore bodies</u>: At the Stampede mine ore bodies have considered to be either discrete bodies in a series of related veins (White, 1942, p. 345), or shoots within the Stampede vein (Ebbley and Wright, 1948, pp. 10-13); the work done by the Bureau of Mines did in fact show that the Stampede vein between some shoots, like the Mooney and Libby, was continuous. Based on the older work, the ore bodies, from west to east, can be summarized as:

Name of Shoot	Maximum Dimensions	Tons	Reserves
1. Glory Hole	65'x25'x45'	700	Level about 45' below mining level has 250'x 3.9' of 2.06% Sb with some pods of 10% ore
2. Unnamed surface body	80'x narrow'x25'	?	unknown
3. Neese Winze	40'x20'x150'	80	Drill holes 2 & 3 DMEA (Barker) encountered ore zone. Ore zone starts about 6' below upper level

4. Emil Winze	60'x30'x120'	500	Reserves of about 4000 tons of mill ore (10% Sb) in caved workings
5. Mooney	120'x30'x100'	250	Reserves of high-grade and mill ore. Probable ore below lower tunnel (DMEA drill holes 4 & 5)

Reserves and resources: The reserve status of the mine is uncertain, partly because of lack of knowledge of extent of stoping on some well-sampled ore shoots. It is believed certain, however, that high-grade (50% Sb) reserves on the order of 100s of tons and possibly over 1000 tons are present in the lower part of the Neese Winze ore body and in the Mooney ore body on and below the Lower Tunnel level.

White in 1942 estimated 6000 tons of rock grading about 10-15 percent antimony in the workings of the Stampede mine, probably mainly in the Emil Winze ore body, and more than 1000 tons of weathered antimony rock of about 20 percent Sb in talus below the original ore outcrops. These reserves are probably still in place.

Antimony resources are in the ground between the Mooney workings in the Lower Tunnel and the Kobuk adit and shaft 500 feet east; also in the ground between the Kobuk and Ridge Top claims, and east of the Kobuk lode under Stampede Creek. The unprospected ground between the Mooney workings and Kobuk lode extends about 500 feet along the projected vein system, or about the strike length as developed in the segment between the Glory Hole and Mooney workings. Based on this strike length, it could have a correlative tonnage of high-grade stibnite to that already produced--3000 tons. Ground below the creek level east of the Kobuk down the plunge of the Stampede anticline is also believed to have a potential for high-grade resources. Based on its close relation to the Stampede fault, it could represent the most fractured part of the Stampede warp.

A resource of more than 10,000,000 pounds of antimony in high-grade and medium-grade (10-15% Sb) seems likely in the immediate Stampede area. It is probable that highly-detailed work on wall rock types would show that White's (1942) interpretation of the relation of ore with structure and wall rock type is oversimplified. Yet the relation of ore shoots to the more quartzose host rocks seems a general one, and future exploration should rely more on the combination of rock type, fold and fault structures, than on exploration for a projected vein segment, especially below ore shoots.

Exploration north of Stampede Creek should be based on extension of favorable structures into quartzose wall rock. It is possible that the northernmost trenches (fig. 4.1-A(2)-d(2)) were above the ore zone stratigraphically.

e. Other deposits or anomalous areas--Placer gold has been produced from Little Moose, Crooked Creek, Stampede and Bearpaw Creek; total production from all the creeks in the area is probably about 1000 ounces. The alluvial channels of the area are narrow and major placer deposits are unlikely.

Other recognized deposits include an antimony deposit at the south side of the map area (locality 66A), a barite-quartz vein on the Clearwater (locality 149), and tactite at locality D.

The mineralized tactite at D was previously described as the Little Caribou occurrence by Bundtzen as a weakly-mineralized body about 5 feet thick and 550 feet wide. Geochemical sampling (fig. 4.1-A(2)-e; table 4.1-A(2)-e) in two lines (nos. 165-178; nos. 151-157; 158-164--figs. 4.1-A (2)) indicate a larger extent of mineralization, but generally confirms low metal contents. Bundtzen mentioned pyrite-chalcopyrite-magnetite and sphalerite at the Little Caribou; tourmaline also occurs and stibnite was found in limestone replacement masses found abundantly in float at locality D-1. The results of soil samples show a correlation of antimony with gold, silver, copper, lead, and zinc suggesting a relation between the stibnite deposits and the tactite.

(3) Chitsia Mountain-Tekla Hills Area: Chitsia Mountain is the northernmost peak in the Kantishna Hills; the Tekla Hills are the low, rounded hills to the east, separated from the Kantishna Hills by the lower Toklat River. The area has not been recognized as a metalliferous area, but work by Bundtzen, Smith, and Tosdal (1976) and Gilbert and Bundtzen (1976) shows the existence of widespread metalliferous units in the Totatlanika Schist and Keevy Peak Formation, which characterize both Chitsia Mountain and the Tekla Hills.

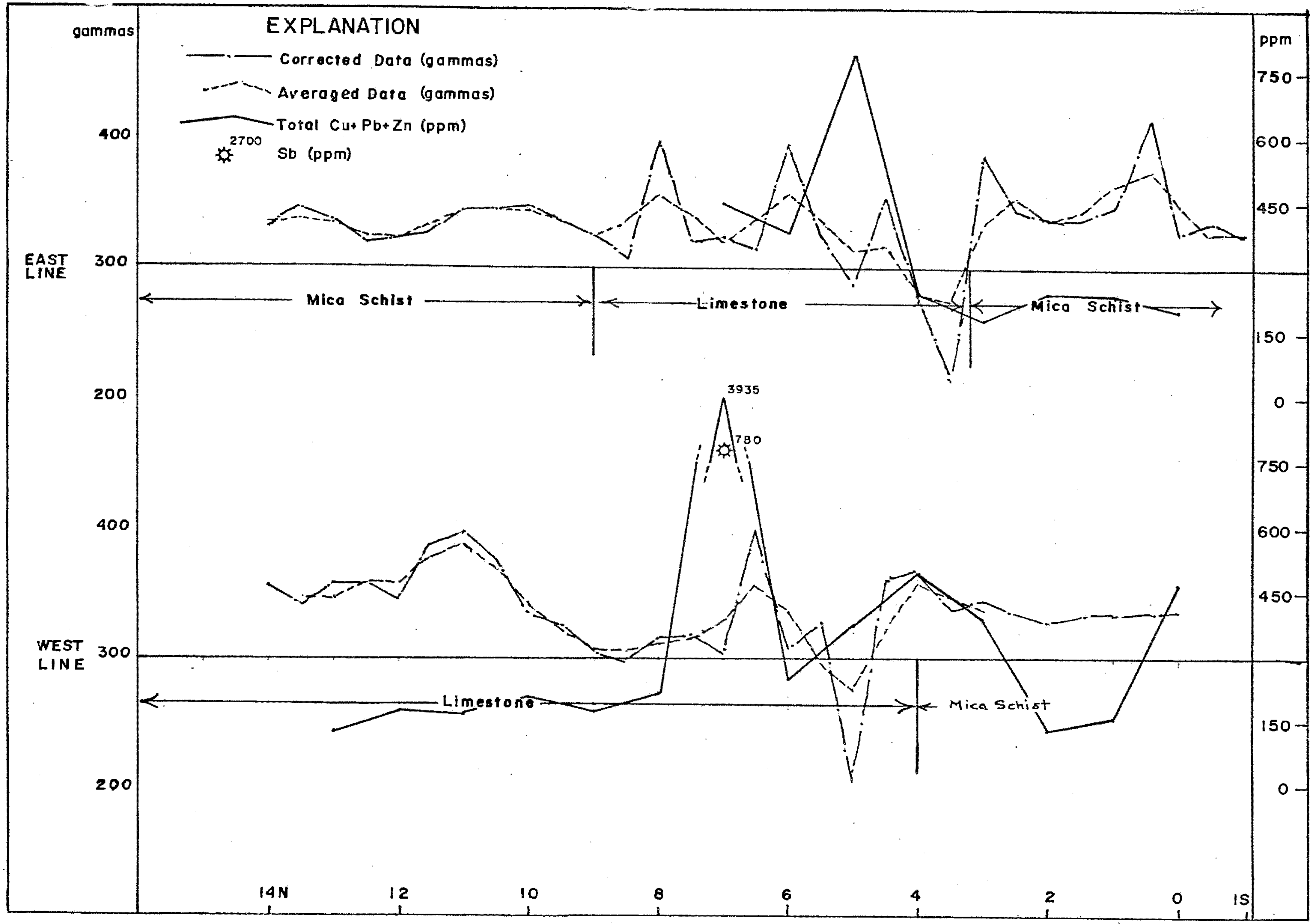


Figure 4.1-A(2)-e Profiles of geochemical and magnetic data, Little Caribou occurrence, Stampede Mining Area. Geochemical data are results of analysis of soils for copper, lead and zinc.

TABLE 4.1-A(2)-E

INDEX OF MINERAL DEPOSITS AND GEOCHEMICAL SAMPLES
IN THE LITTLE CARIBOU AREA, SHOWING RESULTS
OF ANALYSES OF ANOMALOUS SAMPLES

MD=Mineral Deposit--Sample types: Ch-3'=Chip with length
Gb=Grab

Geochemical sample types: SS=Stream sediment S=Soil
P=Pan concentrate R=Rock

Map No. or Symbol	Field No. or Deposit Name	Mineral Deposit or Geochemical Type	Kardex No.	Results in parts per million unless indicated % or oz/ton						
				Cu	Pb	Zn	Ag	Au	Sb	Other or Remarks
151	750	S		70	50	260	<.2	.04	.70	500E, 600N
152	751			80	210	495	<.2	.06	36	" 500N
153	752			70	45	120	<.2	<.1	16	" 400N
154	753			35	35	110		<.02	16	" 300N
155	754			60	45	135		.03	50	" 200N
156	755			70	45	115		<.02	30	" 100N
157	756			60	50	95		<.02	28	" 000N
158	699			75	65	310		<.02	36	" 700N
163	704	R-Flt					5.6	<.02	2700	grab of stibnite-bearing lms.
164	705	S		—	345	430	<.2	.30	95	
165	636			285	60	130	<.2	<.02	5	0E, 00N
166	637			50	30	75		<.02	5	, 100N
167	638			35	30	65		<.02	22	, 200N
168	639			105	65	215		<.02	180	, 300N
169	640			125	75	295		<.04	75	, 400N
170	641			80	70	220		<.1	30	, 500N
171	642			65	50	135		<.04	60	, 600N
172	643			85	1700	2150	1.4	.26	780	, 700N; Near Otcp.
173	644			50	65	100	<.2	.06	85	, 800N
174	645			35	45	90	<.2	<.04	65	, 900N
175	646			45	45	110	.2	<.04	50	, 1000N
176	647			30	35	100	<.2	<.02	32	, 1100N
177	648			35	35	105			30	, 1200N
178	649			20	30	90			19	, 1300N

a. Geologic setting--The Chitsia Mountain and nearby Tekla Hills are mainly underlain by relatively young units of the Yukon Crystalline Complex--the mainly sedimentary Keevy Peak Formation and the mainly volcanic Totatlanika Schist.

In the area near Chitsia Mountain, the Totatlanika consists mainly of fine-grained gossanized metavolcanics and chert, limestone and calc-schist, and of coarsely porphyritic (K-feldspar) rhyolite. The Keevy Peak Formation of the area includes graphitic schists and quartzitic units.

b. Geochemistry and mineral deposits--Except for a few widely-scattered samples in the Alder Creek drainage, most geologic and geochemical work done for this project was concentrated in the area near Chitsia Mountain and in sections 25 and 35 about four miles southwest of Chitsia Mountain, near mineral occurrences previously reported by Bundtzen--our nos. 10, 52, and 58. Occurrences 10 and 52 are in fine-grained rhyolitic volcanics and cherts which are highly pyritic (as much as 30 percent) and contain disseminated sphalerite. Occurrence no. 58 is a stratiform body of barite containing galena and anomalous amounts of zinc and silver. Mineralized rocks first described by Bundtzen are also at localities 7,8,53 54, and 55.

The pyritized volcanics which include mineral localities 10 and 52 are in a belt of gossanized chert and fine-grained rhyolitic volcanics reported by Bundtzen (1976, pp. 12-13) to be about six miles long. To make a preliminary view of this belt, scattered soil and rock samples were taken in sec. 35, and two geophysical-geochemical lines were run across the strike of gossanized zones in sec. 25 (fig. 4.1-A (3)-b).

The results obtained are not conclusive, they show (figs. 4.1-A(3) and 4.1-A(3)-b) zones 200-500 by 300 feet across which are anomalous in zinc, lead, and silver. They also show that radiation measured in counts/second shows some degree of correlation with rhyolitic tuff--which appears to host most geochemical anomalies, and that both magnetic properties and radiation appear to reflect a contact between cherty argillite and zinc-bearing rhyolite at about 700 feet southeast on line 2.

VLF-EM was also run along the two traverses. On line 1 near 0-1 NW, a reversal could indicate a massive conductor. On the same line, relatively high radiation correlates with strongly anomalous amounts of lead and zinc near 4-5 NW. Poor radio signals and heavy rain-which caused trouble with the electronic instruments--interfered with planned work in the Chitsia Mountain area. The work accomplished is consistent with Bundtzen's geochemical results, and his inferrences of the possibility of lengthy mineralized zones in tuff of the Totatlanika Schist. Further work compatible with a scale of about 1:6000-12,000 is needed to evaluate this zone.

The barite occurrence at locality 58 (sample nos. 56-58, table 4.1(A)-3) is exposed on a ridge nearly barren of vegetation about half a mile southwest of Chitsia Mountain. It is within a gray phyllite sequence invaded by sill-like or cross-cutting coarsely-porphyritic

TABLE 4.1-A(3)

INDEX OF MINERAL DEPOSITS AND GEOCHEMICAL SAMPLES IN THE CHITSIA MTN AREA, SHOWING RESULTS OF ANALYSES OF ANOMALOUS SAMPLES

MD = MINERAL DEPOSIT--SAMPLE TYPES: CH-3' = CHIP WITH LENGTH: GB = GRAB
GEOCHEMICAL SAMPLE TYPES: SS = STREAM SEDIMENT S = SOIL
PC = PAN CONCENTRATE R = ROCK

Map No. or Symbol	Field No. or Deposit Name	Mineral Deposit or Geochemical Type	Kardex No.	Results in parts per million unless indicated % or oz/ton						
				Cu	Pb	Zn	Ag	Au	Sb	Other or Remarks
1	209	R		-	-	60	<.2	-	-	
2	210	S		-	-	425	<.2	-	-	
3	211	S		-	-	95	<.2	-	-	
4	212	S		-	-	105	<.2	-	-	
5	214	S		-	-	330	<.2	-	-	
6	213	S		-	-	275	<.2	-	-	
7	75 AST 1665	R GB		200	-	-	-	-	-	
8	75 AST 1683	R GB		102	385	-	2.0	-	-	
9	388	SS								
10	71	MD	GB	Tr.	Tr.	5200	3.4	Tr.		Gossan zone
10A	71	GB		Tr.	600	1600	10.0	Tr.		° ,BUNDTZEN
11	650	S		-	35	60	3.8	<.02	-	SOIL LINE #I,0N
12	651	S		-	40	165	< .2	<.02	-	,2N
13	652	S		-	25	60	< .2	<.02	-	,3N
14	653	S		-	45	355	1.0	<.04	-	,1N
15	654	S		-	105	600	1.2	<.04	-	,4N
16	655	S		-	195	395	<.2	<.02	-	,5N
17	656	S		-	45	130	< .2	<.02	-	,6N
18	657	S		-	25	50	0.6	<.02	-	,7N
19	658	S		-	30	45	0.6	<.02	-	,8N
20	659	S		-	20	50	0.2	<.04	-	,9N
21	660	S		-	45	75	0.2	<.02	-	,10N
22	661	S		-	50	70	< .2	<.02	-	,11N
23	662	S		-	30	50	0.6	<.04	-	,12N
24	663	S		-	55	55	< .2	<.02	-	,13N
25	664	S		-	80	55	< .2	<.02	-	,15N
26	665			-	5	5	< .2	<.02	-	
27	666			-	35	60	< .2	<.02	-	
28	667			-	45	70	< .2	<.02	-	
29	690			-	30	70	< .2	<.02	-	
30	668	S		-	40	70	0.2	.03	-	SOIL LINE, #2
31	669	S		-	95	145	0.2	<.02	-	
32	670	S		-	60	135	< .2	<.02	-	
33	671	S		-	220	90	< .2	<.02	-	
34	672	S		-	155	135	< .2	<.02	-	

TABLE 4.1-A(3) INDEX OF MINERAL DEPOSITS AND GEOCHEMICAL SAMPLES IN THE CHITSIA MTN. AREA, SHOWING RESULTS OF ANALYSES OF ANOM LOUS SAMPLES

MD=Mineral Deposit--Sample types: Ch-3'=Chip with length
Gb=Grab

Geochemical sample types: SS=Stream sediment S=Soil
P=Pan concentrate R=Rock

Map No. or Symbol	Field No. or Deposit Name	Mineral Deposit or Geochemical Type	Kardex No.	Results in parts per million unless indicated % or oz/ton						
				Cu	Pb	Zn	Ag	Au	Sb	Other or Remarks
35	673	S		–	75	70	0.4	<.02	–	SOIL LINE NO.2
36	674	S		–	85	80	< .2	<.02	–	
37	675	S		–	70	65	< .2	<.02	–	
38	676	S		–	30	210	1.0	<.02		
39	677	S		–	30	105	.2	<.02	–	
40	678	S		–	30	100	.2	<.02	–	
41	679	S		–	55	150	< .2	<.02	–	
42	680	S		–	40	150	< .2	<.02	–	
43	681	S		–	40	205	< .2	<.02	–	
44	682	S		–	30	180	< .2	<.02	–	
45	683	S		–	80	390	<.2	<.02	–	
46	684	S		–	25	105	<.2	<.02	–	
47	685	S		–	35	215	0.6	<.02	–	
48	686	S		–	15	115	0.6	<.02	–	
49	687	S		–	15	70	<.2	<.02	–	
50	688	S		–	20	60	<.2	<.02	–	
51	689	S		–	25	50	<.2	<.02	–	
52	Gunlitzen No. 72	MD GB		100	100	2100	7.0	Tr.		
53	Gunlitzen No. 73	MD GB		6500	100	Tr.	4.8	–		Float-vein in
54	75 AST 1725	R GB		–	645	–	2.4	–		Rhyolite.
55	Gunlitzen No. 74	R GB		–	10.45%	–	2.72 oz/ton	–		Vein in Rhyolite.
56	701	MD R	85	85	1,650	720	3.4	<.02	18SB;52%BA	QTZ-JAROSITE ROCK
57	702	MD R		125	1,050	2,400	2.0	<.02	15SB;1.6%BA	
58	703	MD R		–	–	–	–	–	36% BA	SELECTED SAMPLE
59	700			–	90	260	0.4	<.02	–	
60	Gunlitzen No. 75			400	400	500	.34	–		
61	75 AST 2754			780	4000	1650	–	–		Grab-altered Rhy-
62				1280	–	–	–	–		olite vein.
63	75 AST 2755			620	–	–	–	–		
64	364			25	45	100	< .2	<.02	–	
65	365			10	20	80	< .2	–	–	
66	363			20	30	115	< .2	–	8	
67	499			10	40	185	1.0	–	4	
68	498			40	25	165	< .2	–	5	
69	497			20	20	135	< .2	–	5	

rhyolite. The mineral body is about 300 feet long, 10 feet thick, strikes northeast, and dips about 30° northwest. It contains barite layers 1-6" thick. It is not large or rich enough in itself to be of economic interest, but is a well-exposed example of a stratiform and probably volcanogenic deposit in the Totatlanika Schist.

B. Metallic Mineral Areas in Mt. McKinley National Park

Prior to about 1935 the McKinley Park area was actively searched for mineral deposits by the old breed of prospectors who set out each winter with dogs and supplies, and encouraging prospects were found and staked. Since that time and especially since World War II, prospecting has been occassional, with the most recent activity centering about antimony prospects during times of high price.

The main published accounts of McKinley area prospects are in the U.S. Geological Survey and Bureau of Mines reports cited in Table 4.1-B. This information is supplemented by private maps and reports by Pilgrim and by the recent Park Service buy-out mineral appraisal conducted by Chadwick (1975).

The major prospects belong to at least three distinct types; (1) zinc-lead bearing tactite deposits, (2) bulk copper deposits of either porphyry or tactite type, and (3) antimony-mercury deposits. Partly because of topography and climate, and partly because of geology, the known occurrences are clustered in the central part of the Park.

TABLE 4.1-B

ANNOTATED BIBLIOGRAPHY OF MAIN MINERAL OCCURRENCES IN MT. MCKINLEY NATIONAL PARK
(ARRANGED CHRONOLOGICALLY)

Moffit, F. H., 1933, The Kantishna district: B 836-D, pp. 301-339. Describes the roads, trails, geology and mineral deposits. Describes antimony and other minerals in Stampede, Slate, Slippery and Clearwater Creeks, the silver-lead deposit on Mt. Eielson, the prospects between Slippery Creek and Mt. Eielson, lode deposits between Friday and Eureka Creeks, lode deposits of Eldorado, Glen, and Spruce Creeks, the placer mining in the area, and coal occurrences.

Reed, J. C., 1933, The Mt. Eielson district: B 849-D, pp. 231-287. Describes the geography, geology, igneous rocks, areal geology, structure, geological history, ore deposits, their character and mineralogy, economic factors, metallurgy and the prospects. Contains a description of each claim in the area.

Wahrhaftig, C. and G. O. Gates, 1944, Zinc deposits of the Mt. Eielson district, Alaska: USGS OF 16. Describes the geology, structure, mineralization, ore deposits, and reserves. Contains three maps.

Muir, N. M., B. I. Thomas, and R. S. Sanford, 1947, Investigation of the Mt. Eielson zinc-lead deposits, Mt. McKinley National Park, Alaska: BM RI 4121, 13 pp. Describes the location, access, physical features, climate, history, ore deposits, geology, structure, and mineralization. Contains 1"=1000' claim map, 1"=100' geological map of the Virginia and Denver claims, 1"=100' geological map of the Jiles and Georgia claims, analyses, with comments, of 26 channel samples for lead, zinc, copper, gold, and silver and beneficiation tests on 18 of the samples which contained over 7% combined lead and zinc.

Chadwick, R. H. W., Consulting Geologist, September 1975, Gross mineral appraisal of Mt. McKinley National Park, Katmai National Monument, Proposed Lake Clark National Park: U.S. Department of the Interior, National Park Service, Western Region. Objective of appraisal was "to estimate the cost of acquisition of all mineral property interests by National Park Service." Describes how this was done, discusses the properties and the general geology and description of Kantishna, Foggy Pass limestone deposit, Mt. Eielson lead-zinc and Greenback occurrence. Includes information on each claim visited (including Kardex information).

The zinc-lead tactite deposits are exemplified by deposits of the Mt. Eielson area. As described by Moffit, Reed, and sampled by Muir and others, they are pod-like bodies of massive sulfide minerals, many of which contain in excess of seven percent combined lead and zinc--but relatively low silver contents, generally less than 5oz/ton.

The lead-zinc deposits occur over a four-mile long zone on the hanging wall of a granodioritic intrusive into limestone north of Mt. Eielson. The ore is of tactite type and occurs in Devonian limy rocks shot through with dikes and sills related to the major intrusive. Reed (1933) considered the intrusive to be of Jurassic age, but because of its spatial location, it is more likely that it is Tertiary age, probably related to the Foraker intrusive series of middle-Tertiary age.

No precise reserve figures are available for the Mt. Eielson deposit. Chadwick (1976, p. 21) states that "An estimated 100,000 T (tons) of material running 10 percent combined lead and zinc are present in talus on the property." He also infers that this ore could be loaded, processed in a nearby mill, and shipped at a small profit. In 1933 Reed (p. 285) noted that "the present natural exposures and prospect pits indicate a reserve of many hundreds of thousands of tons of zinc and lead bearing material, which, from the indications of a few assays, should carry at least 10 percent total sulfides."

This approximate grade was confirmed by sampling done by Muir, Thomas, and Sanford (1947). A composite of 18 samples collected in this investigation (1943) was, in percent:

Pb Sulfide	Pb Non Sulfide	Zn	Cu	Fe	Insoluble
4.22	1.27	5.27	0.36	7.30	69.5

The other recognized deposits which appear to have fairly large tonnage possibilities (Chadwick, 1976, table 3) are those near the Greenback claim. The Greenback, restaked in 1966 by Arly Taylor and others of Fairbanks, was originally discovered by E. R. Shannon, and has also been known as the Shannon Copper property. It is in the headwaters of Slippery Creek, in the vicinity of the Mineral Mountain or Merinzer antimony claims. The area has had recent development for stibnite--premature in the opinion of Chadwick (1976).

Little has been added to the geologic information on these properties since the work of Pilgrim (1929) and Moffit (1933), and Pilgrim's map is reproduced here (fig. 4.1-B) to retain information unavailable elsewhere. Like Mt. Eielson, the Greenback and associated claims appear to be in the limy hanging wall series of a granitic intrusive, and they contain some massive sulfide (copper) and disseminated minerals in intrusives and in limestone. Unlike Mt. Eielson, chalcopyrite and pyrrhotite exceed galena and sphalerite. Gold and silver contents are unknown, but judged from mineralogy, both should be present.

C. Dall Trend

(1) Location and Geologic Description

Layered rocks exposed along the Yentna River between the Denali Fault and an unnamed subparallel fault about thirteen miles south, formerly thought to be Mesozoic, are now known to be middle and upper Paleozoic (B. Reed, U.S. Geological Survey, communication, 1976), and are in a sequence which can be traced from near Cathedral Spires north-eastward 45 miles to the Lacuna Glacier area along the southeast side of McKinley Park (fig. 4.0-B). The Paleozoic rocks include limestone, limestone cobble conglomerate, basalt, graphitic schist, and argillite. The layered rocks are intruded by granitic igneous rocks of Mesozoic and Tertiary age and are locally cut by sill-like masses of ultramafic rock of Paleozoic or Mesozoic age.

The name Dall Trend is given to a strong, newly recognized, and mineralogically complex, mineral-bearing zone which lies near the south edge of the Paleozoic rocks (fig. 4.0-B). Some of the mineral deposits in the trend are strata-bound; others are related to plutonic rocks which cut through the Paleozoic and adjacent (south) Mesozoic sedimentary rocks.

As this is both an extensive and poorly-known belt (approximately 45 miles long and several miles wide) and contains a great variety of rocks, only the more important types and their general sequence are described here. Argillite and sandstone of middle and upper Paleozoic age are the dominant units in the Dall Trend. A very thick, extensive unit of limestone cobble-pebble conglomerate is also important, underlying most of the Mount Dall area. Apparently underlying the conglomerate are several massive limestone beds, minor thinly-banded siliceous limestone, chert, siltstone, graphitic shale, and well-bedded argillite.

All layered units are locally cut by one of the three discrete ages of plutonic rocks that have been mapped and dated by the U.S. Geological Survey (Reed and Lanphere, 1973). The Dall granodiorite and related intrusions of Yentna type are about 65 million years old. The Cathedral Spires granite (part of the McKinley sequence) is about 56 million years old. The Foraker pluton and several smaller related intrusions are 35-38 million years old.

Structurally complex, the Paleozoic rocks exposed along the south side of the Dall trend are in fault contact with Mesozoic rocks along a northeast trending zone. Imbricate or sheeted thrusting, highly deformed and contorted rocks, and large recumbent and isoclinal folds characterize the Paleozoic rock sequence, although the Dall limestone conglomerate forms broad, open anticlines and synclines that trend northeast. Dikes, sills, and roof pendants are common near granitic contacts, and extensive silicification, pyritization, and thermal metamorphism has occurred. Characteristically, favorable altered zones in the limestone cobble conglomerate of the Mt. Dall type are marked by extensive hydrothermal bleaching--and little iron staining.

(2) Economic Geology

Mineral deposits of the Dall Trend belong to at least three major types: (1) tactite and other contact-related deposits; (2) ultramafic magmatic segregations; and (3) stratabound sedimentary deposits associated with graphitic shales. Tactite zones in the Mt. Dall limestone pebble conglomerate and underlying limestone beds near Yentna-type intrusives form extensive bleached white areas and local red-stained zones. The associated deposits are characterized by gold, silver, and copper, with less common anomalous amounts of many other metals, including nickel, tin, and tungsten. In addition to high-grade deposits, a good potential for large tonnage, low-grade copper and gold deposits appears to exist, as evidence by widespread alteration and distribution of anomalous amounts of these metals--especially gold.

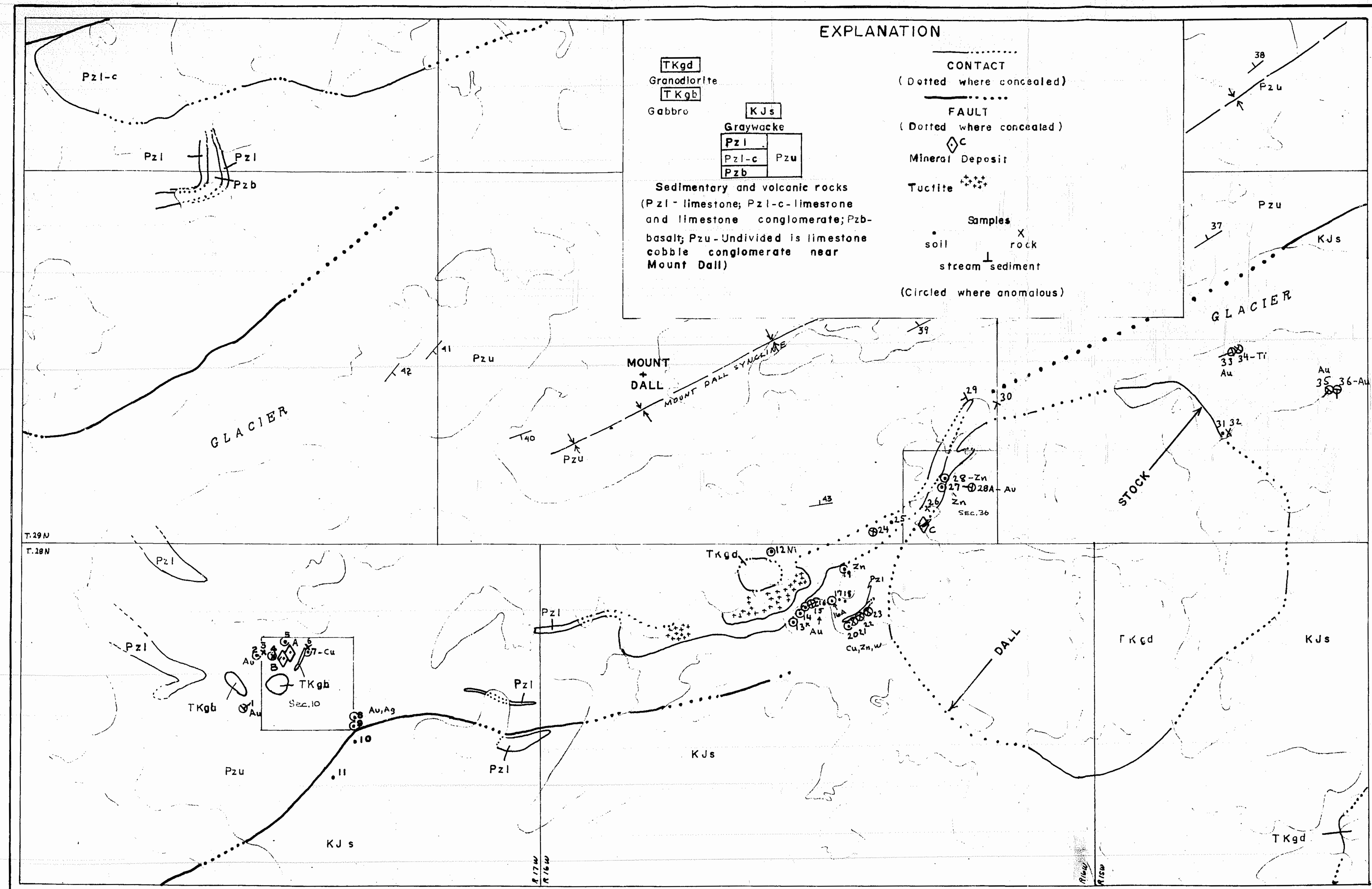
Mineral deposits related to ultramafic rocks occur in an arcuate belt at least twenty miles long, which partly parallels and partly cuts across the south boundary of the Dall Trend. Chromium, nickel, and copper are characteristically anomalous metals in this belt of dunite, serpentinite, and talc schist.

(3) Descriptions of Mineralized Rocks in the Dall Trend

As presently recognized, the Dall Trend extends from the Cathedral Spires granite in T27N, R17W, northeastward across the Yentna River, the Dall Glacier, and along the north side of the Lacuna Glacier to T32N, R12W, where it is truncated by the Foraker granite pluton. The intrusives exposed south of Mt. Dall are complex and range from peridotite to granite, but average as granodiorites (B. Reed, oral communication, 1977).

a. Dall Mountain area (fig. 4.1-C(3); table 4.1-C(3): The east end of the Dall tactite region is characterized by extremely rugged mountains more than 6000 feet in elevation, and numerous glaciers. Vegetation is sparce. The largest intrusion--termed the Dall stock--covers approximately twelve square miles. It is a multi-phase pluton of varying composition, but is chiefly granodioritic along its western contact.

A high-grade copper-silver-gold deposit of unknown extent is present in the north half of section 36, T29N, R16W, in a banded tactite zone. Adjacent to the contact, the country rocks consist of siliceous black argillite, a thick band of massive limestone, and minor siltstone. The massive limestone is extensively marblized and, where it approaches or is in contact with the granodiorite, tactite has developed. The tactite consists of diopside, wollastonite, garnet, calcite, and sulfide minerals. The recognized high-grade deposit occurs on a knife-edged ridge at about 5300 feet elevation where tactite is separated from the intrusive by a few feet of pyritic, silicic black argillite. Massive sulfide minerals form a replacement band in the tactite and occur in concentrations ranging from a few inches up to three feet thick. Ore minerals



BASE FROM U.S. GEOLOGICAL SURVEY, TALKEETNA C-5 QUADRANGLE

FIGURE 4.1-(C)3 **GENERAL GEOLOGIC AND MINERAL MAP, MOUNT DALL AREA**

TABLE 4.1.C(3)

RESULTS OF ANALYSES, MOUNT DALL AREA

(FIGURE 4.1C(3))

(IN SAMPLE TYPE R=ROCK, SS=STREAM SEDIMENT, S=SOIL, PC=PAN CONCENTRATE)

Map No.	Field No.	Sample Type	Cu	Pb	Zn	Ag	Au	Ni	As	Cr	Other	
			(all results in parts per million)									
1	464	SS	80	-	-	<.2	.07					4W
2	330	R	490	15	30	2.0	<.02					<2W
3	331	S	65	15	85	<.2	.05					
4	346	S R	300	<10	<200	<1.0	-	1500	<500	3000		
5	332	S	65	15	85	<.2	0.05					
6	341	R	50	15	<200	<1.0	-	200				
7	340	S	205	15	50	0.8	<.2					13W
8	335	S	115	50	145	1.2	0.43					
9	336	S	155	310	575	10.5	1.90					
10	337	S	110	15	200	0.6	-					
11	338	S	100	30	210	0.6	<.02					2W
12	219	S	70	-	70	-	<0.4	295				
13	463	S	220	-	-	0.4	1.1					
14	462	S	55	15	65	<.2	0.90					
15	460	S	80	25	145	.2	0.46				<10Sn	<2W
16	461		150	<5	<200	<1.0	0.19	100				
16A	236	S	250	30	1050	2.0	0.5					2W
17	238		115	35	135	<.2	-					
18	233		45	25	210	<.2	<.02					
19	146	R	100	10	1350	<.2	-				<10Sn	<2W
20	459	SS	45	25	340	<.2	-					<2W
21	458	R	310	55	-	.2	<.02					
22	457	S	75	25	725	1.0	<.02					6W
23	232		1900	15	20	1.0	2.9					1000W
	147	S	30	5	105	<.2	<.02	65			<10Sn	<.2W
24	149	R-FH	335,000	275	15	1000	.21	35				
25	148	R-SK	100	<10	<200	1	-	50			200Sn	5000Mn
26	239	R-FH	85	15	25	.2	<.02					
27	240+	R	90	10	575	2.4	.02					
28	241	S	105	30	275	0.8						
28A	242	SS	55	20	105	<2	.06					<2W
29	218	R-FH	30	-	50	<.2	<.02	60				<2W
30	145		25	5	65	<.2	<.02				<10Sn	<2W
31	465		50	-	-	.2	<.02				<10Sn	
32	244	S	60	5	200	1.2	<.02					
33	143	SS	10	5	-	<.2	0.12				<10Sn	34W
34	144	R-FH	50	<10	<200		1.0	-	50		1500Ti	
35	466	SS	20	5	30	0.2	1.1				<10Sn	25W
36	245	SS	60	10	80	<.2	.08					
Mineral Deposits												
A	333	R-9b	70	<10	<200	0.2	0.65	10000	10000	300		4W
B	339	R-15'	1200	10	30	2.2	0.30	650	-	-		-
C	467	R-3'	250,000	-	-	1400	24.0	-	-	-	200	2W

are massive bornite and chalcopyrite. Free gold is also present in thin calcite-diopside seams in the tactite.

The deposit, where sampled, contains 25 percent copper, about 41 oz/ton silver, and 0.7 oz/ton gold over a three-foot width (table 4.1-C(3) - location C). The tactized country rocks contain lesser amounts of copper, but probably more gold because free gold was visible in the tactite adjacent to the sulfide deposit. Because of the extremely rugged terrain, the size of the high-grade deposit is not known accurately, but is probably on the order of tens of feet long. It occurs in a zone of tactized and geochemically anomalous rocks at least ten miles long that extend to the northern part of T28N, R17W. Float, probably from the sampled deposit, but possibly from a similar deposit, collected at locality 24 assayed 33.5 percent copper.

Northeast of the Dall Stock sediment samples from streams that drain the intrusive contact contain anomalous gold and/or tungsten (sample nos. 33, 35, 36, table 4.1-C(3)). Approximately one mile southwest from the high-grade occurrence is an area with several strongly anomalous samples between the main pluton and a small outlying stock. The stock, which intrudes the Dall limestone pebble conglomerate, consists of several phases. It has altered the conglomerate and has formed an extensive bleached tactite zone for hundreds of yards adjacent to the stock. Limestone conglomerate, argillite, and banded limestone lie between the

4

stock and the main intrusive body. Samples of black argillite contain up to 310 ppm Cu and 1350 ppm Zn. A rock sample of limestone (no. 23) taken at the contact of limestone and a dike, contains 1900 ppm Cu, 2.9 ppm Au, and 1000 ppm W. Samples from the altered conglomerate also contain anomalous concentrates of copper and gold.

The west end of the presently-recognized Dall tactite region is ten miles west of the Dall Stock. In this area, mineralized outcrops are exposed on a steep side hill above the West Fork of the Yentna River, and extend to the top of a 4600-foot high ridge in section 10, T28N, R17W. Mineralization is associated with the uppermost part of a multi-phase intrusion that cuts the Dall conglomerate. The conglomerate is hydrothermally bleached and contains local zones of tactite. The predominant phases of the intrusion are gabbro and porphyritic granite. Mineralization consists of disseminated pyrite, chalcopyrite, and possibly a nickel arsenide mineral (sample no. 33 contains about 1 percent nickel and greater than 1 percent arsenic, but negligible amounts of other metals). Occasional higher grade pods of sulfide minerals are present in the tactite. One soil sample (no. 9) showed anomalous lead and silver, and most samples contained anomalous amounts of gold and copper. Nickel and chromium were anomalous in some samples associated with the gabbro phase of the intrusive.

Eight miles to the southeast (fig. 4.0-B) of localities in section 10, a stock of quartz monzonite porphyry intrudes Mesozoic siltstone. Soil samples collected near the intrusives contain up to 335 ppm Cu, 0.55 ppm Au, 10 ppm Mo, and 100 ppm W.

b. Ultramafic Mineralization: Ultramafic rocks are discontinuously present along a belt extending from the Dall Glacier (T30N, R15W), eastward across the southern tip of the Foraker pluton, northeastward along the pluton-sedimentary rock contact for at least twelve miles, making the total length at least 24 miles. Dunite, serpentite, and talc schist are the predominant rock types. Regional aeromagnetics help outline this belt and indicate a magnetic high at the belt's widest portion. A pod of massive sulfides (sample nos. 234) with exposed dimensions of about four feet wide and twenty feel long, consists mainly of pyrrhotite; a representative sample assayed 0.14 % Cu, 0.17% Ni, and 0.08% Cr, but the possibility of other metalliferous bodies is suggested by the magnetic survey and very widespread sulfidized rocks. Soil samples in this portion of the belt reached 1500 ppm Cu, 6000 ppm Ni, and a rock sample of dunite assayed 7000 ppm Cr (sample nos. 224-244, table 4.0-B).

Podiform chromite bodies are present in dunite, which form part of an alpine-type suite of ultramafic rocks exposed in T31N, R12W (B. Reed, oral communication, 1976). Sediment samples from this area (nos. 217-231) contain anomalous amounts of chromium, nickel, and copper. The strongest chromium anomaly on the hillside below the occurrences is 1200 ppm. High background copper values were also indicated. The ultramafic rocks form an arcuate zone which extends from a point about five miles south of Mount Russell, northeastward along the southern contact of the Foraker pluton to T22S, R19W (B. Reed, oral communication, 1976).

The Dall trend is a mineral zone only previously recognized by the U.S. Geological Survey (B. L. Reed, oral commun., 1977). It deserves extensive prospecting at least for (1) gold-copper replacement bodies in limestone and the conglomerate of Mt. Dall, and (2) ultramafic affiliated bodies. Some of the deposits like the high-grade copper tactite mass are at such remote locations as to probably defy development; others--such as the chromite deposits and the disseminated deposits above the Yentna River (sec. 10, T28N, R17W)--are not too inaccessible to contemplate development.

D. Shellabarger Pass Area (fig. 4.1-D; table 4.1-D)

Discovered in 1967 during a U.S. Geological Survey Healy Metals Investigation, massive sulfide deposits in this area occur in several bodies. The deposits occur within a volcanogenic, eugeosynclinal sequence of middle to upper Paleozoic age (B. Reed, oral communication, 1977). The upper (?) part of this sequence is a series of submarine basaltic pillow flows and minor tuffs, breccia, and agglomerate, which apparently overlie interbedded chert, shale, siltstone, dolomite, volcanic greywacke, basaltic aquagene tuff, and conglomerate. The basalts have high background copper values (160 to 190 ppm), as do some of the other units. The known massive

EXPLANATION

Pzl	Pzu
Pzca	
Pzb	

Sedimentary and volcanic rocks
Pzl-Limestone, Pzca-chert and argillite, Pzb-basalt, Pzu-undifferentiated rocks, mostly sedimentary.

Approximate contact
(Dotted where concealed)

Fault
(Dotted where concealed)

Strike and dip of bedding

Massive sulfide deposit

Disseminated sulfide deposit

SAMPLES

Stream sediment   Soil   Rock
(Circles where anomalous)

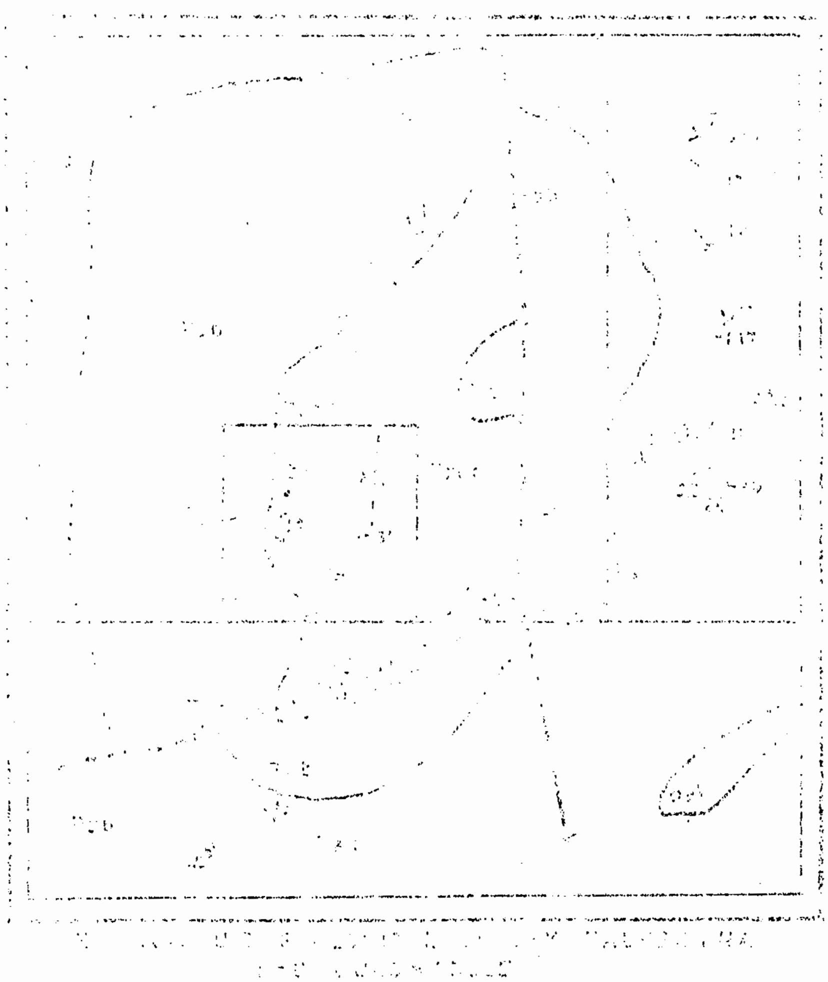


FIGURE. 4.1-D Geologic sketch map of the Shellabarger Pass Mineral area.

TABLE 4.1-D

RESULTS OF ANALYSES

SHELLABARGER PASS MINERAL AREA

(IN SAMPLE TYPE R=ROCK, SS=STREAM SEDIMENT, S=SOIL, PC=PAN CONCENTRATE)

Map No.	Field No.	Sample Type	Cu	Pb	Zn	Ag	Au	Ni	As	Cr	Other
			(all results in parts per million)								
1	C163	SS	165	30	175	< .2					
2	C164	R	140	20	105	< .2					
3	C162	S	215	< 5	95	< .2					
4	C161	S	1,100	-	640	2.8	-	-			
5	C165	S	190	25	125	< .2					
6	C170	S	160	15	85	< .2					
7	C169	SS	150	20	100	< .2					
8	C168	SS	135	80	130	< .2					
9	V138	SS	70	N	< 200	N	<.02	500Ni			
10	C166	R	85	25	180	< .2					
11	C167	S	100	65	390	2.2					
12	V140	SS	100	10	N	< .2	<.02				
13	V141	SS	70	10	N	N	< .02				
14	V142	SS	100	15	N	N	< .02				
15	V143	SS	70	15	N	N	< .02				
16	C07	SS	90	30	125	< .2	< .02				
17	C08	SS	45	25	150	< .2	< .02				
18	C348	SS	45	40	140	0.4	< .02				
19	C414	SS	50	40	130	<.2	< .02				
20	C413	S	45	85	85	<.2	< .02				
21	C412	R	10	30	20	< .2	<.02				
22	C09	SS	55	45	235	< .2	< .02				
23	C349	R	35	20	185	0.2	< .02				
24	C415	SS	65	35	635	.8	< .02				

sulfide bodies are low grade and contain about 1 to 1.5% copper, 0.8 to 1.7% zinc, and 0.9 to 2.4 oz/ton silver.

The Shellabarger Pass deposits have been described by Reed and Eberlein (1972). The massive sulfide bodies shown on figure 4.1-D correspond essentially to the bodies shown in their report. There have been more detailed industry studies made since this report, and additional massive sulfide bodies have been found. At the time of the U.S. Geological Survey report, however, the known occurrences were as shown below:

NAME	EXPOSED DIMENSIONS	ORIENTATION	ASSAY DATA
(1) Upper Sulfide	100' x 17'	Plunge N20W	1.1-1.3% Cu 1.1-1.7% Zn 1.55 oz/ton Ag
(2) Middle Sulfide	50' x 20' largest lens	N80W, Steep	0.9-3.8% Cu 0.2-3.7% Zn 0.1-6.4 oz/ton Ag
(3) Lower Sulfide	75' x 27'		1.0-1.7% Cu 0.2-1.6% Zn 0.9-6.7 oz/ton Ag

Assuming an essentially volcanogenic origin for the Shellabarger Pass deposits, two areas east of Shellabarger Pass could contain similar deposits--one is an area underlain by basaltic rocks similar to those of Shellabarger Pass in the approximate center of T29N, R27W; the second area is in the southwest part of T30N, R25W, south of Surprise Glacier. The area in T29N was examined briefly in 1976. Because of bad weather, the volcanic area in T30N was not sampled or visited, except to confirm an identification of basaltic rocks made in airborne reconnaissance.

4.2 Comanagement Area

A. Chulitna District

The Chulitna district of this report corresponds to the highly-mineralized region discovered in the early 1900s by prospectors who included John Coffee and Alonzo Wells. The district has been prospected at intervals since that time, and has had continued discoveries made through 1976. One mine, the Golden Zone, produced briefly before World War II, and several other prospects have yielded small lots of hand-picked ore.

For descriptive and map purposes, the district is divided into northern and southern parts; the northern part contains the Golden Zone and Snoopy (Nim) occurrences. The southern part includes the Partin Creek, Eldridge Glacier, Ohio Creek, and Coal Creek occurrences.

Main private and published references, in chronologic order, are annotated in table 4.2-A.

(1) Northern Part: The northern part of the Chulitna district contains clusters of mineral deposits, along a general northeast trend, which can be followed fourteen miles northerly from Long Creek to the Bull River (fig. 4.2-A(1).

a. Geologic setting--The northern part of the Chulitna district is in mainly Permian-Triassic rocks which are faulted against or over middle-late Cretaceous rocks on a major fault zone (Upper Chulitna fault) which essentially

TABLE 4.2-A

ANNOTATED BIBLIOGRAPHY OF CHULITNA DISTRICT
(ARRANGED CHRONOLOGICALLY)

Capps, S.R., 1919, Mineral resources of the upper Chulitna region: B 692-D, pp. 207-232.
Describes geography, geology, economic geology and the results of early prospecting in the Chulitna area.

Ross, C. P., 1933, Mineral deposits near the West Fork of the Chulitna River, Alaska: B 849-E, pp. 289-333.
Describes the geography, geology, lode deposits and prospects in the area. Prospects include Ready Cash, Copper King, Lindfers, Golden Zone, Mayflower, Riverside, Silver King, Liberty, Lucrata and Stevens (coal). Contains 1:125,000 geologic map of area.

Smith, A., Geologist, 1944, Report on the Golden Zone mine: Ridgeway R. Wilson & Associates, 28 pp.
Description of the mine including history, geology, workings, tunnels, samples, assays, drilling, ore reserves, mill, costs, etc. Also has drill results and assays from 1938, assays from 1932, 1937 and 1939, smelter returns from 1947, maps of the prospect, geologic plan of the upper tunnel and an assay plan of the lower tunnel.

Mulligan, J. J., R. S. Warfield and R. R. Wells, 1967, Sampling a gold-copper deposit, Golden Zone mine, south-central Alaska: BM OF 917.
Describes the work done on the Golden Zone mine in 1950-51. Contains assay data, drill hole data, flotation, test data, graphic drill logs and sample maps.

Clark, A.L., S.H.B. Clark and C. C. Hawley, 1972, Significance of upper Paleozoic oceanic crust in the Upper Chulitna district, west-central Alaska Range IN Geological Survey Research: B 800-C, pp. 95-101.
Discusses an ophiolitic assemblage. Describes the lithologic units and discusses interpretations and comparison with the eastern Alaska Range.

forms the eastern boundary of the district (Hawley and Clark, 1973-74 and personal communication, Wyatt Gilbert, 1976).

South of the Chulitna River, the rocks immediately west of the Upper Chulitna fault are an ophiolite complex of serpentinite, basalt, chert, and argillite of uncertain age, but possibly as old as Devonian (Swainbank, Smith, and Turner, 1977), or a red bed series of Permian-Triassic (Jurassic?) age. These rocks are succeeded, westerly, by limestone of Triassic age, and graywacke-argillite which probably ranges from Jurassic into the Early Tertiary. North of the West Fork of the Chulitna River, the ophiolite is represented by lenticular serpentinites, and most of the layered rocks are the Jurassic and younger clastic series. Locally, as at the Dunkle mine, coal deposits of Tertiary age unconformably overlie the layered rocks.

Hypabyssal intrusives of several types cut all rock units except the Tertiary coal deposits. These rocks include fine- to medium-grained diorite and quartz diorite porphyry. Quartz diorite porphyry is the host of the mineral deposit at the Golden Zone mine.

Monzonite and diorite porphyries are characteristic of the region between Costello Creek and Bull River. The diorite porphyry is a dark-colored rock with garnet and hornblende phenocrysts.

Light-colored granite or quartz porphyry forms small stocks, as at the Lookout Mountain prospect, or dike-like masses cutting the more mafic intrusive series.

Because of the hypabyssal nature of the intrusives, it is difficult to make direct correlation with the dominantly plutonic rocks of the rest of the McKinley area. The copper-gold mineralization associated with the diorite-quartz-diorite suggests an affinity with Yentna type plutonic rocks, tin locally present with the quartz porphyry suggests an affinity with the McKinley type intrusives. Recent work reported by Swainbank, Smith, and Turner (1977) suggests that correlation could about correct for the Golden Zone quartz diorite, as the rock has been dated as about 68 m.y., or only slightly older than most Yentna-type intrusives.

The structural grain in the Chulitna district is northeast; rocks mainly dip northwest, and are thrown into faulted northeasterly folds with one overturned limb (Hawley and Clark, 1974, sec. A-A; plate 1).

b. Economic geology--The northern part of the Chulitna area contains a variety of types of mineral deposits, some of which appear to have commercial potential. Varieties include (1) sulfide veins valuable for gold or silver, (2) bulk fracture-controlled copper-molybdenum deposits, (3) skarn, and (4) breccia pipe deposits of two subtypes.

Arsenic is probably the most characteristic trace element of the area, but gold, silver, copper, lead, zine, antimony, bismuth, tin, and tungsten occur. The arsenic is present principally in arsenopyrite or its oxidation product scorodite.

The major deposits are the Golden Zone, a gold-copper-silver bearing breccia pipe, and the Snoopy or Nim bulk copper prospect. Other recognized deposits include the Copper King (skarn?), Silver King (tactite-breccia pipe), and numerous vein deposits.

From south to north, recognized deposits with type and metal content are:

NAME	TYPE	MAJOR METALS	POTENTIAL
1. LONG CREEK	VEIN DISSEMINATED	AG-AU, CU, BI, SN	POSSIBLE POORLY EXPOSED DISSEMINATED DEPOSIT
2. COPPER KING	SKARN DISSEMINATED	CU-AG, AU, MO	PROBABLY SMALL
3. GOLDEN ZONE	BRECCIA PIPE	AU-AG CU	MEDIUM TO LARGE DEP.
4. VEINS NEAR GOLDEN ZONE (LINDFORS, MAYFLOWER, LITTLE, BANNER, RIVERSIDE)		AU-AG CU, PB, ZN	SMALL, MIGHT BE DEVELOPED IF GOLDEN ZONE PRODUCTIVE
5. LOOKOUT MTN	PORPHYRY	PB-ZN-AG SN	POSSIBLE GUIDE TO DEEPER MINERALIZATION
6. SILVER KING	BRECCIA PIPE DISSEMINATED VEIN	AG-AU, SB, CU, BI	POSSIBLE GUIDE TO DEEPER MINERALIZATION
7. VEINS NEAR SILVER KING (LIBERTY, LUCRETA, EAGLE)		AG-AU	POSSIBLE POTENTIAL WITH DEVELOPMENT OF LARGER DEPOSITS
8. NIM	DISSEMINATED	CU, AU, AG, MO	OUTCROP AND NEAR SURFACE LOW GRADE. POSSIBLE EXTENSION TO N UNEVALUATED
9. NIMROD	BRECCIA PIPE	AG, CU, SB	REPRESENTATION OF EXPLOSION BRECCIA. UNEVALUATED. POSSIBLE BULK SILVER DEPOSIT.

Local zoning patterns may be imposed on parts of the district. For example, lead-zinc appears to increase relative to gold-copper outward from the Golden Zone mine. The Golden Zone has all the recorded metallic production of the district, with about 1580 oz gold produced from about 10,000 tons of arsenic-rich ore in 1941 and 1942.

c. Main deposits--The historical Golden Zone prospect was described by Hawley and Clark in several reports as a breccia pipe 100-300 feet across of unknown vertical extent and grade, on the order of 0.1-0.3 oz/ton gold and with local significant copper-silver values. Since the field work done by U.S. Geological Survey, nine more test holes have been drilled in or near the prospect, and detailed geochemical and some geophysical work has been done. This report will mainly summarize the new data. Since the U.S. Geological Survey field work, the so-called Snoopy or Nim copper occurrence was found, along with other deposits between the Chulitna and Bull Rivers.

Golden Zone

The Golden Zone deposit is in the approximate center of a biotite quartz diorite plug two miles south of the West Fork of the Chulitna (fig. 4.2-A(1). The plug was intruded into silty and calcareous or volcanic sedimentary breccias, which are now extensively bleached and pyritized (fig. 4.2-A(1)-c(1)). The complex Bryn Mawr fault zone forms the eastern border of the highly altered terrane near the prospect.

Physical exploration has centered on the mineralized breccia zone exposed within the quartz diorite. This work is summarized on fig. 4.2-A(1)-c(2)--a composite plan view, and 4.2-A(1)-c(3), a near east-west section. Workings include a 100-foot level which was started about 1917, and was completed as a mining level in about 1937. It essentially cuts across the southwest edge of the pipe. A 200-foot level was started about 1930 and extended in stages, with most work in the late 1930s. It first encounters mineralized rock about 160 feet from the portal; from that point is mostly in the pipe. A series of 18 diamond drill holes were placed from the 200-foot level. Some like DH-1 were drilled outward looking for extensions of ore; others, like DH-10 and 6 in and downward were drilled to define edges of an ore body.

Some information is available from these drill holes--all drilled between 1937 and 1939. Core recovery was not, however, generally satisfactory, and it is difficult to base an average grade on differing core and sludge assays. Another drill hole, USBM DH-1 was drilled over 1,000 feet downward from the 200-foot level in 1951 (Mulligan and others, 1967). Core recovery was also poor in this program, but it suggested an ore zone on the east side of the pipe.

The first satisfactory drilling was in 1973 when a private company put down two deep holes from the surface outside the pipe; these are shown as IDC-GZ 1 and 3 in plan and section. Wire-line equipment made possible good core recovery, and especially in GZ-3 core recovery approached 100 percent. The drill holes encountered low-grade breccia mineralization at depth, and significant vein mineralization--especially the Blind vein of GZ-1, which shows about 0.45 oz gold/ton, 7 oz silver/ton, and about 6 percent combined lead-zinc over 4.0' in a 100-foot wide vein zone. Because of the distance between intercepts and earlier drilling, however, exact correlation of ore zones is uncertain. To gain better knowledge of the pipe itself, six holes were fanned from a surface set up shown as R (holes R-1 through R-6) in 1974, and two holes were drilled from set up H (H-1 and H-2) in 1975. Core recovery was satisfactory in these holes, and with the existing underground data, are the bases for the detailed cross sections shown in figs. 4.1-A(1)-c(4), -c(5), and -c(6).

The results of exploration to date suggest a vertical or steeply north plunging pipe about 300 feet across in an east-west direction and a maximum of 150 feet across in a north-south direction. Surface exposures and the 100 and 200-foot levels suggest a peripheral distribution of ore near the outer edge of the pipe, which is partly confirmed by drill holes R-1 and R-3. As examples, hole R-1 cuts a 35-foot intercept, assaying .31 oz/ton gold near the west edge of the pipe, shown as the <u>west zone</u> and R-3 a 50-foot intercept of 0.21 oz/ton gold near the east edge shown as the <u>east zone</u> (figs. 4.2-A(1)-c(3) and -c(4).

Deeper drill holes, especially R-2 and H-2, are consistent with two interpretations of shape. Either the pipe is nearly vertical and has a central plug of sulfide-rich ore, as suggested in -c(4), or the pipe has a steep north plunge, and the mineralized rock intercepted in R-2 and H-1 is the highly mineralized footwall of the pipe. The differences in the two models are suggested in section -c(5). The contact labeled as model 1 assumes a more nearly vertical plunge; the contact labeled as model 2 assumes about a 60° plunge north where intercepted in R-2.

A steep north plunge of the pipe is consistent with some of the older drilling. The footwall of the main mineral zone could be between drill holes GZ-17 and 18 (figs. 4.2-A(1)-c(2) and -c(6). GZ-18 was in well mineralized rock, with gold in sludge assays exceeding 0.2 oz/ton for about 150 feet.

The resolution of shape is critical for reserve estimation. If the correct interpretation is a vertical "plugged" pipe, as suggested in section fig. 4.2-A(1)-c(3), the tonnage of the pipe is limited to something on the order of 500,000 - 1,000,000 tons assaying near 0.15 oz/ton gold, and occurring above 500 feet. If model 2 holds, the ore zone is open at depth and, since mineralization is indicated to at least 1500 vertical foot depth in IDC-GZ no. 3, tonnage potential in the pipe could greatly exceed 1,000,000 tons. Smaller portions of the ore zone--such as, the west zone near R-1, and the east zone in R-3--are higher grade.

The tonnage possibly available obviously depends on cut-off grade, and the breccia pipe contains a significant amount of mineralized rock above 0.05 oz/ton in gold. As a low-grade resource, the pipe contains about 250,000 tons/100 vertical feet.

The mining in 1941 and 1942 was by shrinkage stoping, and was satisfactory with production per manday of 25-40 tons (Smith, 1944). Some form of sublevel caving might also be employed. Milling was not satisfactory in 1941 and 1942, but tests made by the operator and the U.S. Bureau of Mines (Mulligan and others, 1967) suggest that a copper-silver-gold concentrate could be produced, which could contain most of the values, along with a low-grade gold-iron concentrate, which could be treated by cyanidization.

Additional resources are present in the Blind, Little, and probably the Mayflower and Lindfors veins. Assay data are relatively sparse, but indicate the possibility of vein-type ore shoots containing 0.4-0.6 oz gold/ton with by-product silver, copper, or lead-zinc. It also appears geologically possible that the existing pipe is the surface expression of a much larger mineralized body. The results of soil sampling, shown in an overlay for fig. 4.2-A(1)-c(1), show that the pipe is at the north edge of a soil anomaly in arsenic (and gold). The rocks within this halo are mostly altered sediments cut by sparse intrusive dikes and veins. Both geochemistry and magnetics (overlay for 4.2-A(1)) are consistent with an abrupt change and decrease in intensity of mineralization east of the Bryn Mawr fault. Based on the size of the geochemical and magnetic anomalies, there is room for a buried deposit, partly expressed at its north edge in the breccia deposit, in tens of millions of ton class.

Nim or Snoopy

An area about 7 miles north-northeast of the Golden Zone, first staked in about 1971 as the Snoopy claims, now as Nim, contains disseminated copper, arsenic, gold, silver, and molybdenum-bearing minerals over an area of more than a square mile. The most intense exposed mineralization is near the common corner of sections 10, 11, 14, 15 between Costello Creek and the Bull River.

The area is underlain mostly by a hypabyssal intrusive complex composed of dark garnetiferous diorite porphyry, cut by monzonite porphyry, and granite or quartz porphyry (fig. 4.2-A(1)). The area has been mapped in detail and sampled on a grid. A few rotary holes were drilled to shallow depth in 1972. Minerals include chalcopyrite, pyrite, arsenopyrite, and molybdenite. Chalcocite of secondary origin occurs sparsely. The dominant mode of mineral occurrence is fracture surface-type dissemination.

Grades estimated from surface exposures are 0.1 percent or less copper. In general, the area of near surface mineralization is enclosed in a 100-ppm copper isopleth (fig. 4.2-A(1)) with better mineralized areas enclosed in 300-ppm copper isopleths. The grades exposed are submarginal; fracture density and mineralization of fractures are not great enough to produce near ore grade materials. More recent work (Resource Exploration Consultants, 1975) does, however, suggest other targets within the area. A magnetic anomaly (generalized as axes of plus and minus magnetization) is about a half mile north of an area of surface mineralization in section 11. No drilling has been done to check this anomaly, which may mark the approximate north boundary of the Nim intrusive complex.

Other Prospects

Very little work has been done on most of the other prospects in the area, and the status of most prospects is nearly the same as reported by Hawley and Clark in 1974, with disseminated-type mineralization exposed at Long Creek, Lookout Mountains, Silver King, and a few other places. The Camp Creek mineral localities reported in Hawley and others (1969, fig. 5, table 5) were staked by REC, Inc. as the Nimrod and Nimbus groups in 1976. At Nimbus, a series of hand excavated trenches, have been cut along a northeast trending vein zone. Assay results (table 4.2-A(1)) show gold and silver in highly-arsenical veins, with a maximum gold content of 9.3 ppm in 2.0-foot vein at Nimbus. At Nimrod, a breccia consisting largely of sedimentary rock fragments with pyritized matrix contained 110 ppm silver; U.S. Geological Survey collected samples (nos. 10-13) showed generally anomalous amounts of lead or zinc. The breccia zone at Nimrod crops out over 200-300 feet; it should be resampled to further check silver values. Outcrop is poor; all exposures are in cutbanks, and geophysics, such as IP, might be necessary to check extent of sulfide-bearing rocks at Nimrod. The breccia exposed at Nimrod is only one of many of explosion fault type breccias exposed in the general Nim area. Swainbank, Smith, and Turner (1977) report: "At least 22 discrete subcircular outcrops and

TABLE 4.2-A(1)

INDEX OF MINERAL DEPOSITS AND GEOCHEMICAL SAMPLES IN THE CAMP CREEK AREA, SHOWING RESULTS OF ANALYSES OF ANOMALOUS SAMPLES

MD=MINERAL DEPOSIT--SAMPLE TYPES: CH-3' = CHIP WITH LENGTH; GB=GRAB

GEOCHEMICAL SAMPLE TYPES: SS=STREAM SEDIMENT; S=SOIL; R=ROCK; PC=PAN CONCENTRATE

Map No-Symbol	Field No or Deposit Name	Mineral Deposit or Geochemical type	Kardex No	Cu	Pb	Zn	Ag	Au	Other or Remarks
				(Results in parts/million unless indicated % or oz/ton)					
1	H723 Nimbus	MD Ch-2'		-	20	45	1.2	9.3	22% Arsenic
2	H724 - do	Ch-5'			-	-	0.6	<.02	1200ppm As on north side of sample 1
3	H725 - do	Ch-8'			-	-	1.0	1.4	2.2% As, wall rock on south side of sample 1
4	H726 - do	Ch-3'			-	-	6.0	2.0	1.9% As; between samples 1 and 3
5	H727 - do	Ch-5'			-	-	22.0	.5	3.0% As
6	H-728 - do	gb					<.2	.11	550ppm As
7	H-729	gb					.8	<.02	180 ppm As
8	H-730	gb					<.2	<.02	60 As; trench not into bedrock
9	H-731 Nimrod	gb-10lbs		460	25	160	110	<.02	Breccia
10	USGS 3B Nimrod			10	100	<200	Tr.	.02	
11	do 4B Nimrod			100	150	700	Tr.	-	
12	do 5B Nimrod			10	50	500	.5	-	
13	do 6B Nimrod			500	50	1000	.7	.6	150 Sb

rubble crops of breccia have been mapped. Several are highly biotitized and contain copper sulfides."

The Lookout Mountain occurrence reported by Hawley and others (1969) was resampled to check earlier determined silver values, which are partly confirmed by the newer work (fig. 4.2-A(1)-c(7). The samples collected by S.H.B. Clark (Hawley and others, 1969, table 5) showed anomalous amounts of silver, lead, zinc, and tin in quartz porphyry and breccia. At the occurrence quartz porphyry and breccia are concentrated in a 1,000 x 1,000' area cut by a minor stream drainage, but small bodies of breccia and quartz porphyry occur over a 4,000 foot area elongated north-easterly which includes the main exposures.

The results of assays on samples collected in 1976 are consistent with earlier U.S. Geological Survey analyses. Limonitic material sampled in breccia contain a maximum of about .19 percent copper, .150 percent lead, .39 percent zinc, and 26 ppm silver. The grade of samples is less than that necessary to indicate a commercial deposit. The weakly-mineralized outcrops may, however, indicate the uppermost part of a largely buried intrusive stock. A magnetic survey made in 1976 was not extensive enough to indicate possible shape of a buried body, although the magnetic field measured decreases markedly near 1300 west.

In general, the northern part of the Chulitna area suggests rather shallow intrusive conditions and possibly that intrusives are barely uncovered. Porphyritic, rather than granitic, intrusives are the rule in the area. Intensity of mineralization is great, and the results of deep exploration done at the Golden

EXPLANATION

- Quartz Porphyry — Quartz and sanidine porphoblasts
- Breccia — Clasts of quartz porphyry and argillite
- Country Rock — Argillite and siliceous argillite

Conentration in PPm's

Sample TYPE	NO.	Cu	Pb	Zn	Ag	Mo	Remarks
SS	600	35	85	370	.8		
R	601		— LOST —				
R	602				3.8		
R	603	55	25	925	1.0		
SS	604	35	25	520	.4		
R	605	1,900	4,950	3,900	26.0	2	Limonitic Material in breccia
SS	606	5	50	545	12.0	14	Spring Deposit
S	607	155	110		3.6	60	Black Argillite bedrock
S	608	15	15	30	<.2		
S	609	40	15		.2		
SS	610	75	600	2,150	4.2	4	
SS	611	145	320	1,100	1.2		
S	612	20	15	80	<.2	<2	
S	613	30	30	110	.6		
S	614	30	25	115	<.2		
S	615	30	35	275	.6		
SS	616	20	15	325	<.2		
SS	617	20	15	90	<.2		
R	618	55	25	70	<.2	<2	
S	619	540	340	310	20.		

SS – stream sediment   S – soil   R – rock

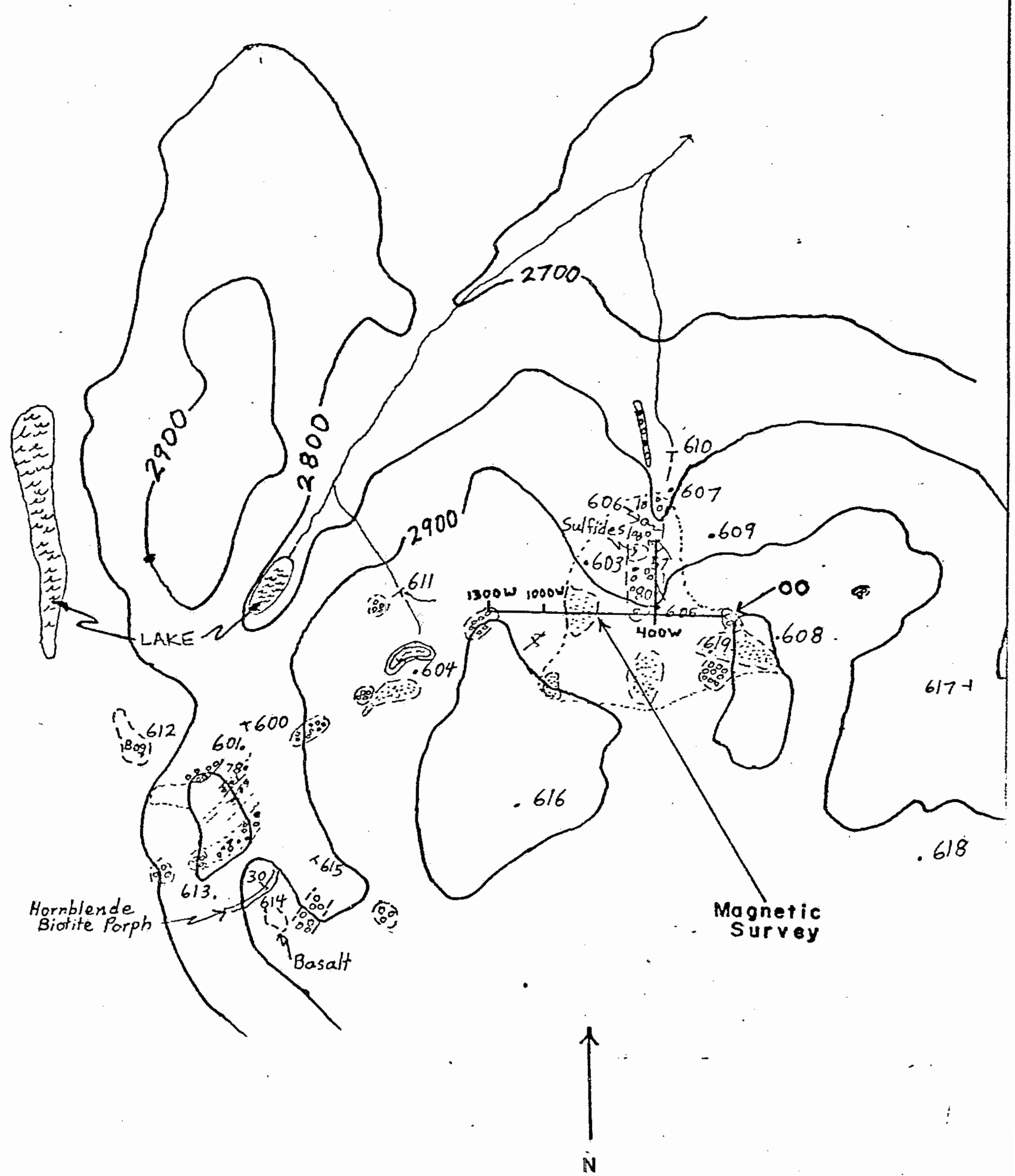


FIGURE 4.2-A(1)-c(7)

1000' 0 1000'
Scale in feet

LOOKOUT MOUNTAIN PROSPECT
Geology by Geoff Garcia

Zone suggests that mineralization is not confined to near surface rocks. Based on the exposed mineral deposits, copper-bearing, arsenic-rich gold and silver deposits are the most likely targets, but there is more than average probability for occurrence of tin and molybdenum-bearing deposits based on fairly wide distribution of anomalous concentrations of these metals.

(2) Southern Part (Chulitna District--Figure 4.2-A(2); Table 4.2-A(2))

The southern part of the Chulitna district, including Ohio Creek, Partin Creek, and their main tributaries, is also locally strongly mineralized. Upper Ohio Creek and the Coal Creek areas could be significant tin-silver areas; Partin Creek has one outcropping ore zone with high gold values.

Most of the area is in the comanagement zone, but the (d)(2) comanagement boundary crosses Ohio Creek just above Canyon Creek and includes part of the upper Ohio Creek area.

a. Geologic setting--The setting of the southern part of the Chulitna district is very similar to that of the northern--Permian-Triassic rocks faulted against mid-late Mesozoic rocks on the east, and succeeded westward by Triassic, Jurassic, and Cretaceous and possibly Tertiary (Cantwell Formation) rocks. It differs in an unusual unit of basalt, mafic volcanic breccia, and interstratified limestone which overlies the red-bed limestone sequence of Permian-Triassic age and underlies the Mesozoic graywacke-argillite. The mafic volcanic-limestone unit is important as the host of mineral deposits in Partin Creek and in Canyon Creek, part of the Ohio Creek area. Ultramafics tentatively considered to be ophiolitic are abundant along the eastern part of the belt.

Except for the granitic stock in upper Ohio Creek, and the cluster of intrusives near Coal Creek, intrusives are less abundant than in the northern part of the Chulitna district.

TABLE 4.2-A(2)
INDEX OF MINERAL DEPOSITS AND GEOCHEMICAL SAMPLES IN THE SOUTHERN PART OF CHULITNA AREA, SHOWING RESULTS OF ANALYSES OF ANOMALOUS SAMPLES

MD=MINERAL DEPOSIT--SAMPLE TYPES: CH-3' = CHIP WITH LENGTH: GB = GRAB

GEOCHEMICAL SAMPLE TYPES: SS = STREAM SEDIMENT   S = SOIL
PC = PAN CONCENTRATE   R = ROCK

Map No. or Symbol	Field No. or Deposit Name	Mineral Deposit or Geochemical Type	Kardex No.	Results in parts per million unless indicated % or oz/ton						
				Cu	Pb	Zn	Ag	Au	Sb	Other or Remarks
1.	722	SS		115	950	825	2.4	< .02		
2.	721	SS		70	20	890	< .2	< .04		
3	488	Gb-6"		100	< 10	500	2.6			700Sn in 6" gossan vein
4	487	R-Gb								1500Sn, 3000Ba
5.	720	S		70	< 10	< 200	1.0	< .02		10Sn,50Mo,3000Ti
6	489	Ch-5'		15	100	< 200	6.8	< .02		300Sn
7	490	Gb		10	< 10	200	1.4			15Mo,150Sn,3000B
8	491	Ch-10		15	10	700	1.2			700Sn,200Bi,70W 1000 As
9	478	SS		110	15	130	0.4	-	-	
10	480	S		135	20	280	.8	<.02	-	
11	479	SS		80	25	205	0.2	-	-	
12	485	S		80	40	170	0.6	<.02	-	
13	484	SS		55	25	115	0.6	<.02	-	
14	483	SS		80	30	240	0.2	<.02	-	
15	259	SS		100	-	235	< .2			300Sn,3W
16	260	SS		275	55	725	4.2	< .02		65W 50W
17	261	R		500	70	500				700Sn,1500B,30Be
18	263	R		2	15	< 200	<1.0			10Sn(typical granite)
19	264	SS		235	35	385	3.4			300Sn,38W
20	265	R		30	10	200	<1.0			20Sn
21	256	S		65	-	170	< .2			2W, < 10Sn
22	255	S		145	-	275	-			3W, < 10Sn
23	427	R		50	-	-	1.6			2W /<10,000 Mn
24	436	R		10	< 10	< 200	1			Opal (silica)/
25	428	R		200	30	-	15.			265W, 20Sn
26	429	S		125	-	-	< .2			44W
27	430	R		30	-	-	.2			20W
28	431	R		85	-	-	.4			180W, 10Sn
29	432	R-Flt.		1150	-	-	130			<2W, 500Sn
30	433	MD-9b 6"		2.6%	500	3150	147 oz/t	.04		1.25%W
31	434	SS		-	-	-	-	-		55W
32	435	SS		135	25	260	-	-		<10Sn, 8W
33	257	SS		-	20	15	< .2			11W
34	258			-	20	145	< .2	.12		4W

TABLE 4.2-A(2) (CONTINUED)

MAP NO. OR SYMBOL	FIELD NO. OR DEPOSIT NAME	REMARKS
A	''COAL CREEK'' SKARN	ZINC-BEARING SKARN (P.4-104 AND 5) 3-4' THICK, ABOUT 300' EXPOSED LENGTH. ASSAYS TO 12.25% ZINC. IN COAL CK ANAMALOUS AREA (SAMPLE NOS 1-9 THIS TABLE)
B	PARTIN CREEK (PAR CLAIMS)	PYRRHOTITE-CHALCOPYRITE-ARSENOPYRITE SKARN (P.4-97 AND 98)
C	PARTIN CREEK (WOOD-FENNIMORE CLAIMS)	SAME AS ABOVE.
D	ELDRIDGE GLACIER	MASSIVE AND DISSEMINATED CHALCOPYRITE ASSOCIATED WITH SERPENTINITE. MAXIMUM ASSAY 7.5% CU (HAWLEY AND OTHERS, 1969)
E	PARTIN CREEK (CHULITNA MINING CORP. LOCALITY)	COPPER-BEARING VEIN AND STOCKWORK AT BASALT-SERPENTINE CONTACT. STOCKWORK ABOUT 50' ACROSS CONTAINS 0.20-0.25% CU; 6' VEIN FROM 0.3-1.8% CU.
F	''SHOTGUN CREEK'' CHULITNA MINING CORP.	DISSEMINATED COPPER (CHALCOPYRITE) IN TRIASSIC BASALT SHALLOW DIAMOND DRILL HOLES.
G	''SHOTGUN CREEK'' CHULITNA MINING CORP.	DISSEMINATED AND VEIN COPPER IN TRIASSIC BASALT. 15' CHIP SAMPLE OF COPPER-STAINED BASALT ASSAYED 0.21% CU. VEINS CONTAIN UP TO 3% CU OVER 3' WIDTH.
H	UNNAMED MINERAL LOCALITY IN COPELAND CREEK	DISSEMINATED AND MASSIVE SULFIDE (PYRITE) LENSES IN COUNTRY ROCK NEAR BIOTITE QUARTZ DIORITE STOCK. ANALYSES SHOW, IN PPM, GOLD 0.1-0.9; COPPER 150-4000; AND SB, 0-3000 IN HAWLEY AND CLARK (1974, TABLE 16, ANALYSES 27A-D).

b. Economic geology--Types of mineral deposits include (1) segregations of chromite in ultramafic rocks, (2) massive sulfide skarn in limy hosts, and (3) veins. Greisen and tourmalinized zones locally occur in granitic intrusives. Copper and locally native silver is disseminated in the basaltic volcanics.

Two important prospect areas had been identified prior to this season: (1) Upper Partin Creek, and (2) the Canyon Creek or Ready Cash area. On the basis of work done in 1976, it is now believed that the Coal Creek area and upper Ohio Creek areas have considerable potential.

As in the northern part of the district, arsenopyrite is the most abundant sulfide in most vein deposits, but associated metals vary. In arsenopyrite-rich veins at Partin Creek, chalcopyrite exceeds galena or sphalerite; at Canyon Creek, galena, sphalerite, lead-bearing sulfosalts, and an unknown tin-mineral comprise the rest of the vein suite.

Skarns are predominantly composed of pyrrhotite, but also locally contain arsenopyrite and, in most places, sufficient chalcopyrite to constitute 0.5-1.0 percent copper in the massive sulfide. Locally, as at Coal Creek (locality A, fig. 4.2-A(2)), iron-rich zinc predominates in skarn.

c. Main deposits--Based on the extent and grade of ore material, four predominant mineral areas have thus far been recognized: (1) Partin Creek, (2) Canyon Creek, (3) Upper Ohio Creek, and (4) Coal Creek.

Partin Creek

The Partin Creek area (localities B and C, fig. 4.2-A(2)) was apparently discovered before 1918, but was rediscovered and relocated in the mid 1960s. The main deposits are massive sulfides, interpreted to be replacement skarn bodies in limestones interlayered in a dominantly volcanic pile. Cross-cutting arsenopyrite rich veins, locally with chalcopyrite and, at one place, stibnite, are present through the same area. Altogether, the strongly mineralized area is over one mile long and over 1000 feet across.

The largest skarn body can be traced on strike for 440 feet and ranges from about three to over twenty feet thick (locality B, fig. 4.2-A(2)). At this place the skarn is mainly pyrrhotite with about 3-5 percent chalcopyrite and locally abundant arsenopyrite. Gold locally exceeds 2 oz/ton over a five-foot thickness. The skarn layer probably ends eastward near a small sparsely mineralized biotite-quartz diorite intrusive, and is covered under talus to the west.

A second body is exposed at locality C, fig. 4.2-A(2). It also has about 3-5 percent chalcopyrite, but only about 0.2 oz gold/ton judged from chip samples taken at outcrop. In addition to localities B and C, at least seven other limy layers have small skarn lenses.

No diamond drilling has been done at either the Par or adjacent Wood-Fennimore claims in the Partin Creek area. Shallow trenches have been excavated and outcrops freshened by blasting. Based on the surface exposures and assays, tonnage of inferred reserves in the main lens (locality B) are about 198,000 tons of rock in a body with an exposed strike length of 440 feet, dip length of 400 feet, and average thickness of 9 feet. Weighted average grade is about 0.68 oz/ton gold, 0.6 percent copper, and a trace of silver. A similar tonnage is probably present at locality C, but grade is apparently only about 0.2 oz/ton gold.

Based on the number of limestone contacts which have local skarn masses, the potential tonnage in massive bodies would exceed 1,000,000 tons with at least 0.2 oz/ton gold. The highest grade zone is close to the contact of a quartz diorite porphyry stock, and it would seem to be justified to check other limestones at depth as they project toward the quartz diorite body.

<u>Ready Cash and Adjacent Claims</u>

The Canyon Creek area, several mineral localities, was also discovered before 1920, and nine claims were patented in 1927 in what is known as the Ready Cash group. Unpatented claims essentially surrounding the Ready Cash are held by Chulitna Mining Corporation. Mineralization is similar to Partin Creek. There are peneconcordant pyrrhotite skarns in limy layers and arsenopyrite-rich vein deposits. But at the Ready Cash, veins predominate over skarns, and galena and sphalerite are present in the veins, and locally exceed arsenopyrite in abundance. Fairly detailed mapping (fig. 4.2-A(2)-c) has shown that veins range from 1 to more than 12-feet thick and can be followed for as much as 2000 feet. Some veins are low grade arsenopyrite gold veins (Ready Cash no. 3); others are medium grade silver-tin veins, averaging about 20 oz silver with a few tenths to over one percent tin. Pyritization and alteration of volcanics is locally intense, but except for northeast trending granitic dikes, there are no exposed intrusives. The extent of mineralization is at least two miles by one mile, elongated in a northeast direction.

Massive sulfide skarn occurs locally, especially near locality 1 (table 4.2-A(2)-c(1)), where it partly replaces a limestone lens. Massive sulfide material occurs over a strike length of at least 200 feet. The zone was sampled at one place where it assays 5.1 percent copper over a six-foot width. In general, the skarn bodies elsewhere on the claim group appear to contain between 0.5 and 0.9 percent copper. Massive sulfide material of unknown extent also is found in argillite; in one locality (0.C-8) supergene argentite occurred with pyrite; a grab sample assayed 65.9 oz/ton silver.

More detailed sampling was done in the areas shown as A and B in fig. 4.2-A(2)-c--table 4.2-A(2)-c(2). Vein materials assay as much as 43.1 oz/ton silver and 1.15 percent tin. One vein, Ready Cash no. 4, has a shoot of well-mineralized material exposed over a strike length of about 400 feet. Based on sample nos. 7, 8, 9, 10, 11, 12, and 32, it assays 20.8 oz/ton silver, 4.0 percent lead, and 0.5 percent tin with some zinc and copper over 3.3 feet. The vein continues, but is inaccessible for 1000 feet north of the sampled interval.

TABLE 4.2-A(2)-c(1)

RESULTS OF SAMPLING, READY CASH

Massive Sulfides

New Number	Field No.	Description	Au (oz/ton)	Ag (oz/ton)	Cu -	Pb (%)	Sn -	Zn -
O.C.-1	19	6.0' chip, layer in lms.	.09	4.3	5.1	-	-	.12
O.C.-2	16*	Grab. of sulfide pods in limestone	.025	4.5	0.9	-	-	.04
O.C.-3	12	Grab. of sulfide lens 6' x 20'	.025	<.01	.7	-	-	.01
O.C.-4	10	Grab. of sulfide pods in limestone	.04	.20	.8	-	-	.02
O.C.-5	9	Massive sulfide pod in argillite	.03	<.01	.43	-	-	.005
O.C.-6	5	Massive sulfide pod in argillite	.008	5.09	.45	-	-	1.5
O.C.-7	1	Heavy sulfides in argillite	<.005	<.01	.60	-	-	.05
O.C.-8	2	Heavy sulfides in argillite. Has supergene argentite on pyrite.	.03	65.9	.05	-	-	1.1

Mineralized Country Rock

New Number	Field No.	Description	Au (oz/ton)	Ag (oz/ton)	Cu -	Pb (%)	Sn -	Zn -
O.C.-9	3	50' chip of hornfels meta-chert unit, diss. sulfides	.02	.46	.10	.21	.001	.02

* Rio Tinto 21 location

TABLE 4.2-A(2)-c(1) (continued)

Vein Materials

New Number	Field No.	Description	Au (oz/ton)	Ag (oz/ton)	Cu -	Pb (%)	Sn -	Zn -
O.C.-10	6	4.0Q-Aspy-Gn-Sph vein, sulfides=50% Vein No. 4 (?)	.005	28.3	.47	7.2	0.1	.3
O.C.-11	8	4.0 Q-sulfide vein 25% oxidized. Scorodite vein No. 4 (?) H.W. No. 4 (?)	<.005	26.5	.24	4.6	0.1	.17
O.C.-12	7	1.0 vein, Q-Aspy H.W. No. 4	.014	24.0	.34	4.2	0.1	.48
O.C.-13	4	1.5 vein steep N. 10W. Set	.012	7.38	.26	1.4	.02	.68
O.C.-14	11A	6" - 1' Q-Aspy vein FW of 15	.046	1.42	.045	.06	.002	.0025
O.C.-15	11B	2.0' Qtz vein. H.W. of 6.0 vein-dike system	<.005	<.01	.045	.02	.007	.01
O.C.-16	-	-	.035	6.69	.25	.03	.015	.003
O.C.-17	13	1.5' Qtz-sulfide vein	.29	.87	1.25	.004	.002	.013
No sample 18								
O.C.-19	15	10.0 qtz-aspy vein Q=75+%	<.005	1.67	.095	.62	.01	.12
O.C.-20	17	1.0' Q-MnAg(?) Min Vein	<.005	<.01	-	-	-	-
O.C.-21	18	1.5' Q-Aspy-Gn-Cpy-Sph in 6.0 vein zone	<.005	6.3	.065	2.65	.03	.39
O.C.-22	H267	2.0'Q-Aspy-Gn-Cpy in 15.0' altered zone	-	6.5	.40	.40	.09	-
O.C.-23	H266	Pyritic Zone	-	3.2	.21	.04	.04	-

TABLE 4.2-A(2)-c(2)

RESULTS OF SAMPLING, READY CASH AREAS A AND B

Item	Sample No.	Au (oz/T)	Ag (oz/T)	Cu (%)	Pb (%)	Zn (%)	Sn (ppm)	Width of samples feet
1.	1	<.005	3.86	.195	1.2	.615	1,250	5.0'
2.	2	<.005	<.01	.044	.004	.014	90	
3.	7	<.005	43.1	.76	8.4	.495	11,500	4.0'
4.	8	<.005	19.0	.36	3.6	.80	4,000	2.0'
5.	9	<.005	20.2	.36	4.6	.695	5,600	4.7'
6.	10	<.005	1.22	.048	.092	.35	350	2.0'
7.	11	<.005	2.08	.078	.37	.018	1,800	3.0'
8.	12	<.005	20.4	.20	3.1	.165	4,000	5.0'
9.	13	<.005	2.92	.38	.012	.018	50	1.5'
10.	14	<.005	<.01	.076	.004	.004	< 50	9.0'
11.	15	.009	<.01	.22	.004	.007	< 50	10.0'
12.	16	.066	.55	.52	<.002	.008	< 50	9.0'
13.	17	.13	.07	.46	<.002	.008	< 50	8.0'
14.	18	.17	1.61	.74	.004	.014	< 50	12.0'
15.	19	.15	1.25	.22	.018	.004	< 50	10.0'
16.	20	.022	3.61	.56	.008	.009	50	9.5'
17.	21	.006	.14	.36	.002	.003	< 50	GRAB
18.	22	<.005	<.01	.088	.002	.007	< 50	GRAB
19.	23	<.005	<.01	.052	.004	.006	< 50	GRAB
20.	24	<.005	5.84	.22	1.3	.40	2,800	
21.	25	<.005	.18	.042	.028	.017	< 50	
22.	26	<.005	<.01	.048	<.002	.009	< 50	
23.	27	.014	1.85	.060	.014	.010	< 50	
24.	28	<.005	.41	.96	.006	.040	50	
25.	29	<.005	8.14	.28	2.5	.96	2,300	Grab 2.0-3.0'
26.	30a	.028	11.3	1.55	.16	.21	900	Grab 2.0-3.0'
27.	31	.023	15.2	.58	.56	.145	1,800	
28.	32	.010	33.8	.44	7.0	.245	8,800	3.0'
29.	33	.025	10.8	.70	1.1	.335	2,400	2.0'

Ready Cash no. 3 is lower grade; it averages 0.08 oz/ton gold, 1.06 oz/ton silver, and 0.33 percent copper over a 9.6 foot width (sample nos. 14, 15, 16, 17, 18, 19, and 20).

Tonnage which could be inferred directly from the sampled interval in vein no. 4 is about 25,000 tons. Overall tonnage potential of the area, based on length of exposure of vein systems, is 100,000's of tons.

Upper Ohio Creek

About three miles above Canyon Creek and bisected by the Ohio Creek glacier, is a tourmaline-bearing granite stock about one mile across. The stock is light colored, fine-to medium-grained, and is locally converted to greisen. It is intruded into graywacke-argillite which has been weakly-metamorphosed by the granite and is noticeably reddened due to iron for a half mile from the granite contact.

The granite contacts (northeast and northwest) dip outward from the stock and banded arsenopyrite-bearing veins or pegmatites are in the granite within a few feet of the contact. The granite and greisen were reported by Hawley and others (1969, p. 8, 9, and 13) to locally contain more than 0.10 percent tin, at least partly in the form of cassiterite.

Sampling for a private company subsequent to 1969 established a tungsten anomaly in the gulch southeast of the granite, and additional sampling was done. This sampling is not definitive, but suggests that the area surrounding the granite locally has disseminated deposits (fracture-filling type) and veins containing tin, tungsten, silver, and commoner metals. Soils overlying a red-stained area east of the granite at 5000 feet elevation are anomalous in tungsten, and a six-inch vein (sample 30, table 4.2-A(1)) contained 1.25 percent tungsten, 147 oz/ton silver, plus tin, lead, and copper.

Stream sediment samples collected between the granite stock and Canyon Creek along Ohio Creek are locally anomalous in elements of the suite As, Ag, Cu, Sn, and W, suggesting undiscovered vein deposits in this area.

Coal Creek

Anomalous amounts of silver, gold, copper, lead, and zinc were reported from Coal Creek by Hawley and others in 1969, but the source was unknown. Based on subsequent work by Bryant, Sothen, and Swainbank (1972), and especially field work in 1976, the area is believed anomalous due to veins and replacement deposits related to light-colored tourmaline-bearing (tin) granites exposed sparsely in the slopes south of Coal Creek.

Two prospects are reported in the area. One is a zinc-bearing skarn (locality A, fig. 4.2-A(2)); the second was not found, but has argentiferous rhodonite, according to George Fennimore who has located the zinc deposit. The skarn is exposed in a northeastern trending zone about 300 feet long in hand excavated prospect pits. A four-foot chip, a three-foot chip and grab sample from the pits assay respectively 6.25, 12.25, and 7.75 percent zinc, with trace amounts of gold and silver. Samples 1, 2, 3, 5, 7, 8, and 9 (fig. and table 4.2-A(2)) contain elements of the suite Sn, W, Be, Zn, and Pb and Ag. Mapping by Bryant, Sothen, and Swainbank (1972) suggests several small granitic plutons in the Coal Creek area.

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Implications of Tin-Silver Bearing Zones

The presence of tin and silver and associated metals in the upper Ohio Creek, Canyon Creek, and Coal Creek areas is sufficiently interesting that more prospecting should be done. Because of the strength and continuity of mineralized zones, the area near the Ready Cash especially deserves prospecting. On a world-wide basis, deposits of tin occur with granites in many places associated with small granitic roofs or cupolas. Except for aplitic dikes, no intrusives are exposed at the Ready Cash, but the implication is very strong that the area is underlain by a stanniferous granite. The area is sufficiently known on the surface that future prospecting should be done by drilling or underground methods.

Both the upper Canyon Creek and Coal Creek areas need detailed surface mapping and sampling. The association of tin-silver in this area of sparse, generally hypabyssal intrusives, is reminiscent of Bolivian-type tin-silver deposits. The tin-bearing areas are aligned northwesterly across the general northeast trend of the Chulitna belt.

d. Other deposits--Locations of other deposits are shown in fig. 4.2-A(2)--locally with assay data. Several of the occurrences are in basalt and consist of copper-bearing veins or zones. Copper also locally occurs in vein-like bodies with serpentine. Chromite occurs sparsely in the serpentinite and massive chromite has been reported at one locality (Hawley and others, 1969, locality 10, table 1). Copper occurrences in the Triassic basalt are exemplified by Chulitna Mining Corporation occurrences in shotgun Creek (F and G, fig. 4.2-A(2)). At these places the basalt contains local concentrations and disseminations of pyrite and chalcopyrite and, where weathered, has a green malachite stain. Chalcopyrite also occurs in veins subparallel to the regional strike of basaltic layers at locality G. Locally in Christy and Canyon Creeks, native copper and native silver fills small vesicles in the basalt.

B. Yentna District

The Yentna district (fig. 1-2, table 4.2-B) includes the Cache Creek area, the Collinsville area, and the drainage of the Kahiltna River below the Cache Creek area. The district has been placer mined continuously since 1905 and has produced over 204,000 ounces of gold, by-product silver, some platinum, and very small amounts of cassiterite (tin) and scheelite (tungsten).

The district has some reserves which are in the probable and possible classes, and resources in areas which have not been prospected in other than casual fashion.

(1) Geologic Setting

The Cache Creek and Collinsville areas lie along the southwestward projection of major faults, like the Chulitna fault zone of the Chilitna district. Structures--faults, fold axes, bedding directions--as in the Chulitna mining area, are dominantly northeast striking or trending, and Hawley and Clark (1973) proposed that both Yentna and Chulitna mining areas are in a mineral belt which lies on the southeast flank of a portion of the Alaska Range. Features common to both districts are abundance of arsenic and gold, and local presence of tin and tungsten.

Bedrock of the placer deposits of the Yentna district is of two distinct ages. The older bedrock comprises graywacke-argillite of Jurassic-Cretaceous age. It forms most of the Peters and Dutch Hills and part of the upland of the Collinsville area. The graywacke-argillite series

TABLE 4.2-B

ANNOTATED BIBLIOGRAPHY OF THE YENTNA DISTRICT

Barnes, F. F., 1966, Geology and coal resources of the Beluga-Yentna region, Alaska: B 1202-C, pp. 1-54.

Description of Tertiary sedimentary beds in widely scattered outcrops throughout Beluga-Yentna region. Good stratigraphic sections of Tertiary beds. 1:250,000 map of Beluga-Yentna region.

Capps, S. R., 1912, Gold placers of the Yentna district: B 520-F, pp. 174-200.

__________ 1913, The Yentna district, Alaska: B 501, 64 pp.

__________ 1913, The Yentna district, Alaska: B 534, 75 pp.

__________ 1925, An early Tertiary placer deposit in the Yentna district: B 773-A, pp. 53-61.

Discusses the origin of gold in the Thunder Creek-Dollar Creek areas. Contains two cross-sections, description of geology and character of gold found.

Hawley, C. C. and A. L. Clark, 1968, Reconnaissance geology, mineral occurrences and geochemical anomalies of the Yentna district, Alaska: USGS OF 311, 64 pp.

Contains detailed geological description of claims and analysis of rock types for gold and other elements. Recommends prospecting for lode gold.

__________________________ 1973, Geology and mineral deposits of the Chulitna-Yentna mineral belt, Alaska: PP 758-A, 10 pp.

Describes general geology and mineral associations of the Chulitna-Yentna mineral belt. Also gives geologic and mineral occurrence maps, 1:250,000 scale.

were folded and faulted in latest Cretaceous or early Tertiary time. They were also intruded at about this time by abundant fine-grained granite dikes and by sparse mafic dikes, both of which types are locally mineralized.

The second type of placer bedrock formed in basins subsequent to erosion and weathering of the Jura-Cretaceous series. It constitutes a basal quartz pebble conglomerate, which grades up into coal-bearing series of poorly consolidated rocks and sediments correlative with the Kenai Formations of Tertiary age. The basal quartz pebble conglomerate locally is auriferous and has two distinct types of facies--one argillaceous and poorly consolidated, and a second with limonite cement.

The Tertiary rocks and deposits fill a large part of the basin between the Peters and Dutch Hills in the Cache Creek area, the basin southeast of the Peters Hills (fig. 4.2-B(3), and much of the Collinsville area (fig. 4.2-B(4). Subsequent to deposition of the Tertiary series, the area was glaciated. Valley glaciers existed in the higher parts of the Dutch Hills and major glaciers flowed down the Yentna and Tokositna Rivers. Apparently the major glacial directions were across, rather than parallel, to the Dutch and Peters Hills, and many placer deposits were preserved in the strike valleys between and adjacent to the hills.

(2) Economic Geology

Two main classes of gold deposits have been recognized in the area: placer deposits and lodes associated with igneous dikes. Coal seams have been mined for local use, and parts of the basins have at least theoretical potential for uranium. Three major classes or ages of placer deposits are recognized--Tertiary, glacial, and past-glacial. Locally placer deposits developed on the weathered older (Mesozoic) bedrock surface and are preserved in the basal Tertiary (Capps, 1925; Mertie, 1919). Other deposits developed before at least part of the glacial period.

The most productive deposits developed in inter or post glacial time and are buried by recent alluvium in the modern stream valleys or slightly older bench deposits. The placer deposits contain angular to flattened gold of about 870-900 fine, up to 2-3 percent platinum metals relative to gold, and locally scheelite, cassiterite, chromite, and uranothorianite (Robinson and others, 1955). Locally placer concentrates also contain pyrite, arsenopyrite, and native copper. Platinum metals have been reported for Cache Creek, Kahiltna River, and the Collinsville area. Cassiterite has been reported especially from the Poorman Creek area; scheelite from Bird Creek; and chromite from Dutch Creek and Collinsville.

Lode deposits have been essentially non-productive, but exist fairly widely in the area and based on an incomplete survey, are especially abundant in upper Nugget and Bird Creeks. Most are in or adjacent to igneous dikes. Most of the dikes have been silicified, sericitized, and contain arsenopyrite. Locally, they contain gold, scheelite, and other valuable minerals. Except for small pockets which might be rich enough to mine, they have little commercial

TABLE 4.2-B(3)

GEOCHEMICAL SAMPLES IN THE CACHE CREEK AREA, SHOWING RESULTS OF ANALYSES OF ANOMALOUS SAMPLES

MD = MINERAL DEPOSIT--SAMPLE TYPES: CH-3' = CHIP WITH LENGTH
GB = GRAB

GEOCHEMICAL SAMPLE TYPES: SS = STREAM SEDIMENT S = SOIL
PC = PAN CONCENTRATE R = ROCK

Map No. or Symbol	Field No. or Deposit Name	Mineral Deposit or Geochemical Type	Kardex No.	Results in parts per million unless indicated % or oz/ton						
				Cu	Pb	Zn	Ag	Au	Sb	Other or Remarks
1	448	S		30	10	200	4	—	—	Ni=50, Cr=300
2	449	S		40	10	—	0.2	.02	—	< 2 W
3	550	S		—	—	—	0.6	.02	—	2 W
4	551	R		—	—	—	—	.06	—	Ni=15, W<50, Sn<10, Sr=1500/Ti=5000
5	733	R		—	—	—	<.02	<.02		
6	735	SS		—	—	—	<.2	<.02		
7	440	S		—	—	—	—	5.3		W=16: Stained area/near dike
8	93	S		—	35	—	<.2	<.02		
9	92	S		—	—	—	<.2	<.02		
10	732	SS		—	—	115	<.2	<.02		
11	94	SS					<.2	<.02		
12	739	SS					<.2	.04		
13	438	SS		—	—	—	—	1.4		W=2
14	439	R		420	30	1050	<.2			
15	441	R		15	10	200	<1	2.6		W=50, Ti=5000, AS=10,000, Ba=3000
16	442	R		—	—	—	—	.1		W=8
17	444	SS		—	—	—	—	.07		W=9, AS=180
18	443	SS		—	—	—	—	—		W=4, As=70
19	91	SS		—	—	—	<.2	.07		
20	600	R		300	50	500	10,000	1,900		Ni=300, Sb=100, As=10,000
21	446	S		—	—	—	.03	.4		
22	650	R		—	—	—	—	.27		
23	651	S		—	—	—	.2	.18		
24	445	R		—	—	—	—	.05		
25	447	R		—	—	—	—	.03		W=4

importance, but erosion of similar deposits has furnished some of the valuable placer minerals of the area.

(3) Cache Creek Area

The area (fig. 4.2-B(3); table 4.2-B(3)) centered in the Cache Creek drainage and including the Peters and Dutch Hills, has been the major source of placer gold in the Yentna district, probably producing about 170,000 ounces from 1905 to 1970. Two creeks, Cache and Peters, have dominated production, but significant amounts of gold have come from Bird, Thunder, Dollar, Poorman, and other creeks. Major reserves are in the Peters Creek-Cottonwood System; resources are in relatively old channels covered by extensive glacial deposits in the Cache Creek area, and in creeks including Bear and Dutch north of the Dutch Hills and possibly in Peters, Bunco, and other creeks south of the Peters Hills.

Cache Creek itself flows southwesterly in the strike valley between the Peters and Dutch Hills southwest of Peters Creek. Cache Creek has been mined by sluice box-cat or dredge methods for almost ten miles. Its south flowing tributaries, including Gold, Nugget, Lucky, Rambler, Thunder, Falls, and Dollar have also been productive. Many of the claims have been consolidated in the Cache Creek group controlled and mined by Phil Brandl and associates. Other active miners in recent years have included Bob Young on Falls Creek and George McCullough on Dollar Creek.

The time available to this study was not sufficient to distinguish all individual types of deposits, but the major deposits are in the valley of Cache Creek cut into the Tertiary series and comprise deposits both buried by alluvium in the modern stream and higher level bench deposits. Because of the extensive mining activity, it is difficult to assess reserve areas, but apparently most, if not all, claims have at least small blocks which can be mined by cat-sluide box methods. One such tract is in a Cache Creek, a left limit bench near Cheechako Gulch. Grade is not known on most placers, but according to Phil Brandl and Robert Young ground down to about ten cents per bedrock foot has been mined profitably in both Cache and Lower Falls Creek in recent years. The creek alluvial channels are shallow (5-10 feet). Grades in the more productive parts of pay streaks mined during the most productive periods were $2-$3/bedrock foot at $20.67 gold.

Gold feeding Cache Creek comes at least partly from Tertiary and Quaternary channels cut by Nugget, Thunder, Falls, and Dollar Creeks. The high level channels are apparently of more than one type: upper Thunder Creek appears to be a Tertiary channel; Nugget Bench channel appears to be either cut in or buried by glacial (Quaternary) outwash gravels; and Short Creek may be an interglacial period channel.

The Thunder Creek channel is marked by highly argillaceous white quartz breccia or conglomerate. Thin layers or seams of lignite are present with the conglomerate, and largely because of this, the channel is inferred to be

Tertiary in age. As suggested by Clark and Hawley (1969) the channel may follow an ancient fault zone.

The Nugget Bench channel has been mined both northeast and southwest of Nugget Creek. It trends generally southwest and has been mined for about 1000 feet; it may have produced as much as 30,000 ounces of gold. The channel can be projected by geophysical means for at least 400 more feet (fig. 4.2-B(3)-a). Where exposed in a modern excavation, the channel has a steep wall cut in Jurassic-Cretaceous argillite and is filled with rounded gravel and cobbles. At Nugget bench it slopes southwest away from the natural drainage direction, so bedrock drains have to be cut back to Nugget Creek. According to Phil Brandl, grades are about $3/bedrock foot. The channel is well marked magnetically (fig. 4.2-B(3)-a) from the end of the present cut to near the airstrip, but it then becomes indistinguishable at least to the method used.

Although speculation has asserted continuity between high channels, distribution of mapped old channels in Nugget, Thunder, Falls, and Dollar suggest a series of old southwest flowing drainages. Gold eroded from the old channels has undoubtedly been reconcentrated in Cache Creek.

Present Bird Creek which flows into Peters Creek appears to have captured a drainage which at some previous time may have gone into the ancestral Cache Creek drainage. Because most of the main alluvial valley of the Cache Creek has been mined, it is believed that more than half of the total Cache Creek gold has been mined. Significant resources are left, however, in Dollar Creek, probably in the high channels and in some bench deposits on Cache Creek. Falls Creek and its tributaries also have some mineable reserves.

Peters Creek Drainage--The Peters Creek drainage has produced placer gold in a fairly large-scale operation from Petersville in about 1937-42 and 1946-58, and on a small scale from Bird Creek, Poorman, and Willow Creeks. It appears possible that most of the gold in this drainage system is unmined.

The approximate source for most of the Peters Creek gold is in Tertiary deposits, essentially residual in character. The base of the Tertiary section crosses the head of Peters, Willow, Poorman, Divide, and Canyon Creeks. The base is locally a highly argillaceous white quartz conglomerate containing angular gold. One such occurrence is plastered on weathered quartz-veined argillite in the NE ¼ section 25, T29N, R9W in what is known as the Gopher, Sidehill, or Jennings cut, where about 1500 ounces were mined from residual material in a 320 by 660 foot cut. In Willow Creek, adjacent to unweathered argillite, the basal Tertiary is a hard limonite cemented quartz sandstone and conglomerate, also reported to be auriferous (Capps, 1925).

Some exploration development information is available for the area; much of it was summarized in private reports prepared by Renshaw (1973, 1974).

The area was actively prospected and mined before World War II; some test drilling was done by W. C. Stoll in 1946 and by Callahan Zinc and Lead Company in about 1951. Essentially no new exploration work was done from the early 50s until 1972, when the gold price started to move up. Reserve data on the Peters Creek Mining Corporation property area (fig. 4.2-B(3)-b) is divided according to whether they were generated in a 1972 exploration program, or whether they were compiled by Renshaw from earlier work.

According to Renshaw (table 4.2-B(3)-b) probable reserves are about 4,100,000 yards containing almost 100,000 ounces of gold.

Possible reserves--those based on limited old physical exploration--and "permissive" reserves, the approximate yardage of untested gold-bearing gravels, are much larger. Possible reserves total on the order of eight million yards with similar value to probable reserves. Some of the other creeks in the area are known to be, at least locally, auriferous. This would include Canyon and Long Creeks.

Bird Creek, a right limit tributary of Peters Creek, is also gold-bearing and some proven reserves are in a high channel deposit, sometimes known as the St. Louis channel. The channel was being mined in 1976 by Earl Ray on a property owned by Alaskan Exploration and Mining Co., Inc. It was drilled in 1942 by Calumet and Hecla Copper Mining Co., with results of drilling summarized in a map (11/1/43) by mining engineer F. C. Fearing. This map shown in fig. 4.2-B(3)-c

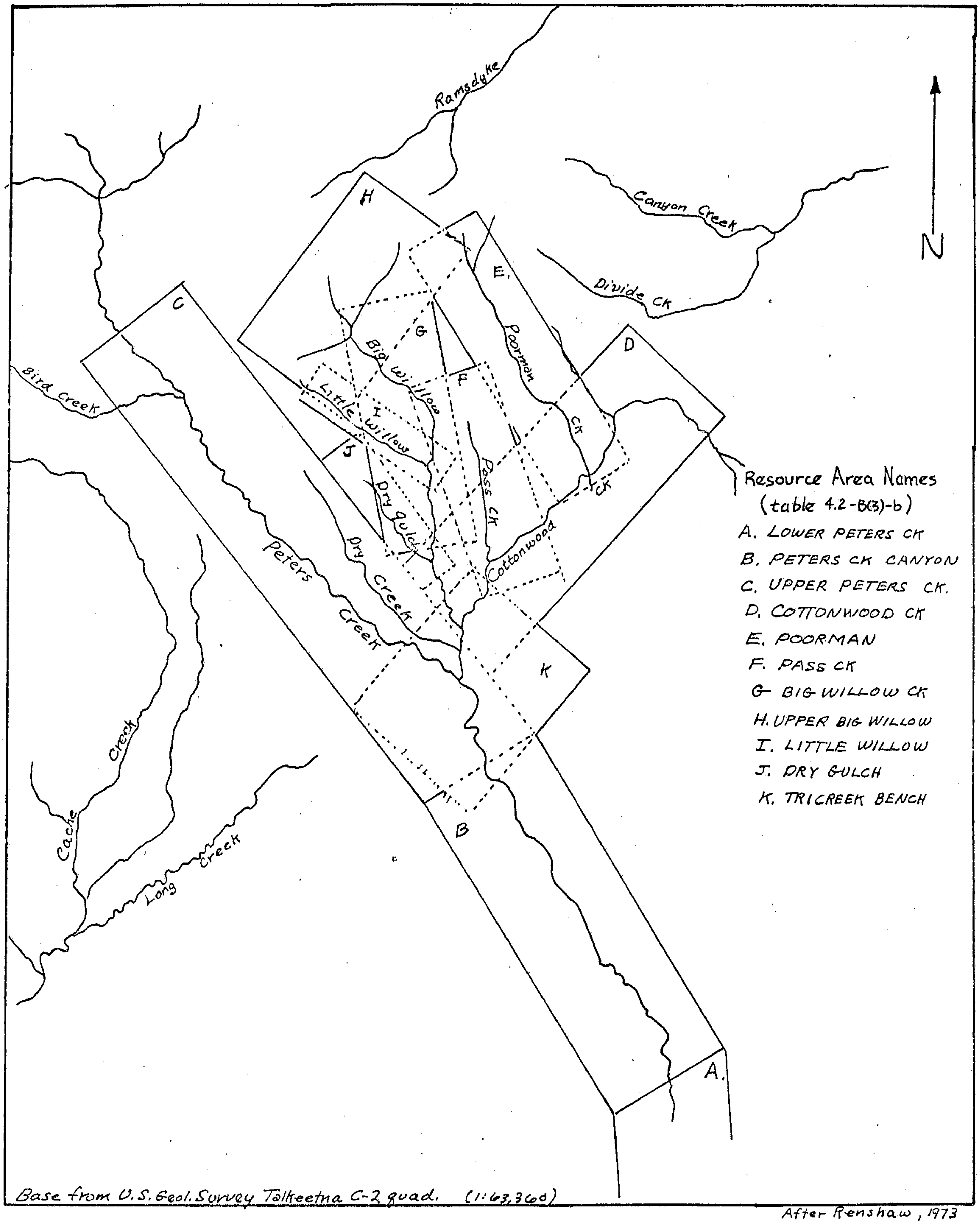
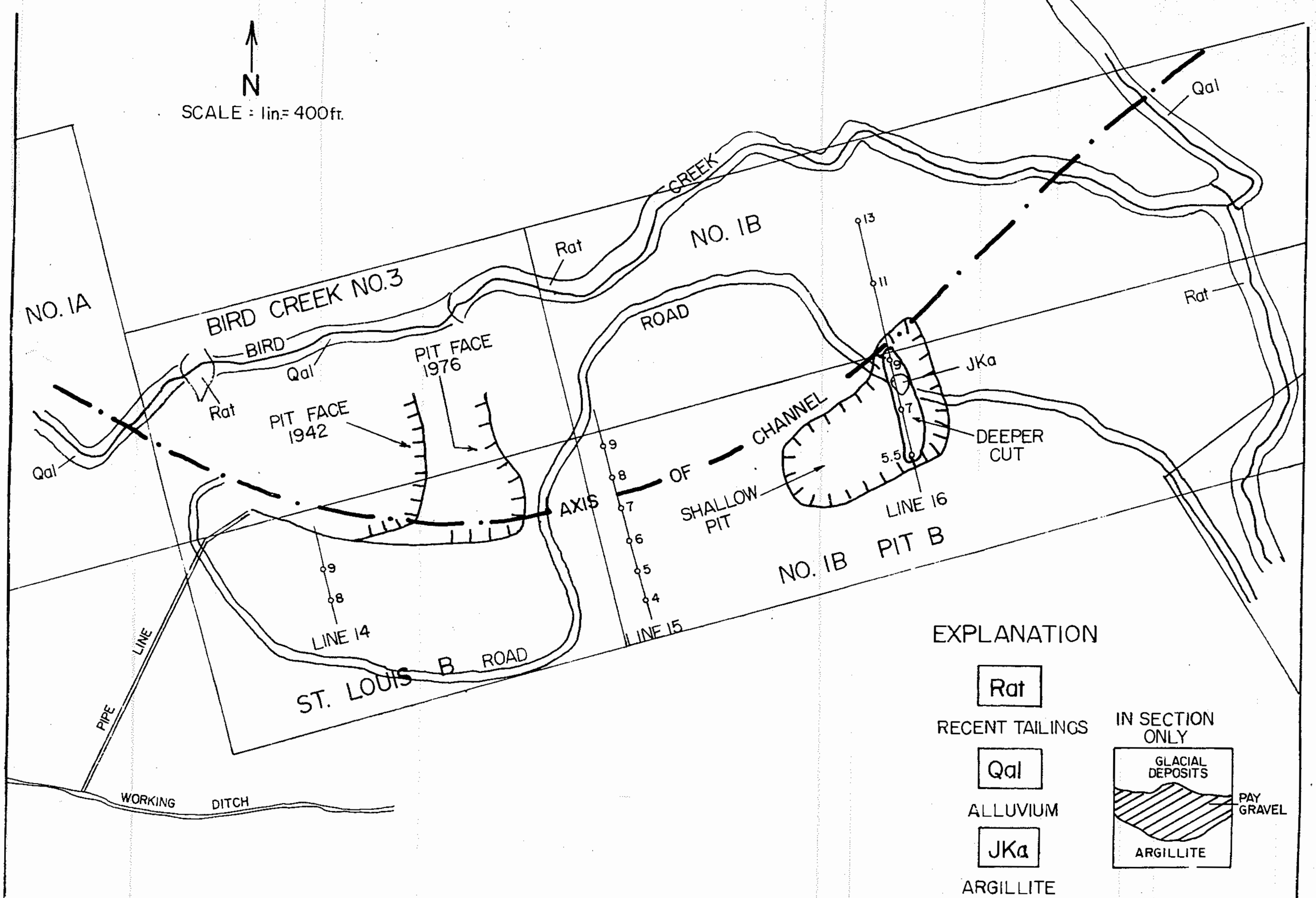


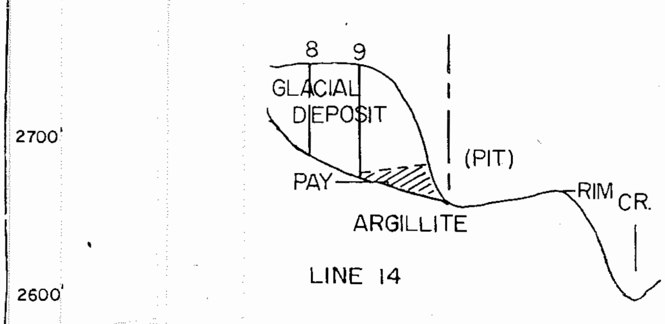
FIG. 4.2-B(3)-b INDEX MAP OF RESERVE AREAS, PETERS CREEK MINING CORPORATION, YENTNA DISTRICT

0 1 2
Miles



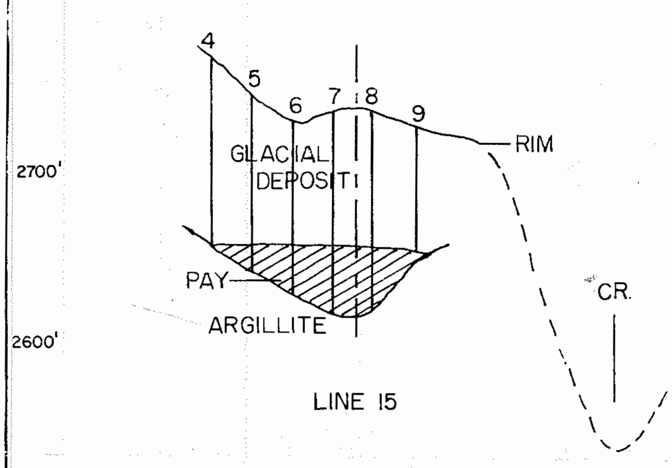
CROSS-SECTIONS AND SUMMARIES OF DRILL HOLES

(PAY VALUES ARE OF GOLD AT $20.00/OZ.)



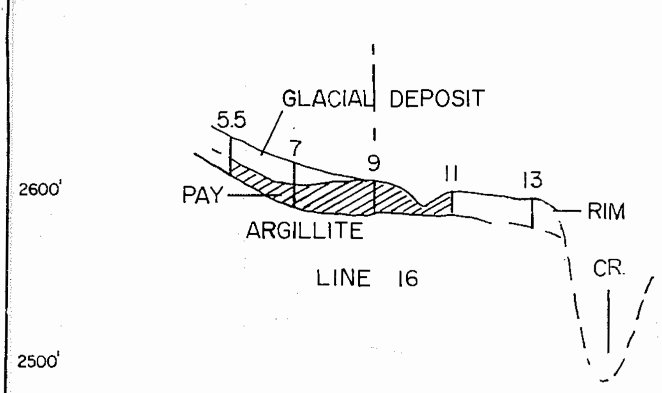
HOLE NO.	8	9	PIT	RIM	CR.
EL. SURFACE	2744	2746	—	—	2594
EL. TOP OF PAY	(NOT ON CHANNEL–NO PAY HOLES)				
EL. TOP OF B.R.	2687	2677	2672	2685	
PAY VALUE/CU. YD.	TR.	TR.			

BOTH HOLES LOCATED JUST BEYOND LIMIT OF CHANNEL



HOLE NO.	4	5	6	7	8	9	RIM	CR.
EL. SURFACE	2774	2750	2733	2747	2743	2735	2720	2541
EL. TOP OF PAY	—	2663	2662.5	2662	2661	2660		
EL. TOP OF B.R.	2661	2649	2634	2623	2626	2654		
PAY VALUE/CU.YD.	—	$0.48	$0.96	$3.53	$1.89	$0.87		

BEDROCK FOR NO. 9 IS NOT TRUE BEDROCK. ACTUAL BEDROCK IS 8.5' LOWER.



HOLE NO.	5.5	7	9	11	13	RIM	CR.
EL. SURFACE	2657	2622	2616	2608	2606	2606	2491
EL. TOP OF PAY	2625	2611	2616	—	—		
EL. TOP OF B.R.	2614	2598	2596	2595	2587		
PAY VALUE/CU. YD.	$3.34	$1.32	$0.48	TR.	TR.		

BEDROCK FOR NO. 5.5 IS CLAY. TRUE BEDROCK IS 5' LOWER

FIGURE 4.2-B(3)-c PLAN AND SECTIONS OF ST. LOUIS CHANNEL, BIRD CREEK, YENTNA DISTRICT

SCALE: HORIZONTAL— APPROX. 1in.=350 ft.
VERTICAL— APPROX. 1in.=80ft.

AFTER F. C. FEARING, 11-1-43

DRILLING BY CALUMET AND HECLA COPPER MINING CO., 1942

TABLE 4.2-B(3)-B

PROBABLE RESERVES IN THE PETERS CREEK MINING CORPORATION AREA, AFTER RENSHAW (1973), AND IN REFERENCE TO FIGURE 4.2-B(3)-B

		Area of Fig. 4.2-B(3)-b	Volume Yds^3	Unit Value/Yds^3 Gold=$140.00/oz.
I.	Probable based on 1972 work	C. Line PE-1 to PE-2	80,000	2.96
		D. Cottonwood Creek	481,000	2.84
		G. Big Willow Creek	68,000	1.07
			629,000	2.66
II.	Probable reserves based on older exploration data.	A. Peters Creek, unworked	891,000	2.14
		B. 1. Peters Creek bed, mouth of Canyon to Little Bowl.	365,000	3.73
		2. Peters Creek bed, Little Bowl to Upper Bowl. Left limit bench	228,000	6.45
		C. 1. Bridge to "dike" at Cottonwood confluence	118,000	1.40
		2. Dike to PE-1 and CO-1 Lines	253,000	3.15
		3. Guise Block 2-12	584,000	1.68
		D. Left limit bench, Peters Creek to CO-1	64,000	4.48
		G. 1. Discovery claim, unmined	36,000	15.44
		2. do , rework	13,000	3.08
		3. No. 1 below, unmined	79,000	14.05
		4. do , rework	11,000	1.40
		5. No. 2 below	122,000	8.30
		6. No. 3 below	147,000	4.60
		7. Nos. 4, 5, &6, below	115,000	3.01
		8. Stoll Block W1, W2, & W3.	236,000	3.73
		9. Nos. 7, 8, & 9, below	183,000	.93
		10. Left limit above Cottonwood	22,000	3.96
			3,467,000	5.39

has been modified to show 1976 pit and workings. The channel is subparallel to Bird Creek, but its base is almost 100 feet above the present Bird Creek canyon. The pay is a yellowish gravel overlain by about 60 feet, on an average, of bluish glacial clay and gravel, which is also auriferous. Values in the pay section are up to $50/yard.

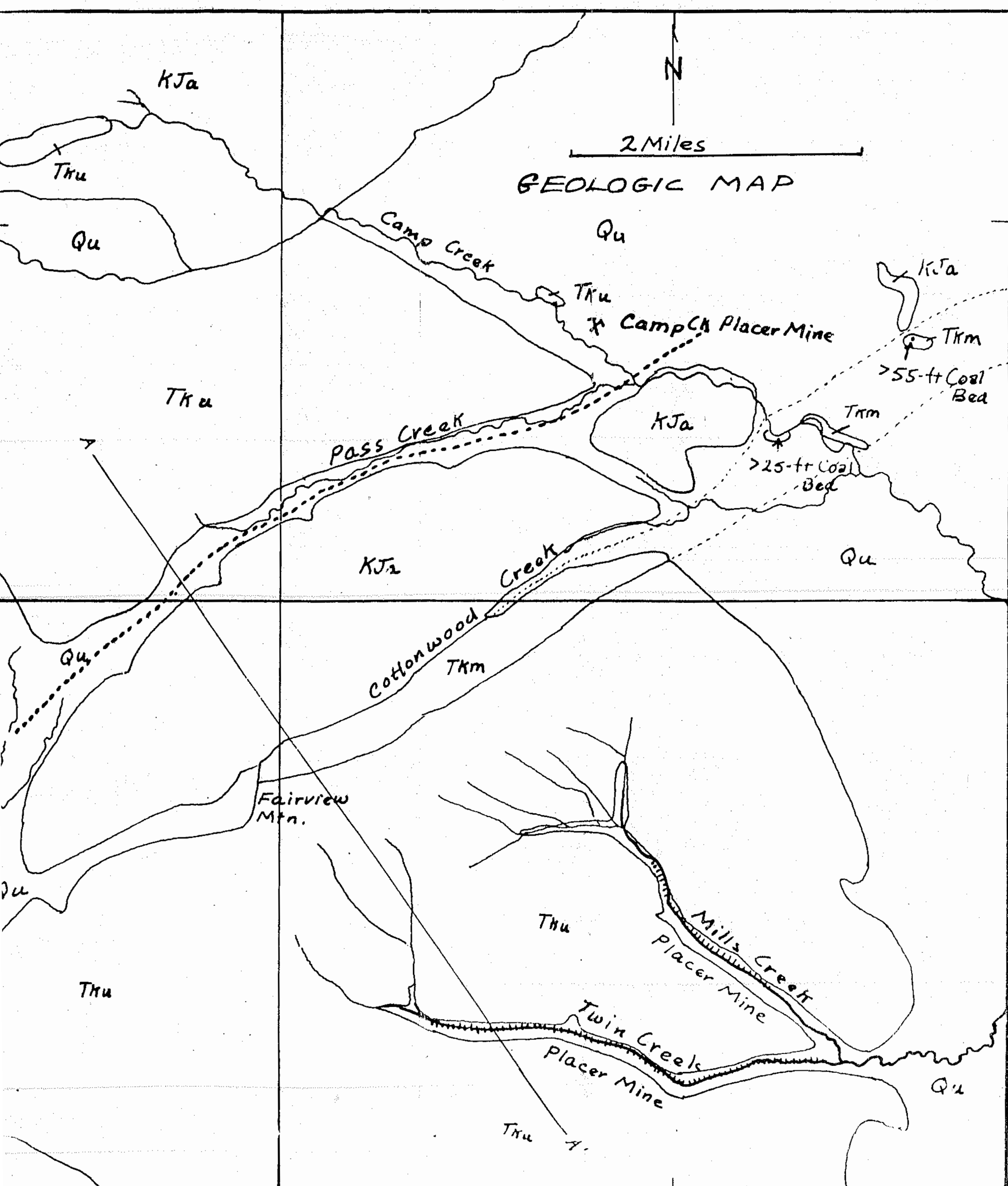
(4) Collinsville or Fairview Mountain Area

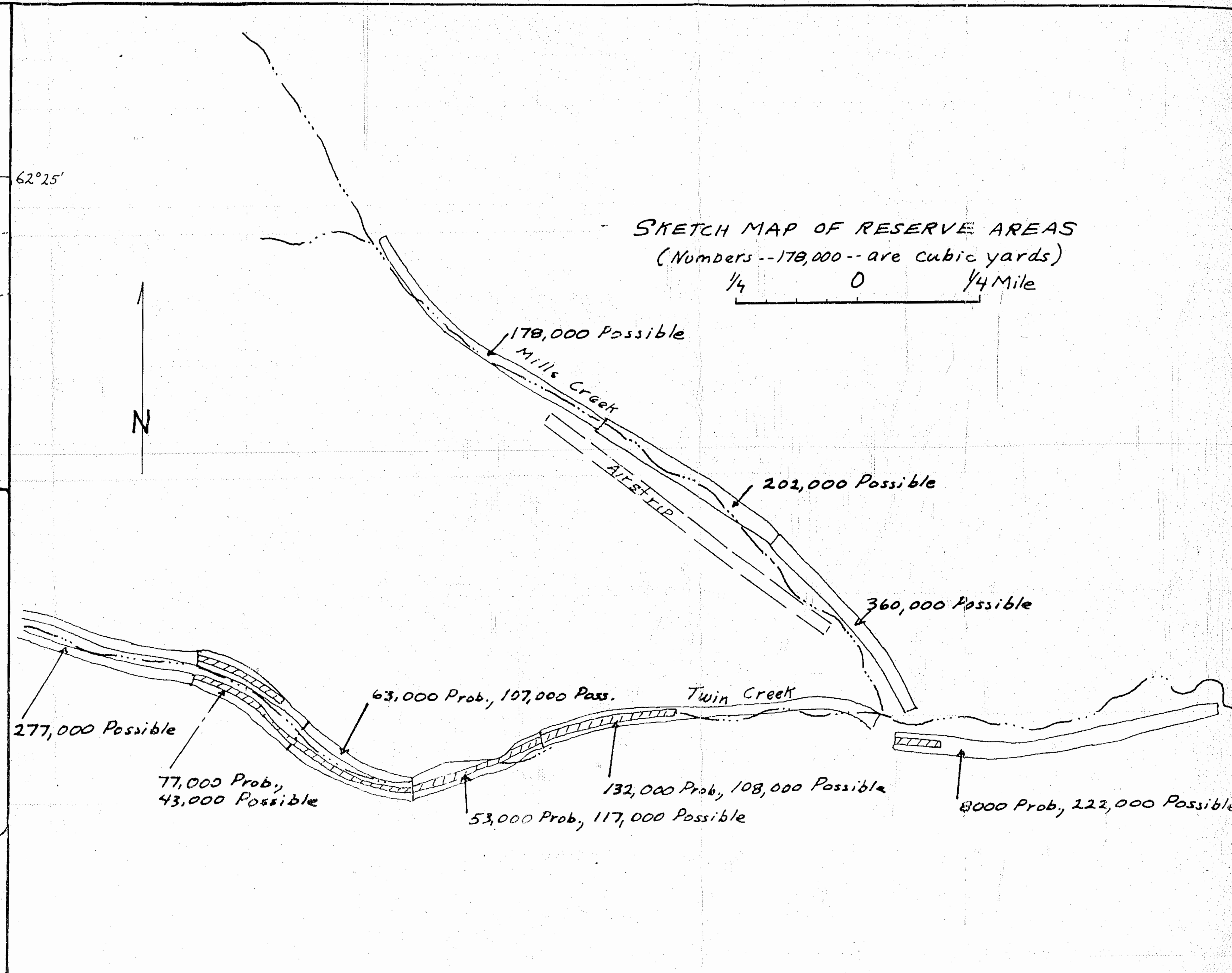
(Fig. 4.2-B(4)) Gold in excess of 30,000 ounces has been produced from the Collinsville area about twenty miles southwest of Cache Creek (Gutrath, 1973A and B, 1974) mainly from Twin and Mills Creeks, and subordinately from Pass Creek and Camp Creek and tributaries of Mills and Twin Creeks.

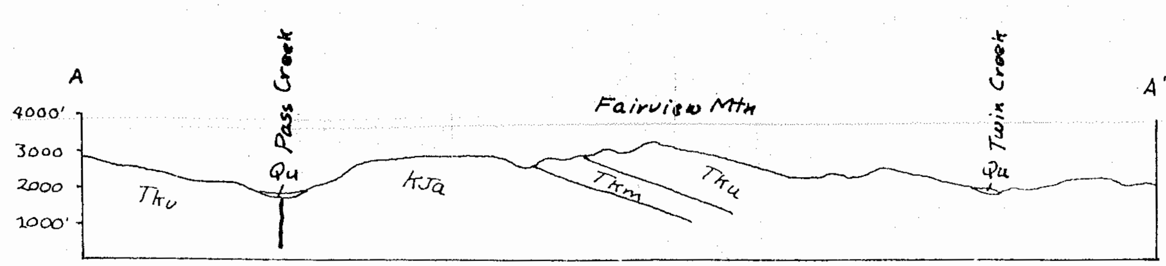
Tertiary semi- and unconsolidated bedrock predominates in the Fairview Mountain area; Mesozoic graywacke-argillite crops out between Pass and Cottonwood Creeks. In Twin and Mills Creeks, the main gold-bearing section is on top of a brown to orange-brown clay bed about 15 feet deep and consists of about 5 feet of quartz-bearing gravel.

Production estimated by Gutrath came from about 1.6 million yards of ground mined in a drag line washing plant operation and 100,000 yards mined by sluice box which, respectively, contained about $.60 and $1/yard gold at $35/ounce.

The gold, almost certainly, is derived by reworking of Tertiary clastic sediments. It is accompanied by about ten pounds/yard of black sand, which in turn contains, on the basis of one assay, about 0.78 oz/ton platinum metals. Reserves estimated from limited drilling by Lori Explorations







EXPLANATION

Qu — Unconsolidated deposits

Tku / Tkm — Kenai Formation of Barnes
Tku - poorly consolidated sandstone and conglomerate
Tkm - interbedded sandstone, siltstone, claystone and coal

KJa — Graywacke-argillite

Contact, dotted where concealed

Concealed Fault

Probable Reserve

Possible Reserve

Reserves in cubic yards

C.C. HAWLEY AND ASSOCS, I

FIGURE 4.2-B(4)
MAPS OF THE FAIRVIEW MT
OR COLLINSVILLE AREA

Scales
1:63,360 - geologic map
1:14,120 - sketch map

Geologic Map from Barnes, 1966; Sk map from Rens 1975

J0166107

in 1973-1974 outlined about 200,000 yards of material in relatively small blocks averaging about $1.16/yard at $100 gold. Resources of essentially untested ground in Pass and other nearby creeks are measured at 1,000,000 or more yards.

Reserves, as recalculated by Renshaw (1975) from the Lori Exploration drill and back hoe data, were: (1) 327,000 cubic yards of probable reserves, mostly covered with old tailings, and (2) 1,614,000 cubic yards of possible reserve. These reserves are in Mills and Twin Creeks (sketch map--fig. 4.2-B(4)) and are stated as of currently mineable grade, but with no value given.

C. Boulder Creek Area

(1) Geologic Setting

The Boulder Creek or Tonzona area (fig. 4.2-C; table 4.2-c) is on the north flank of the Alaska Range about ten miles west of the McKinley Park boundary in U.S. Geological Survey Talkeetna D-5 quadrangle. The main focus of exploration activity has been the contact region of a stock (Tonzona) of Tertiary granite intruded into a series of Paleozoic and Mesozoic sedimentary and metamorphic rocks. The country rock units are dominantly argillite, quartz schist, and limestone, but include porphyroblastic felsic schists, graphitic schist and phyllite, serpentine, and mafic igneous rock.

The Tonzona stock cuts through rocks of Paleozoic and Mesozoic age separated by a fault, here called Tonzona, subparallel to, but older than, the McKinley strand of the Denali fault. The relations of rock units could not be determined exactly during reconnaissance mapping, but may approximate mapping shown in fig. 4.2-C where Paleozoic rocks are exposed north of Cathedral Gulch west of the Tonzona stock and in the Heart Mountains area east of the stock, and south of the McKinley strand of the Denali fault, with mostly undivided Mesozoic argillaceous rocks between the McKinley strand and Tonzona fault.

The layered units are steeply dipping, tightly folded, and have a predominant northeast strike. The northernmost Paleozoic series may be correlative with the Birch Creek-

TABLE 4.2-C

INDEX OF MINERAL DEPOSITS AND GEOCHEMICAL SAMPLES IN THE BOULDER CREEK AREA, SHOWING RESULTS OF ANALYSES OF ANOMALOUS SAMPLES

MD = Mineral Deposit--Sample types: Ch-3' = Chip with length: GB = Grab

Geochemical sample types: SS = Stream Sediment S = Soil
PC = Pan Concentrate R = Rock

Map No. or Symbol	Field No. or Deposit Name	Mineral Deposit or Geochemical Type	Kardex No.	Results in parts per million unless indicated % or oz/ton						
				Cu	Pb	Zn	Ag	Au	Sb	Other or Remarks
1	U294	SS								
2	U295	SS		150	20	300	N	<.02	–	7Mo
3	U296	SS		150	20	300	N	<.02	–	7Mo
4	U297	SS		150	30	700	N	<.02	–	7Mo
5	U298	SS		150	30	700	N	<.02	–	7Mo
6	U299	SS		300	30	1000	N	<.02	–	
7	T 41	S		–	35	130	< .2	< .04	–	< 10Sn
8	T 42	S		–	65	225	< .2	< .02	–	< 10Sn
9	T 49	SS		–	40	800	0.6	<.04	–	<10Sn
10	T250	SS		–	30	550	2.2	<.02	–	<10Sn
11	T251	SS		–	40	265	1.0	< .02	–	
12	T252	S		–	45	330	0.8	< .02	–	
13	T210	SS		–	35	1150	0.4	<.10	–	<10Sn
14	T209	S		–	35	120	1.6	<.10	–	<10Sn
15	U301	SS		50	20	N	N	<.02	–	7Mo
16	U300	SS								
17	T006	S		30	55	150	< .2	< .02	–	< 10Sn
18	U286	SS		70	15	300	N	<.02		
19	U292	SS		150	15	700	N	<.02	–	
20	T 28	S		–	45	220	0.4	< .02	–	
21	27	S		–	30	145	0.4	< .02	–	
22	26	S		–	55	110	5.0	<.02	–	
23	25	S		140	30	80	1.6	<.02	–	
24	24	S		95	75	80	7.2	<.02	–	
25	43	S		–	40	455	.8	<.02	–	<10Sn
26	44	S		–	40	355	1.2	< .02	–	<10Sn
27	45	S		–	45	360	1.0	<.04	–	<10Sn
28	46	SS		–	35	750	1.2	<.02	–	
29	47	SS		–	40	430	0.8	<.02	–	
30	48	S		–	30	170	< .2	<.02	–	
31	23	S		120	55	180	1.2	<.02	–	
32	20	SS		30	25	100	< .2	< .02	–	
33	T003	S		45	95	275	<.2	<.02	–	15Sn
34	U304	SS		30	70	N	N	<.02	–	
35	U285	SS								

TABLE 4.2-c CONTINUATION SHEET

Map No. or Symbol	Field No. or Deposit Name	Mineral Deposit or Geochemical Type	Kardex No.	Results in parts per million unless indicated % or oz/ton Cu	Pb	Zn	Ag	Au	Sb	Other or Remarks
36	U284	SS								
37	U283	SS								
38	U282	SS								
39	U281	SS		100	15	300	–	<.02	–	7Mo
40	U280	SS		200	15	–	<1.0	<.02	–	20Mo
41	T158	SS		55	–	190	–	–	–	20Mo
42	159	SS		120	15	750	0.8	–	–	
43	160	R		190	–	280	0.8	–	–	
44	156	R		70	–	40	–	–	–	4Mo
45	155	SS		225	–	550	–	–	–	8Mo, <10Sn
46	154	SS		25	–	145	–	–	–	<2Mo, <10SN
47	157	R		280	–	170	–	–	–	20Mo
48	153	R		< 5	–	155	–	–	–	<2Mo, <10SN
49	152	SS		30	10	140	–	–	–	4Mo, <10SN
50	150	R		45	–	110	–	–	–	2Mo, <10SN
51	151	S		< 5	5	90	–	–	–	<2Mo, <10SN
52	207	R		–	60	70	1.4	<.02	–	
53	208	R		–	25	25	0.6	<.02	–	<10SN
54	04	S		70	50	120	<0.2	<.02	–	<10SN
55	05	SS		35	40	120	<0.2	<.02	–	<10SN
56	02	S		35	15	75	<0.2	<.02	–	<10SN
57	01	S		5	5	55	<0.2	<.02	–	<10SN
58	00	S		5	10	55	<0.2	<.02	–	
59	T352	R		–	7000	85000	190	–	1050	15Sn
60	353	R		–	4900	140000	390	–	–	20Sn
61	351			–	6500	1300	230	–	1550	>10Sn
62	350	R		–	40	90	–	–	–	10SN
63	178			125	87000	8600	480	–	–	>10Sn
64										
64A										
64B										
64C										
64D										
64E										
65	354	R		–	40	1250	3.0	–	–	
66	U277	SS								
67	U276	SS		100	20	300	–	<.02	–	
68	U278	SS								
69	U279	SS								
70	U275	SS								

TABLE 4.2-c CONTINUATION SHEET

Map No. or Symbol	Field No. or Deposit Name	Mineral Deposit or Geochemical Type	Kardex No.	Results in parts per million unless indicated % or oz/ton						
				Cu	Pb	Zn	Ag	Au	Sb	Other or Remarks
71	U274	SS		70	15	300	-	<.02	-	100Ni
72	T355	R		-	140	330	.4	-	-	<10Sn
73	356	R		-	55	155	< .2	-	-	<10SN
74	38	SS		80	35	275	.4	<.02	-	<10SN
75	37	S		285	75	305	.6	<.02	-	10Sn
76	36	SS		110	50	290	.2	<.02	-	<10SN
77	35	S		260	55	400	.4	<.02	-	<10Sn
78	U273	SS								
79	U272	SS		70	20	700	-	-	-	7Mo
80	U271	SS								
81	U270	SS		70	15	-	-	-	-	7Mo
82	U269	SS		70	30	700	-	-	-	7Mo, 150Ni
83	U268	SS		70	30	300	-	-	-	3Mo
84	T40	SS		15	15	165	< .2	<.02	-	<10SN
85	39	SS		5	10	130	< .2	<.02	-	10SN
86	701	R		50	20	365	-	-	-	<10Sn
87	702	SS		75	20	175	-	-	-	<10SN
88	703	S		175	40	380	-	-	-	<10Sn
89	384	R		900	20	50	1.4	-	-	10Sn
90	383	R		175	10	45	.4	-	-	2W
91	704	SS		25	30	85	-	-	-	<10SN
92	705	SS		275	120	600	-	-	-	<10Sn
93	374	S		110	20	70	0.4	<.02	-	
94	372	S		-	45	105	3.0	-	-	<10SN, 2W
95	373	S		10,500	45	295	2.0	< .02	-	<10Sn, 2W
96	375	S		195	55	90	0.2	-	-	<10Sn, 2W
97	376	S		60	60	115	1.6	<.02	-	<10Sn, 2W
98	377	S		25	40	40	0.8	-	-	<10SN, 2W
99	378	S		55	60	100	0.2	-	-	<10SN, 2W
100	379	S		35	60	125	0.4	-	-	<10SN, 3W
101	380	S		30	35	105	0.4	-	-	<10SN, 2W
102	381	S		65	85	220	-	-	-	
103	382	S		60	40	320	< .2	-	-	<10SN, 6W
104	34	S		160	50	255	.4	<.02	-	<10Sn
105	33	S		390	140	320	.6	<.02	-	<10Sn
106	32	S		510	75	390	.8	<.02	-	<10Sn
107	U267	SS								
108	U266	SS								
109	U265	SS		[illegible]5	30	-	-	-	-	10Sn
110	371	R		[illegible]0	45	145	0.8	<.02	-	

TABLE 4.2-c CONTINUATION SHEET

Map No. or Symbol	Field No. or Deposit Name	Mineral Deposit or Geochemical Type	Kardex No.	Results in parts per million unless indicated % or oz/ton						
				Cu	Pb	Zn	Ag	Au	Sb	Other or Remarks
111	106	R		300	70	200	1	-	-	20Ni
112	105	S		2,050	130	1,800	3.2	<.02	-	10Sn
113	706	SS		80	40	205	-	-	-	<10SN
114	707	SS		35	55	215	-	-	-	<10SN
115	708	SS		55	35	170	-	-	-	<10SN
116	254	S		-	40	275	< .2	<.02	-	<10SN
117	255	S		-	25	185	< .2	<.02	-	<10SN
118	256	S		-	40	155	< .2	<.02	-	<10SN
119	253	S		-	60	115	< .2	<.02	-	<10SN
120	257	S		-	45	230	< .2	<.02	-	<10SN
121	258	S		-	60	145	< .2	<.02	-	
122	259	S		-	140	340	< .2	<.04	-	10Sn
123	260	S		-	50	85	< .2	<.04	-	<10SN
124	261	S		-	100	170	< .2	<.04	-	<10Sn
125	263	R		50	565	185	.4	<.02		<10SN
126	31	SS		140	60	230	.4	<.02	-	
127	30	S		950	30	235	.4	<.02	-	<10Sn
128	29	S		-	55	295	.2	<.02	-	<10SN
129	101	R		15	30	< 200	<1.0	-	-	7BE
130	100	SS		155	420	1,150	8.8	.03	-	
131	102	S		170	40	395	3.0	-	-	
132	104	SS		315	275	800	.8	<.02	-	<10Sn
133	103	SS		80	65	90	< .2	<.04		10SN
134	U313	SS								
135	U314	SS								
136	U264	SS								
137	U263	SS								
138	U262	SS								
139	U261	SS								
140	357	S		5	45	135	-	-	-	
141	358	R		90	40	140	-	-	-	
142	359	S		1,700	390	680	-	-	-	
143	360	R		450	4000	2,000	12	<.02	-	
144	386	S		245	35	35	0.8	-	-	
145	287	S		40	25	130	< .2	-	-	
146	U310	SS								
147	U311	SS								
148										
149										
150										

Keevy Peak units of the Kantishna District, specifically with the schistose units tentatively correlated with the Birch Creek facies, and volcanic parented schist (quartz-sericite schist) related to the Keevy Peak or other Totatlanika lower Paleozoic series.

Serpentinite and dunitic ultramafics locally occur near the Tonaona fault east of the Tonzona stock. Approximately six miles by four miles, the Tonzona stock is roughly triangular in plan and is granite to quartz-monzonite in composition. Dated as approximately 56 million years old (Reed and Lanphere, 1973), the pluton has associated mineralization along its contact of lead, zinc, silver, tin, and minor uranium and tungsten. Less than a mile south of the southern contact of the stock is the McKinley Strand of the Denali fault which is a wide highly altered shear zone.

The Tonzona granite stock belongs to the McKinley-type of granite described by Reed and Lanphere. These granites are biotite, locally biotite-muscovite, and have local tourmaline-bearing facies. They are characteristically enriched in beryllium and locally show enrichment in tin.

(2) Types of Deposits

Although the deposits previously recognized and sought in the Tonzona area are those related to the McKinley type Tonzona granite, there appears to be good potential for stratabound deposits in volcanic-sedimentary schistose rocks north of the Tonzona fault (as in fig. 4.2-C(3)-c). Ultramafic hosted deposits are also possible east of the Tonzona stock.

Based on metal contents of such elements as tin, silver, tungsten, and uranium, which are characteristically found with tin-granites and physical proximity, several types of deposits are considered genetically related to the Tonzona granite. These types include (1) tin-bearing tactite, (2) tin-tungsten-silver-lead-zinc-uranium veins, (3) manganiferous replacement deposits in limestone, and (4) pyrrhotite-skarn. The possible stratabound deposits are volcanogenic base-metal deposits in felsic schist, and sedimentary base metal deposits in the chert-argillite and graphitic schist units.

(3) Descriptions

a. Jiles-Knudson Area (figs. 4.2-C(3)-a1 and a2): Massive copper-bearing sulfide material was found in early prospecting (1910?-1923) in Boulder Creek at what has been called the Jiles-Knudson, or J+K, prospect in section 32, T33N, R15W. The first discovered deposit was a stratabound skarn from three to over ten feet thick, which strikes about N85E, and dips 80° south. It outcrops for about 140 feet along strike, and has been exposed in a short adit or crosscut just above the valley of Boulder Creek on the west side.

The prospect was rediscovered by I. W. Purkeypile and with other deposits of the area, has been prospected by Mr. Purkeypile or his son, David Purkey, since World War II. The major emphasis of prospecting prior to about 1970 was on silver-lead deposits in veins or replacement zones. About in 1970, Purkey encountered strong tin values in a replacement deposit in the J+K area, and most recent work has been addressed at silver-tin mineralization. The recent tin discovery is about 300 feet north-northeast of the original J+K discovery adit (fig. 4.2-C(3)-a1); also in section 32 is a mineralized outcrop, 3500 feet north, on the east side of Boulder Creek (table 4.2-C).

The pyrrhotite-rich skarn has relatively low valuable metal content. Two samples (nos. 370 and 206) each contained a trace of gold, about one-third oz silver/ton, and ranged from 0.7 to 0.9 percent copper. The samples agree with results obtained by Chadwick (1962) and the Alaska Division of Mines.

The tin-bearing deposits, however, have highly anomalous metal contents which locally are of ore grade. The mineralized outcrops are composed of felsic schist, dolomite, and argillite, which strike nearly east-west and dip steeply south. The deposits are partly concordant, but locally appear to cut across bedding. The occurrence has been explored by shallow shafts, dozer cuts, and diamond drill holes.

The main exposure is about 40 feet across and is circular in plan. Silicification and fracturing are intense. Mineralization consists of chalcopyrite, galena, and unidentified minerals in disseminations and veinlets, and several small pods or veins of massive pyrrhotite with galena and chalcopyrite up to five or six feet long and a foot wide, which display both crosscutting and semi-concordant relationships with the bedrock. Tin contents were as much as 4.0 percent (40,000 ppm) in chip samples.

SAMPLES			Cu	Pb	Ag	Au	Sn	W
			PPM					
#200	14"	Chip across a pod of massive sulfide	3,400	28,500	38.0	Tr	40,000	2
#201	4'	Chip perpendicular to strike of country rock with disseminated mineralization	550	3,250	18.0	Tr	15,000	
#202	8'	Chip across highly mineralized country rock	16,500	12,000	400	.05	10,000	
#203	3'	Chip across almost barren country rocks	140	470	3.4	Tr	500	

Similar appearing mineralization is exposed in a shallow shaft southeast of the main outcrop. An 18-inch wide vein of sulfides (N85E, vertical) is in contact (south) with about six feet of manganosiderite. The vein contains visible pyrite, arsenopyrite, galena, and chalcopyrite and assays: Cu 2250 ppm, Pb 10,500 ppm, Ag 120 ppm (3.5 oz/ton), Au-Tr, Sn 15 ppm. The manganosiderite in the south wall is oxidized, but contains residual disseminated sulfides and assayed: Cu 1450 ppm, Pb 6500, Ag 100 ppm, Au .08 ppm, and Sn 10 ppm.

The tin-bearing area has been tested by at least six diamond drill holes--with uncertain results. The geology of the area suggests, however, that the holes might have had a better orientation. Mineral deposition was apparently controlled at least partly by orientation of favorable rock units, which strike east and are almost vertical or steeply south dipping. Drill holes to test this mineral configuration should have been drilled about due north at a relatively flat inclination. Instead, they appear to have been drilled down the strike direction or vertically nearly in the dip.

A reconnaissance geophysical survey (fig. 4.2-C(3)-a2) using a magnetometer and Chrone VLF (Radem) suggests the use of geophysics in designing another drill program. The skarn mineralization was extended at least 500 feet east-northeast by the magnetic survey, and a zone with similar geophysical properties as the pyrrhotite skarn exists about 525 feet south of the adit, across Boulder Creek. Also, a possible extension southward of the pyrite-arsenopyrite-manganosiderite zone is indicated on line 300W. Although the skarn where sampled did not have good valuable metal content, mineralogically similar skarns can have good copper-gold contents, as in Partin Creek.

A metalliferous zone exposed on the north side of Boulder Creek three-quarters of a mile north of the Jiles-Knudson, also indicates the possibility of other deposits concealed under the alluvial fill of Boulder Creek. The occurrence is poorly exposed, but consists of faulted schistose rock with local veinlets of chalcopyrite. Selected vein material (T 373) contains more than one percent copper, and soils collected north and south of the observed mineral locality are anomalous in copper, silver, lead, or zinc for as much as 400 feet from the vein mineral occurrence.

Because of the widely separated nature of mineralized outcrops, and lack of subsurface information, estimates of reserves cannot be made. The existence of material grading at $100/ton or more (as 1 percent tin) is of sufficient interest that more work is warranted in the Boulder Creek area.

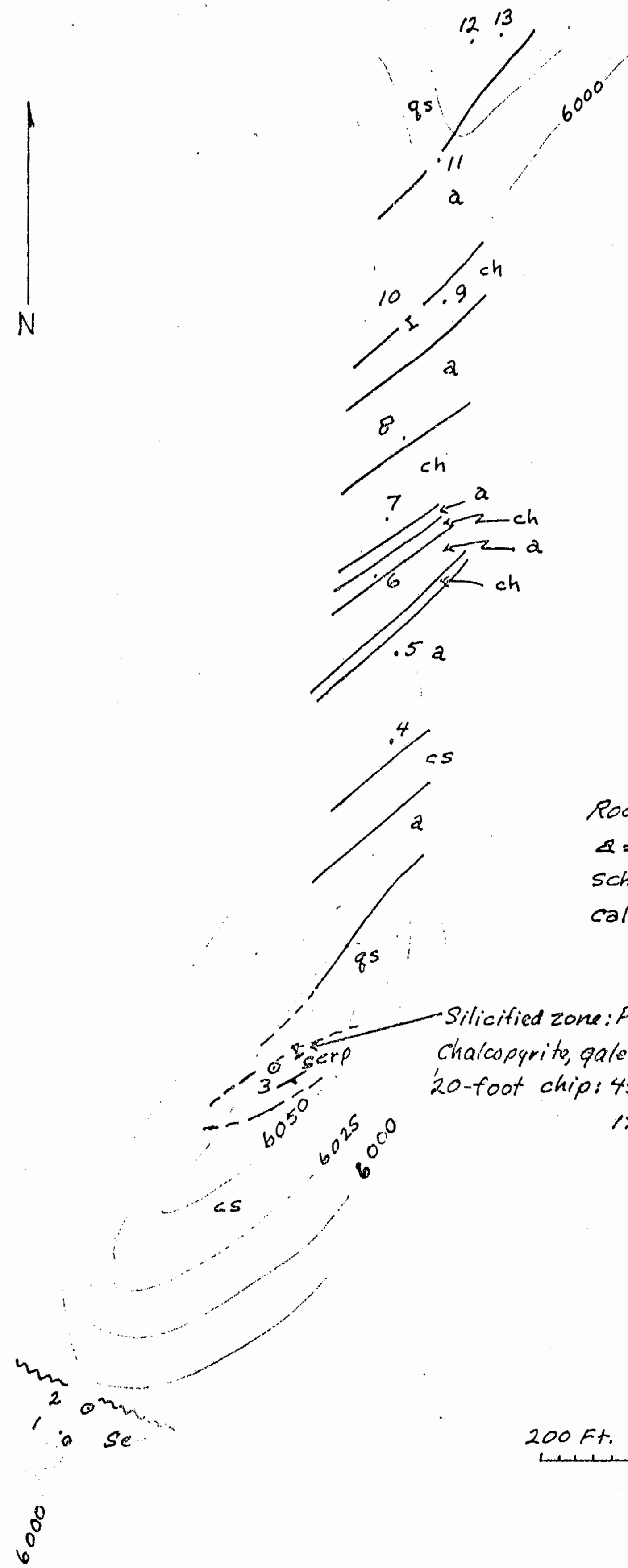
b. Other Prospects: A zone about a mile and a half long along the northwest contact of the Tonzona Stock contains several showings of ore minerals in place and scattered occurrences of ore-grade float at other localities. Most of the occurrences have been described by Chadwick (1962), Maloney and Thomas (1966), and Stanley (1971). Ore minerals described in this area are galena, sphalerite, tetrahedrite, chalcopyrite, stibnite, and some tin, tungsten, and uranium minerals with pyrite, arsenopyrite, pyrrhotite, quartz, and carbonate gangue (Stanley, 1971).

The Mespelt prospect is comprised of a seven-foot wide vein exposed by two bulldozer cuts, a shallow shaft, and small hand-dug pits; the vein appears to be continuous for about 1000 feet, as indicated by tracing gossan float across the hill (Chadwick, 1962). The prospect occurs in the granite near its contact with limestone, dolomite, quartzite, and argillite wall rocks (Maloney and Thomas, 1966). Ore grade mineralization in significant quantities is absent at the prospect, but very interesting high-grade samples of lead, silver, and tungsten and lower grade tin and uranium were taken by the U.S. Bureau of Mines in 1959 (Maloney and Thomas, 1966), and the Alaska Division of Mines and Minerals (Chadwick, 1962). These high grade grab samples assayed as much as Ag 32.91 oz/ton, 46.4 percent Pb, and 2.52 percent Sb. A 10-foot chip sample in the shaft in 1956 assayed 56.3 percent WO_3. In one sample taken across talus in 1959, uranium reached .14 percent eU and tin .06 percent.

The Hogback prospect is a lead-zinc-silver occurrence in metasedimentary rocks exposed in two bulldozer trenches. About 32 feet wide, the zone consists of three or four high-grade stringers separated by vein quartz and altered and sheared quartzite with altered quartzite on both the footwall and hanging wall (Maloney and Thomas, 1966). A weighted average over 12.5 feet of this zone gives these assays: 5.0 oz Ag, 2.8 % Pb, 1.2% Zn. Maloney and Thomas state that the stringer veins might converge 100 feet downslope from the trench in the direction of the granite contact. A four-foot chip sample across a portion of this vein assayed 14.1 oz Ag, 8.7% Pb, and 0.86% Zn (Table 4.2.C).

Two more mineral occurrences south of the Hogback prospect consist of lead-zinc-silver veins with some antimony. One of these veins, located on the granite contact, was traced for 60 feet, was about three feet wide, and a grab sample assayed 6.77 oz Ag, .65% Pb, .13% Zn, and .155% Sb. The other location is an old trench with a six-foot wide vein exposed for about 25 feet with quartzite wallrocks. A chip sample across this vein assayed 5.6 oz Ag, 17% Pb, 8.5% Zn, .11% Sb, and 15 ppm Sn. Much of the Purkey area along the contact is rubble and soil covered, making exploration difficult and concealing most geologic details.

c. New Anomalous Areas: (1) East of Tonzona stock (area fig. 4.2-C(3)-c). Metalliferous rocks are exposed about two and a half miles east of the Tonzona stock, north of the Tonzona fault. They are sketch mapped and soil



	Field No	Copper (ppm)	Lead	Zinc	Silver
1	357	5	46	135	
2	358	90	40	140	
3	359	1700	390	680	
4	362	60	55	105	<.2
5	363	240	55	120	<.2
6	364	315	125	390	.2
7	365	800	125	225	.6
8	366	260	45	70	<.2
9	368	.95	175	225	<.2
10	367	350	195	135	.4
11	369	350	125	650	<.2
12	361	1750	550	310	.2
13	370	25	80	165	<.2

EXPLANATION

Rock Units: qs = quartz schist, a = argillite, ch = chert, cs = calc-schist; Serp = serpentinite and calc schist

- SOIL SAMPLE

I ROCK SAMPLE

Geology by D. Hawley, 1976

200 Ft. 0 200 Feet

FIGURE 4.2-C(3)-c ---SKETCH MAP OF MINERAL ZONE, SEC. 10, T 32 N, R. 24 W. BOULDER CREEK MAP AREA

sampled over a 1500-foot distance, which reduces to about 1200 feet across the strike. The rock series consist of quartz-sericite schist (metarhyolite?), calcschist, argillite, and cherty rocks, with minor serpentinite near the Tonzona fault.

Chalcopyrite, galena, and pyrite were noted in one silicified area (no. 3, fig. 4.2-C(3)-c), but anomalous amounts of copper, lead, and zinc characterize soils developed across the entire area. The porphyroblastic quartz-sericite schist unit is pyritized and has a high background copper content for three miles. Several samples in this unit were extremely anomalous. It is believed to have good potential for stratiform type massive sulfide deposits.

A stream sediment sample draining the same stratigraphic interval (no. 132) and sample nos. 111-112 on strike with the Tonzona fault are also anomalous. Samples with anomalous concentrations of metals are also in section 33, T33N, R15W (nos. 122, 124, 125).

(2) South Tributary Ripsnorter Creek--Stream sediment and soil samples (moraine) in section 17-18, T31N, R15W, contain up to 950 ppm Cu, 140 Pb, 400 Zn, 0.8 Ag, 10 Sn. The float in this stream consists of argillite, quartzite, granite, and gabbro, all with strong iron staining. The source of the anomaly is not known.

(3) Southwest of Pluton--This is an area of somewhat spotty anomalous samples ranging up to 280 ppm Cu, 65 Pb, 1150 Zn, 7.2 Ag, and 20 ppm Mo. The rocks

here consist of an argillite-rich series, some mafic igneous rocks and possible ultramafics, and minor limestone, with several dikes. These sample results may represent a high background mineralization for zinc and copper and small scattered lead-zinc-silver veins. Many of the rocks are pyritized and silicified.

CHAPTER 5

MINERAL FUELS AND CONSTRUCTION MATERIALS

Non-metallic construction materials and mineral fuels identified in or very near to the Mt. McKinley region include lignitic to subbituminous coal, cement quality limestone, clay, perlite, and occurrences of uranium-thorium. Coal was identified in early explorations (Collier, 1903; Prindle, 1907; Brooks, 1911a, 1911b), and the important Nenana field was studied in some detail even before the completion of the Alaska railroad (Martin, 1919a). Interest in non-metallic resources was particularly high in the fifteen-year period after World War II, when Alaskans were interested in local supplies of bulk industrial commodities like cement (Waring, 1947; Rutledge and others, 1953). In addition to coal which is mined in the Nenana field, potentially-commercial deposits of limestone and clay have been discovered, and the region has an only partly assessed potential for deposits of uranium and thorium.

5.1 Coal Deposits

Two and possibly three major coal fields occur peripherally to the McKinley region--Susitna, Nenana, and possibly Tonzona or Minchumina. The Susitna field, which includes the Beluga coal deposits, extends into the south part of the region (figs. 1.2 and 3.0). The producing Nenana field is on the region's northeast side and thick coal beds in what could be an important province occur in the Little Tonzona drainage within the Minchumina Tertiary basin on the region's northwest flank. Coals of possible--and past--commercial importance are also found near Broad Pass on the Alaska Railroad.

(1) Susitna Field

The Susitna field, which includes all the Beluga-Yentna field of Barnes (1966), underlies part of the southern McKinley region. The coal-bearing units are within the Kenai Formation of Barnes which thins to an erosional edge near the Yentna gold district. The Kenai Formation is mainly composed of semi-consolidated sediments, and outcrops only locally in a region covered by glacial outwash and other surficial deposits. The distribution and thickness of coal in the relatively isolated outcrops--shown with designation of thickness in fig. 3.0--suggests that most of the coal is of non-commercial thickness and continuity--although coal has been used by homesteaders and miners in the region.

At least one thick bed is locally present near Fairview Mountain (figs. 3.0 and 4.2-B(4) where Barnes measured greater than 25 and 55 foot thicknesses of coal in Secs. 26 and 27, T27N, R12W, and it is possible, due to extensive cover, that detailed exploration will find commercial coal within the comanagement region.

(2) Broad Pass Field

Coal is exposed in the broad Chulitna Valley about 190 miles north of Anchorage in three main localities: (1) the Broad Pass field of Barnes and others, 1951, p. 137-213; (2) the Costello Creek Basin (Wahrhaftig, 1944; Rugledge, 1948), and (3) in the West Fork of the Chulitna about four miles south of Colorado Station.

Coal of the Broad Pass field is exposed locally and has been mined in shallow workings in T19S,R9W FM east of the Alaska Railroad. About 1185 tons were mined from the deposit in 1920-1921. The coal is lignitic, has a measured BTU value of about 6000-7000 BTU (straight from the pit__11,000 to 12,000 on moisture and ash-free basis). Reserves ascribed from surface measurement of one bed are at least 13.5 million tons; the reserves are probably much greater.

The Costello Creek basin is a local Tertiary inlier in the northern part of the Chulitna area (fig. 4.2-A(1)). The deposit was mined (about 5,000 tons) by W. E. Dunkle in 1941 and 1942, and shipped for military base use in Anchorage. Studies cited by Wahrhaftig and Rutledge suggest that most of the deposit has been mined.

(3) Nenana Field

The Nenana coal field described mainly by Wahrhaftig (1951 with Hickox and Freedman; 1970a,b,c, and d; 1973) is a series of coal-bearing basins of middle Tertiary age exposed on the northcentral flank of the Alaska Range. Wahrhaftig and others (1969) have identified five formations in the coal-bearing group--the basal Healy Creek Formation deposited unconformably on Paleozoic metamorphic basement and overlying Sanctuary, Suntrana, Lignite Creek, and Grubstake Formations. Economic coals occur in the Healy Creek and Suntrana units. Coals range from a few feet thick in the Lignite Creek locality to a maximum of 100 feet in the Healy Creek and Suntrana localities. The coals are of subbituminous rank and have, as received, heat values in the 7,500 to 9,500 BTU range, high ash, high moisture, and 0.1-0.3 percent sulfur (Barnes, 1967; Gates and others, 1946; Ode and Selvig, 1944; Toenges and Jolley, 1949).

The original depositional basins were folded and faulted, possibly starting in Oligocene time during deposition of the Grubstake Formation (Wahrhaftig and others, 1969, p. D26), and the distribution of economic coals is a complex function of originally thick beds, deformation, and thickness of overlying Lignite Creek Formation, local Grubstake Formation and Nenana Gravel.

Most of the past production of the field has come from surface and underground mines in moderately dipping beds in a faulted fold structure subparallel to Healy Creek (fig. 4.0-C). Major near-surface reserves are in Lignite Creek or between Healy and Lignite Creeks.

Total demonstrated coal reserves projected by McGee and O'Conner (1975) are in excess of 2,000 million tons. From surface studies, Wahrhaftig (1973) projected more than this; he measured thicknesses of beds A to E and F in the Healy Creek Formation and beds G and numbers 1-6 of the Suntrana, and assigned reserves on the basis of areal projection of thicknesses. These figures have been recast on fig. 5.1-3 in reserves blocks, with reserves given in two categories--(1) in beds with less than 100 feet of overburden, and (2) those with less than 1,000 feet of overburden. Wahrhaftig's work suggests more than 265 million tons of coal in beds generally thicker than 10 feet, and with less than 100 feet of overburden, and over 3 billion tons of coal at less than 1,000 feet of overburden. Drilling done by Usibelli Coal Mines, Inc. and other companies since Wahrhaftig's report, indicates that this tonnage is minimal.

Coal was formerly mined at the Diamond mine west of Healy in sec. 35, T13S, R8W, and the coal-bearing unit can be traced westerly into the block of state-owned land north of McKinley Park and into the park near the Savage River. From Savage River, coal-bearing beds continue about 15 miles west-southwest to the Wyoming Hills (fig. 4.0-C).

(4) Tonzona Field

Coal basins probably similar to Nenana in age and origin are locally exposed southwest of the Nenana field on the north side of the Alaska Range. Coal is reported locally in the Kantishna Hills (Reed, 1961), but the next apparently important basin west of Nenana appears to be in the Little Tonzona drainage in the Minchumina basin.

Coal near the Little Tonzona has been known locally since before World War II (Ted Meining, communication, 1977), but was rediscovered about 1969-70 by oil company geologists (Gary F. Player, communication, 1976). As exposed in the Little

Tonzona in T31N, R19W (figs. 3.0 and 4.0-B), coal beds aggregating over 100 feet in thickness crop out in steeply dipping and poorly exposed beds. Coal crops out in small exposures in nearby creeks, and it can be inferred from the thickness of the coal that an important Tertiary basin could exist in the area.

5.2 Uranium and Thorium

Existence of uranium and thorium minerals have been reported in the Mt. McKinley region, and poorly known uranium deposits are known to occur locally. Uranium occurs in tin and tungsten-bearing veins of the Tonzona area (fig. 4.2-C); values reported ranged from 0.04 to 0.14 percent equivalent uranium in gossan from the Mespelt prospect (Stanley, 1971; Maloney and Thomas, 1966). Uranium and thorium minerals also have been reported in placer concentrates of the Yentna (Cache Creek area)--Robinson and others (1955) investigated these occurrences and determined the presence of uranothorianite and indicated no economic interest. The sampling techniques used in the 1955 evaluation may not, however, have been valid.

Since 1975 the general area of the Nenana coal field east of Healy and Lignite Creek has been prospected for uranium and an extensive land position has been taken in state claims and prospecting sites--partly for uranium in the Tertiary section and partly for massive sulfide-type volcanogenic deposits in the Totatlanika-Keevy Peak Schist series. Anomalous radioactivity and small concentrations of uranium have reportedly been found in basal Tertiary conglomerates of the Nenana coal field area.

The metarhyolite and rhyolitic tuff of the Totatlanika Schist are radioactive compared with associated units, and stream sediments draining these rocks in the Tekla Hills (fig. 4.0-C and Gilbert and Bundtzen, 1976) contain relatively high amounts of uranium and thorium. Radioactivity is associated with these units in the Chitsia Mountain area, and radioactivity sharply increases (fig. 4.1-A(3)-b) in cherty rhyolitic tuff which also is geochemically anomalous in lead and zinc.

Granites of the McKinley type can be suspected to have local enrichment in uranium and thorium on the basis of a common world-wide association of uranium with granite enriched in tin, beryllium, tungsten, and because of the uranium occurrences with the Tonzona stock of McKinley-type granite. Radioactivity of about four times local background (airborne) is associated with a McKinley-type (?) granitic body northwest of Lake Chilchukubena. The granite was not surveyed for radioactivity on the ground, but two samples (nos. 5 and 6; table 4.0-A and fig. 4.0-A) showed high contents of tin, tungsten, or beryllium. Anomalous amounts of uranium with titanium in stream sediments (as much as 24ppm U--no.352, table 4.0-B -- also occur in drainages from a McKinley-type granite exposed near Buckskin Gulch in T22S, R14W on the Talkeetna quadrangle (fig. 4.0-B); the adjacent granite is weakly stained with jarosite and is pervasively argillized.

A systematic survey for uranium and thorium was beyond the scope of this project. The occurrences reported suggest that uranium could occur: (1) in conglomerate or tuffaceous units of Tertiary age, (2) in association with volcanogenic base-metal deposits of Paleozoic age in the Totatlanika-Keavy Peak, and (3) in association with granitic rocks, of Cretaceous-Tertiary age, especially those of McKinley type.

5.3 Construction Materials

Potential identified construction and industrial minerals include limestone, perlite, sand and gravel, and clay deposits. None of these deposits are being commercially exploited at the present time. However, the limestone deposits are of current speculative interest.

(1) Limestone

The identified limestone resources of the area are in Devonian and in Triassic rocks on the south flank of McKinley National Park. Three main deposits have been identified in the park in Devonian series (fig. 4.0-C). The Windy Pass deposit (Moxham, Eckhart, and Cobb, 1959; Rutledge and others, 1953) is about one mile west of the Alaska railroad (figs. 3.0; 4.0-C), and consists of a 3200 by 600 foot deposit of limestone. It has been drilled and extensively sampled. It does have commercial potential, but has a fairly high content of MgO, which could cause problems in its use as cement material. The largest known deposit is in Foggy Pass, eleven miles west of the Alaska railroad. The deposit has an outcrop width of 3,000 feet and potential in the range of at least 200 million tons. The deposit has some units with excess MgO, but generally good composition. A third deposit in Windy Fork, about eight miles west of the Alaska railroad, has an outcrop size of about 4800 by 300 feet. It has an indicated potential of about eight million tons and, based on surface sampling, has better chemical characteristics than the Windy Pass and Foggy Pass deposits.

Another deposit is in Triassic aged rocks in upper Long Creek (figs. 4.2-A(1) and 4.0-C). Limestone contained within a 14-claim block is exposed over a 7500 by 1000 foot length. A small part of the deposit south of Long Creek has been extensively sampled and has an indicated tonnage of about two and a half million tons. The overall potential is in excess of 100 million tons (Southcentral Resource Company, 1974).

(2) Clay and Clay Minerals

Clay deposits with potential for brick, portland cement, and some ceramic uses, are found in clay-rich units in the coal-bearing units of the Nenana field (Cobb, 1951; Rutledge and others, 1953; and Triplehorn, 1973). The clay of certain coal-group beds is satisfactory for face brick and heavy clay wares and can be mixed in approximate 1-3 ratio with Windy Pass limestone to produce Portland Cement.

(3) Perlite

Perlite, a volcanic glass capable of expansion to a light frothy artificial pumice on heating, was described from four localities by Plafker and others (1953). Three of the localities are in Mt. McKinley National Park, one is about two miles east of the northeast corner of the park at Sugar Mountain. The Mt. McKinley Park occurrences are (1) at about 4,000 feet elevation northeast of Polychrome Pass, (2) east of Calico Creek two miles above its junction with the Teklanika River, and (3) in the West Fork of Calico Creek.

All the deposits are small and only the Sugar Mountain perlite had satisfactory expansion properties. The felsic igneous rocks of Tertiary age are the likely hosts of perlite deposits.

CHAPTER 6

SUMMARY AND CONCLUSIONS

The Mt. McKinley region is significantly mineralized with a variety of metallic minerals, has local concentrations of valuable and non-metallic commodities, and contains commercial coal deposits. Most of the coal deposits and some of the non-metallic resources are mainly peripheral to the region--but metallic deposits are distributed widely--in the National Park, in those (d)(2) lands withdrawn from mineral entry, and in the peripheral area considered for co-management.

Although the distribution of metallic deposits of the region is incompletely known, it is clear that some deposits are clustered into belts or trends conforming to structures or metalliferous layered rock sequences of regional extent. Other metallic deposits show spatial relation to granitic plutons or basaltic rocks outside the favorable trends.

The non-metallic resources are scattered throughout favorable rock sequences--clay in coal-bearing series, cement-quality limestone in both Paleozoic and Mesozoic series, and perlite in rhyolitic volcanics of late Mesozoic or Tertiary age.

6.1 Definition of Mineral Belts or Trends

Three belts of metallic mineral deposits termed (1) Chulitna-Yentna, (2) Dall, and (3) Kantishna, are distinguished by the association of numerous mineral deposits with structures or rock units of regional extent (fig. 6.1). Two other belts, Shellabarger and McKinley, are provisionally defined on the same basis.

A. Chulitna-Yentna

The main parts of the Chulitna-Yentna belt were identified in early geologic studies by Capps (1912, 1913A-B, 1919B), Mertie (1919), and Ross (1933), and the existence of s specific mineral belt was proposed by Hawley and Clark (1973, 1974) mainly on structural and trace-element criteria.

The belt extends from the Fairview Mountain area (fig. 4.2-B(4)) on the south to at least Bull River (fig. 4.2-A(1)) on the north. It parallels the present southeast front of the Alaska Range, and a major series of northeast-striking faults. In the Chulitna and Curry areas (Tuck, 1934), the belts conform generally to Paleozoic-Mesozoic sedimentary-volcanic terrane faulted against late Mesozoic geosynclinal rocks to the east and grading up into the same Mesozoic sequence on the west. At the base of the Paleozoic section is an ophiolitic complex which may be as old as Devonian (Smith, Swainbank, and Turner, 1977).

South of a point near Buckskin Glacier, Paleozoic and older Mesozoic rocks are buried under the younger Mesozoic geosynclinal series, but the northeast regional alignment is

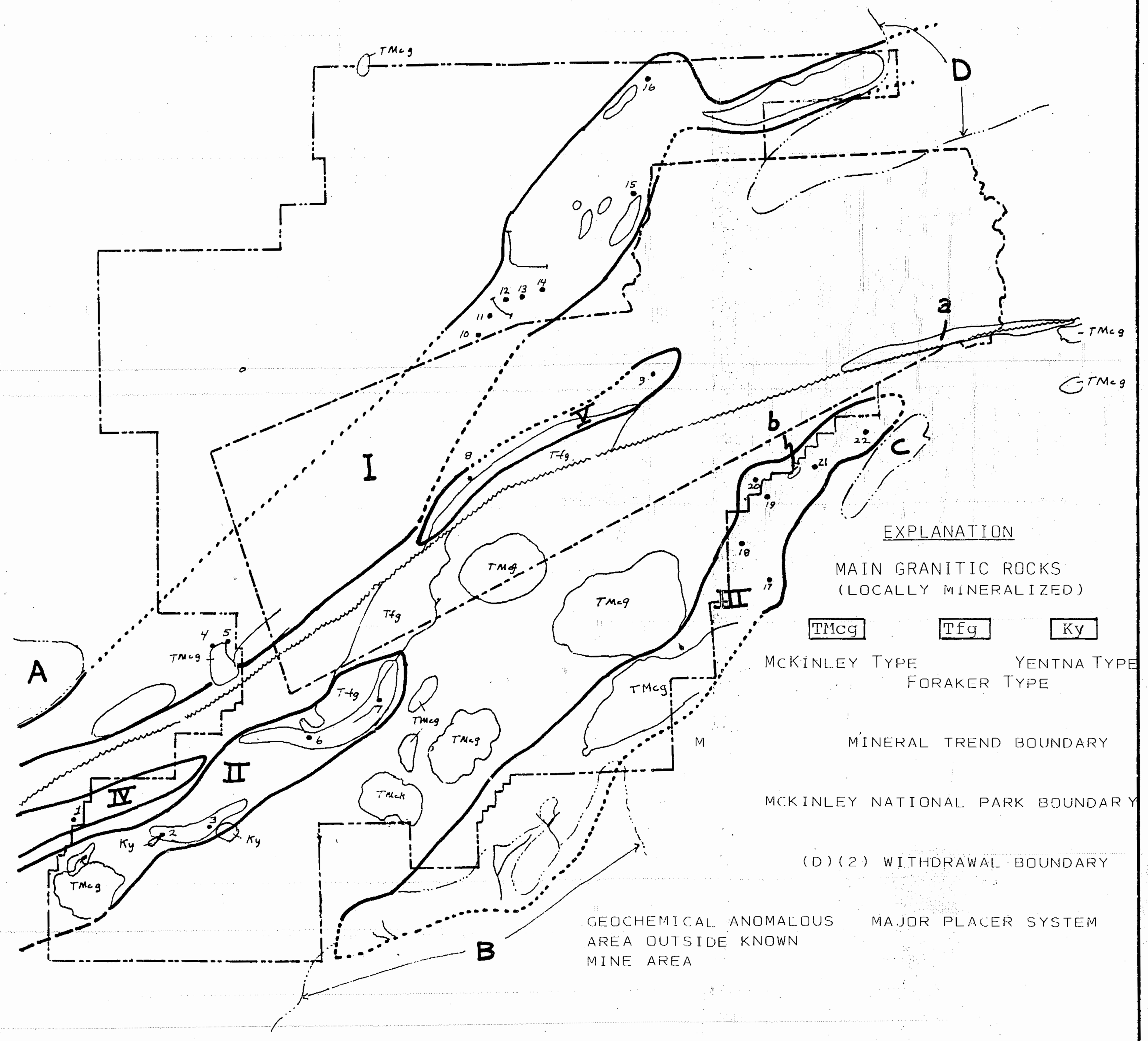


FIGURE 6.1 SUMMARY OF ECONOMIC GEOLOGY OF THE MT. MCKINLEY REGION

SCALE 1:1,000,000

Explanation of

FIGURE 6.1

SUMMARY OF ECONOMIC GEOLOGY OF THE MT. MCKINLEY REGION

MINERAL BELTS OR TRENDS	REPRESENTATIVE DEPOSITS	TYPE + METAL
I. Kantishna	10. Slate Creek	vein - Sb
	11. Alpha	vein - Ag (Pb,Zn,Cu)
	12. Quigley Hill	vein - Ag (Pb,Zn,Cu)
	13. Banjo-Jupiter-Mars	vein - Au (Ag)
	14. Glen Creek	veins and placers-Au
	15. Stampede	vein - Sb
	16. Chitsia Mtn	stratiform - Ba (Zn,Pb)
II. Dall	2. Sec.10,T28N,R17W	dissem.- Cu (Au,Ag,Ni)
	3. Sec.36,T29N,R16W	tactite-skarn-Cu,Au,Ag
	4. Sec. 1-2,T30N,R14W	dissem.- Cu,Ni (Cr?) massive sulfide
	5. T31N,R12W	magmatic - Cr
III. Chulitna-Yentna	17."Coal Creek"	skarn-dissem. Zn (Ag,Sn)
	18. Partin Creek	skarn-massive sulfide Au (Cu)
	19. Ready Cash	vein-skarn Ag,Pb,Sn (Cu)
	20. Ohio Creek	dissem. (greisen vein) Sn,W,Ag
	21. Golden Zone	breccia pipe Au(Cu,Ag)
	22. Nim	dissem. Cu(Mo,Au)
IV. Shellabarger	1. T29N,R19W	volcanogenic Cu,Zn
V. McKinley	8. Slippery Creek	tactite, dissem-Cu,Pb(Ag,Au) veins-Sb,Hg
	9. Mt. Eielson	tactite-Pb,Zn(Ag,Cu)

COAL FIELDS . . . .
A. L. Tonzona (Minchumina Basin)
B. Susitna (Beluga-Yentna)
C. Broad Pass
D. Nenana

LIMESTONE AREAS . . . . .
a. Foggy-Windy Pass Area-Devonian and Triassic Limestone
b. Long Creek - Triassic Limestone

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preserved in structural attitudes of layered rocks, faults or lineaments and in the elongation of granitic plutons of the Tokositna Hills-Buckskin Glacier area.

Deposits and trace element character of the belt depends to some extent on wall-rock and intrusive episodes, but arsenic-rich gold-bearing deposits characterize the entire trend. Copper is most characteristic of the northern part of the region where Triassic basalt and Permo-Triassic red beds have a relatively high copper content. Chromite is present in exposed ultramafics of the northern belt and is locally abundant in placer deposits of the Yentna district, suggesting a source in nearby poorly exposed or buried basic intrusives. In the northern part of the belt, in particular, copper-gold-silver-arsenic deposits are developed in or near relatively mafic granitic rocks, and throughout the belt, tin-tungsten and locally, silver deposits are associated with quartz monzonite, granite, or aplite.

The metallization of the trend was, thus, long continued starting with deposition of metal-rich beds in Paleozoic and Triassic, and continuing and probably culminating in intrusive episodes in late Cretaceous-early Tertiary time.

B. Dall Trend

The Dall Trend has not been described previously. The area of the trend was selected for reconnaissance geologic studies in 1976, because the U.S. Geological Survey had identified a variety of Paleozoic rocks and ultramafic rocks south of the McKinley strand of the Denali fault in an area previously considered as of mid-late Mesozoic age and essentially composed of graywacke-argillite.

Based on the work done thus far, a 45-mile long, 5 to 10 mile wide metal favorable zone extends along this belt from the Foraker pluton on the north to the McKinley-type granite pluton exposed in the Cathedral Spires on the south.

The Paleozoic rocks sequence includes dark carbonacous argillite or shale, limestone, and a limestone cobble conglomerate, which have been intruded by sills of ultramafic rock, stock-like bodies related to the Yentna-type granodiorite, and at its north end, by the Foraker batholith, and at its south end, the Cathedral Spires pluton.

Deposits or occurrences of mineralized rock include zinc-rich argillite, copper-gold-silver-bearing tactite and disseminated deposits in limestone-cobble conglomerate in association with Yentna-type intrusives, chromite and nickel-copper bodies in the ultramafics, and molybdenum deposits associated spatially with Foraker type intrusives. Locally tungsten and tin were detected in Yentna-type contact regions, and B. L. Reed (oral communcation, 1977) reports anomalous levels of tin and tungsten at the north end of the Cathedral Spires pluton.

Like the north part of the Chulitna belt, there is evidence of long continued metallization--probably syngenetic concentrations of zinc in shaley beds of Paleozoic age, ultramafic associated mineralization in Paleozoic or Mesozoic and episodes of complex metallization related to the Yentna-, McKinley-, and Foraker-type plutonic intrusives.

C. Kantishna Trend

Parts of the Kantishna trend were identified by early prospecting and geologic studies (Prindle, 1907; Capps 1919A; Moffit, 1932; and Wells, 1933), but projection of a metalliferous trend between the old Kantishna and Bonnifield districts is a relatively recent development, for example Hawley (1973A) and projection of the trend westward under Tertiary deposits to the Tonzona area is the result of recent work by Reed and Elliott, 1968, and this investigation.

The extent of the trend is still uncertain, but apparently it coincides with the distribution of the part of the Yukon Crystalline Complex south of the Healy basin, and more specifically with metal-rich layers in Birch Creek Schist, Keevy Peak Formation, and Totatlanika Schist in the part of the trend from Kantishna to the Bonnifield district, and within approximately correlative rocks of the Tonzona area.

Unlike the Chulitna-Yentna and Dall Trends, there is only occasional direct evidence of metallization by plutonic granitic rocks in the trend--except in the vicinity of the Tonzona granite stock. The ore deposits exploited thus far in the Kantishna trend are high-grade veins of silver-lead-zinc, gold and antimony developed in the Kantishna Hills, a high-grade gold-arsenic-bismuth massive sulfide deposits near Ferry (Liberty Belle), and gold-bearing placers derived from primary deposits.

Mineral occurrences recognized recently include shales and carbonaceous limestones rich in zinc, lead, silver, gold, and molybdenum and a barite-zinc-lead deposit in the Totatlanika schist. Strong zinc anomalies and deposits of ferricrete near outcrops of highly carbonaceous shale suggest the possibility of shale hosted metal deposits, and the Totatlanika schist hosts a major zinc-bearing color anomaly south-west of Chitsia Mountain.

The existence of metalliferous beds in the Yukon Crystalline Complex extending from east of Healy through the Tekla Hills into the Kantishna Hills suggests a major mineral trend. Deposits in similar terranes, for example, in the Yukon-Northwest Territories near Anvil or in McMillan Pass, have been difficult to prospect because of the fine-grained non-descript nature of mineral beds, and often poor geochemical suggestion of important mineralization. There is at least permissive evidence from these important, but subtle appearing districts, to suggest that the metalliferous rocks of the Kantishna trend could host valuable stratiform deposits.

The history of mineralization of the Kantishna goes back at least into the middle Paleozoic when metalliferous beds were laid down. It can be reasonably postulated from the similarity of the metal suite in the metalliferous beds and that of the veins of the Kantishna district, and the association of these veins with probably Cretaceous-Tertiary aged fold and fault structures, that metals were remobilized and concentrated into rich vein-type deposits during Laramide (?) tectonism, and subsequently eroded to form Tertiary and Quaternary placer deposits.

D. Other Trends

Shellabarger Pass contains massive zinc-copper bearing sulfide deposits associated with basaltic volcanics (Reed and Eberlein, 1972). Although no direct extensions of this type of metallization were found in 1976, similar basaltic rocks are exposed in two groups east-northeast of the Shellabarger Pass occurrences, and it is proposed that similar deposits may be found in association with the volcanic rocks of this trend.

The deposits in Mt. McKinley National Park were not investigated in 1976, but an apparent alignment of deposits exists in the central part of the Park from the St. Peters Dome area to Mt. Eielson, a distance of about 35 miles. The ore deposits reported are igneous associated tactite or disseminated deposits in the hanging wall of the Foraker-McGonagal intrusive, or fault controlled deposits--including several characterized by antimony. The McKinley trend appears real, but the controls are not sufficiently known so as to identify mineralization simply with the McGonagal intrusive, or the Denali fault, or any metalliferous beds of the same area.

6.2 Identification of Other Metal-Rich Areas or Deposits

Although the bulk of mineral occurrences identified in the McKinley region fall in one of the trends just identified, there are scattered mineral deposits and metal anomalies in other areas. Mineralization related to intrusive rocks of the region is sufficiently widespread that any granitic rock needs to be investigated for disseminated or contact-type deposits.

The most widely distributed plutonic rocks of the region are those of the McKinley series of early Tertiary age. These nearly white biotite, or biotite-muscovite, granite bodies have local zones or facies enriched in tin, tungsten, fluorine, uranium and beryllium in several areas outside the defined mineral belts. Examples include the granite just east of the Reindeer Hills and a small stock exposed in the northern Talkeetna Mountains which are anomalous in tin (fig. 3.0), the granite body near Lake Chilchukabena in the north part of the area, and according to Reed (oral communication, 1976), certain parts of the small batholiths of McKinley-type granite exposed between the Chulitna Mineral Belt and Mt. McKinley.

Like most granitic bodies, any mineral deposit to be found will be relatively small when compared with a batholith and probably contained in some igneous facies or unique structural or contact situation--nevertheless, the character of the intrusives suggests that all McKinley-type granites have to be regarded as relatively favorable for occurrences containing one or more of the following metals: beryllium, silver, tin, tungsten, and uranium.

Mafic volcanic and sill-like intrusives of both Paleozoic and Mesozoic age in the areas are likewise regarded as favorable for occurrence of metallic deposits. Numerous copper occurrences are found in Mesozoic (Triassic) basalt of the Chulitna belt (fig. 4.2-A (2)) and copper occurrences have recently been found associated with the Paleozoic mafic volcanics or sills in and near the southeast part of McKinley Park (Hickman and Craddock, 1976, and fig. 3.0).

6.3 Reserves and resources of Metallic Deposits and Occurrences

Ore reserves, considered mineable, and resources, which include both reserves and material too lean to be presently mineable, may be quantified by measurement of volumes and richness. Of the metallic commodities present in the region, only placer gold is being produced; hence, it is very difficult to assign limits of grade or richness to "reserves." For the purposes of this report, a cut-off of $100 per short ton[1] is considered "ore" cut-off for a deposit mineable by selective methods--such as a relatively narrow vein; a lower limit of $25 per ton is used for deposits mineable by bulk underground or open-cast methods. In a very few cases, the "amount" of ore is known by underground or drill measurement and can be assigned as measured or indicated; in most other cases, it can only be assigned by assuming a standard procedure--generally the one-half strike length model and ten cubic feet of mineralized rock per short ton.

[1]Metal values assumed are: gold-$150/troy ounce; silver $5/troy ounce; copper $1/adv. pound; lead $0.30/adv. pound; zinc-$0.50/adv. pound; and tin-$6/adv. pound.

Resources may be classified basically in terms of the degree of geological assurance of their occurrence (U.S. Geological Survey, 1975) as identified and undiscovered, where the identified resources are known as to location, quality and quantity. The undiscovered resources are those "surmised" to exist on the basis of broad geologic knowledge; they in turn can be subclassed into hypothetical resources which are in a known mining district and speculative resources which could exist in a favorable geologic setting. The resources of this report are essentially of identified type.

Reserve and resource data for some properties or occurrences are presented for the Mt. McKinley region in tabular form (Table 6.3), with amounts of reserves or resources assigned in seven classes defined below for all deposits, except those of antimony.

CLASS	TONS OR CUBIC YARDS
I	1,000 - 10,000
II	10,000 - 100,000
III	100,000 - 1,000,000
IV	1,000,000 - 10,000,000
V	10,000,000 - 100,000,000
VI	100,000,000 - 1,000,000,000
VII	1,000,000,000

Antimony reserves are presented in pounds of contained metal. The arrangement of the table generally follows the order of the report.

TABLE 6.3 SUMMARY OF RESERVE AND RESOURCE DATA FOR SOME METALLIC DEPOSITS AND OCCURENCES, MT. McKINLEY REGION, ALASKA

AREA AND SECTION IN TEXT	DEPOSIT, OCCURRENCE, SITUATION	RESERVES		RESOURCES	
		TONNAGE AND GRADE	REMARKS	TONNAGE AND GRADE	REMARKS
Kantishna 4.1-A(1)	Slate Creek	≤100,000 lbs-Sb 45% Sb	Remaining part of high-grade lens. Production about 562,500 lbs of Sb	At least equal to past production	1-2 Sq. Mile area shows Sb-As anomalies, and Sb-bearing veins
	Bonnell	Class I in 1-3.0 veins to 30% combined Pb-Zn, byproduct Ag		Class VII	Resource in ½ Sq. mile porphyry area, metal values in 0.0X-0.X% range
	Eagles Nest	280,000 lbs-Sb	75'x10'x37.5' volume, 50% Sb		Unexplored
	Alpha vein	Class I in vein structure 1-10' thick	10 ton production at 200 oz Ag/ton	Class IX	Resource in mapped 3000' vein length, 5'-wide to 1500'
Kantishna (Cont.)	"Alpha" mineralized schist, Secs 21-22, S. of Alpha Ridge			Class V	Resource in 2000'x1000'x200' volume pyritic schist, Cu-Pb-Zn in 0.0X-0.X% range
Kantishna (Cont.)	Quigley Hill deposits Includes: Galena, RedTop, Polly Wonder, Silver Pick, Little Annie, Gold Dollar	Class I in vein structures 1->20-feet thick of >100 oz Ag/ton. At least Class III in vein structures 1->20-feet thick of about 20 oz/Ag ton equivalent		Class IV	Assumes 10 veins with 1000'x500'x5' volumes

TABLE 6.3 CONT.' SUMMARY OF RESERVE AND RESOURCE DATA FOR SOME METALLIC DEPOSITS AND OCCURENCES, MT. McKINLEY REGION, ALASKA

AREA AND SECTION IN TEXT	DEPOSIT, OCCURRENCE, SITUATION	RESERVES		RESOURCES	
		TONNAGE AND GRADE	REMARKS	TONNAGE AND GRADE	REMARKS
Kantishna 4.1-A	Banjo (Red Top Mining Co)	I – Approx. 0.5-1oz Ag/ton, and 0.5 oz Au/ton	Ore in place after 1939-41 production of 13,653 tons averaging 0.46 oz/ton Au	Class III of 0.X oz Au/ton	In 1000'x500'x12' volume
	Jupiter-Mars			Class V of 0.0X -0.X Au+Ag/ton	In 2000'x1000'x200' volume
	Last Chance			Class II of 0.X oz Au/ton. High-grade masses of stibnite	600'x300'x5' volume (minimum)
Stampede 4.1-A(2)	Stampede Mine	1,900,000 lbs of Sb – Measured to Indicated. 3,500,000 lbs of Sb – Inferred	In 6000 tons of approx. 12.5% Sb in underground workings and 1000 tons of 20% Sb in talus In ground between Mooney and Kobuk	10,000,000 lbs of Sb	In measured to inferred ore, and in hypothetical resources below Kobuk lode along Stampede fault, and in Kobuk-to-Ridge claim group
	Little Caribou Occurrence			Class IV Low-grade Ag+Cu+Pb+Zn, Trace Au, local stibnite	1000'x500'x100' volume
	Graphitic schist situation, Head of Little Moose			Class V Known values to 0.X % zinc	

TABLE 6.3 CONT.' SUMMARY OF RESERVE AND RESOURCE DATA FOR SOME METALLIC DEPOSITS AND OCCURENCES, MT. McKINLEY REGION, ALASKA

AREA AND SECTION IN TEXT	DEPOSIT, OCCURRENCE, SITUATION	RESERVES		RESOURCES	
		TONNAGE AND GRADE	REMARKS	TONNAGE AND GRADE	REMARKS
	Graphitic schist situation. Adjacent to Stampede fault			Class V Known values + 0.X % Zinc	
	Graphitic schist situation Canyon Ck			do	
Chitsia Mtn-Tekla Hills 4.1-A (3)	Chitsia Mtn Barite (No. 58, fig. 4.1-A (3)			Class II Barium max to 36% $BaSO_4$, Pb-Zn in X.0 % maximum.	300'X150'X10' Volume
	Sec 25-35 Volcanic situation 4 Mi SW Chitsia			Class VII Zinc in 0.X % range Traces of Pb, Ag, Au	Miles long gossan belt, Possibility of massive high-grade zones
Mt. McKinley Nat'l Park 4.1-B	Mt. Eielson Lead-Zinc	Class II-III A. 100,000 tons of 10% Pb+Zn in talus (Chadwick, 1976) B. X00,000 tons of +10% Pb+Zn (Reed, 1933)		At least Class IV X.0-X0. % Pb+Zn	
	Greenback Magnet Sourdough			Class V Cu in 0.0X-0.X % range Pb+Zn - Au+Ag Present	6000'x3000'x20(?)' Mineral Zone

TABLE 6.3 CONT.' SUMMARY OF RESERVE AND RESOURCE DATA FOR SOME METALLIC DEPOSITS AND OCCURENCES, MT. McKINLEY REGION, ALASKA

AREA AND SECTION IN TEXT	DEPOSIT, OCCURRENCE, SITUATION	RESERVES		RESOURCES	
		TONNAGE AND GRADE	REMARKS	TONNAGE AND GRADE	REMARKS
Dall Trend 4.1-C	Section 36 Copper occurrence (Fig. 4.1-C(3))	Class II of 25% Cu, 41 oz/ton Ag, and 0.71 oz/ton Au	300' x 150' x 3' - volume of massive sulfide in mineralized tactite	Class III of X.0% Cu with gold and silver	
	Occurrences in T. 28N, R. 16W (Fig. 4.1-C(3))			Class IV of gold in 0.X-X.0 ppm range, copper in 0.0X-.X% range, trace W,	Two areas measured at least 1000 feet long
	Section 10 Occurrence (Fig. 4.1-C(3))			Class V of gold in 0.X-X.0 ppm range, copper in 0.0X-.X%, local nickel	Disseminated mineralization over 1000' x 1000' area
	T30N, R 22-23W Ultramafic area (Fig. 4.0-B)			Class V of Cu, Ni, Cr in 0.X% range	Disseminated and massive deposits in altered ultramafic; >1 mile long
	T 31N, R21W Ultramafic area (Fig. 4.0-B)	Class II-III Massive chromite		Class V of Cu, Ni, Cr in 0.X% range	Disseminated and massive deposits in several 1-mile long ultramafic
Shellabarger Pass 4.1-D	Massive Cu-Zn sulfide			Class II of Cu about 1.5%; Zn of about 1.5%, + 1 oz/ton Ag	
Northern Chulitna District 4.2-A(1)	Golden Zone	(See Next Page)			

TABLE 6.3 CONT.' SUMMARY OF RESERVE AND RESOURCE DATA FOR SOME METALLIC DEPOSITS AND OCCURENCES, MT. McKINLEY REGION, ALASKA

AREA AND SECTION IN TEXT	DEPOSIT, OCCURRENCE, SITUATION	RESERVES		RESOURCES	
		TONNAGE AND GRADE	REMARKS	TONNAGE AND GRADE	REMARKS
Northern Chulitna District 4.2-A(1)	Golden Zone (cont)	Class III A. 45,000 tons measured of 0.31 oz/ton Au	30'x 300'x 50' volume West zone	Class IV A. ≈ 6,000,000 tons of 0.0X oz/ton Au	In 1500' cylinder with approximate 112' radius
	(cont)	B 30,000 tons measured of 0.21 oz/ton Au	30' x 200' x 50' volume of East Zone	Class VI of 0.0X-0.X ppm Au	In 1500' x 2000' x 1000' volume. (Surface anomaly = 1500x 2000')
	(cont)	C 506,000 tons measured of 0.14 oz/ton Au, + Ag + Cu	220'x 230'x 100' volume between East and West Zones		
	Nim			Class VI-VII of 0.0X % Cu with by product Au, Mo, Ag	Possibility of local ore grade zones
	Nimrod			Class III of 0.5-3.0 oz/ton Ag Also Pb, Zn, Sb, Au	Assumed volume 250'x 250' x 125'
	Lookout Mtn			Class V of 0.0X % Pb, Zn. Sn present; silver to 0.9 oz/ton	1000'x 1000' main outcrop area

TABLE 6.3 CONT.' SUMMARY OF RESERVE AND RESOURCE DATA FOR SOME METALLIC DEPOSITS AND OCCURENCES, MT. McKINLEY REGION, ALASKA

AREA AND SECTION IN TEXT	DEPOSIT, OCCURRENCE, SITUATION	RESERVES		RESOURCES	
		TONNAGE AND GRADE	REMARKS	TONNAGE AND GRADE	REMARKS
Southern Chulitna District 4.2-A(2)	Partin Creek	Class III of: A. 0.68 oz/ton Au B. 0.20 oz/ton Au		Class IV Indicated 0.2-0.7 oz/ton Ag and about 1.0 % Cu	Seven main carbonate horizons; ore lenses to about 1000'x500'x10' are possible
	Ready Cash	Class II of: about 20-25 oz/ton Ag, 4% Pb, 0.5% Sn		Class III of high-grade shoots are possible (Vein No. 4 continues 1000-feet beyond sampled interval) Class IV of low-grade veins (Vein No. 3 has about 500,000 tons 0.08 oz/ton Au, 1 oz/ton Ag, and 0.33% Cu)	
	Coal Creek	Class II of about 9% zinc, local silver values		Class III of Sn in 0.0X - 0.X % range; trace Ag, W	Disseminated in at least 200'x200' tourmaline granite area
Yentna District 4.2-B	Cache Creek	Class IV in main Cache Creek System at \$0.50-\$1.00/yd		Class IV in Dutch-Bear Creek Systems - value/yd unknown	
	Nugget Bench	Class II of \$3.00 yd	At least 400'x100'x50' volume		

TABLE 6.3 CONT.' SUMMARY OF RESERVE AND RESOURCE DATA FOR SOME METALLIC DEPOSITS AND OCCURENCES, MT. McKINLEY REGION, ALASKA

AREA AND SECTION IN TEXT	DEPOSIT, OCCURRENCE, SITUATION	RESERVES		RESOURCES	
		TONNAGE AND GRADE	REMARKS	TONNAGE AND GRADE	REMARKS
Yentna (cont) 4.2-B	St. Louis Channel	Class IV of ≥ 10.00/yd	1000' x 350' x 80' volume		
	Peters Creek	Class IV A. Measured: 629,000 yds of $ 2.85/yard B. Indicated: 3,500,000 yds of $ 5.77/yd C. Inferred: 8,000,000 yds at $ 5.77/yd			
	Collinsville	Class III A. Measured 327,000 yds of $ 1.74/yd Class IV A. Inferred: 1,600,000 yds of similar value		Class IV in Camp, Cottonwood and other creeks	
Boulder Creek 4.2-C	Porkey Tin (at J-K)	Class I of more than 1% Sn, 1% Pb, and 1 oz/ton Ag		Class II of 0.X% Sn	Disseminated deposit virtually unexplored

TABLE 6.3 CONT.' SUMMARY OF RESERVE AND RESOURCE DATA FOR SOME METALLIC DEPOSITS AND OCCURENCES, MT. McKINLEY REGION, ALASKA

AREA AND SECTION IN TEXT	DEPOSIT, OCCURRENCE, SITUATION	RESERVES		RESOURCES	
		TONNAGE AND GRADE	REMARKS	TONNAGE AND GRADE	REMARKS
Boulder Creek 4.2-c	Alespelt	Class I of material assaying to 33 oz/ton Ag, 33 % Pb, and 56 % WO_3, all as much as 0.14 %		Class II of X.0 oz/ton Ag, X.% Pb+Zn 0.0X% U, W, Sn	1000'x500'x10' volume
	Hogback			Class II of X.0 oz/ton Ag and X.% Pb+Zn	
	Anomalous situation, Sec. 10 (Fig. 4.2-c(3)-c)			Class VII of 0.0X-.X % Cu-Pb-Zn	1200-foot thick zone; zone persists 3 miles
	Tonzona stock			Class III-IV of 0.00X % Sn	Local concentrations of Be to X.0 % (Class I)

The data summarized in Table 6.3 represent deposits, occurrences, or anomalous situations where there is at least some reliable information on size and metal content--it is not complete.

In general terms, it appears that in the Kantishna district, relatively high-grade reserves and resources of silver and gold-bearing deposits are present in tonnages which could exceed 1,000,000 and are almost certainly present in a 10,000 tons class. Total antimony resources are in excess of 10,000,000 pounds.

The stratiform mineralized beds of the Kantishna trend have major tonnage potential. They contain, where sampled, base metal values in the 0.0X 0.X% range, obviously much below ore grade. Within volumes of many billions of tons of low-grade material, there are, however, distinct possibilities of large mineable ore grade zones. Strata correlative with the Keevy Peak Formation exposed in northwestern Canada contain zinc reserves approaching 1,000,000,000 tons of 10% zinc--so major ore deposits are possible in these rocks.

Placer deposits of Kantishna were not studied, but based on extent of auriferous gravels, fields in excess of 1,000,000 and possible 10,000,000 cubic yards could be present in Moose and the lower part of Caribou Creeks.

In Mt. McKinley National Park, the recognized deposits of largest potential are tactite or associated disseminated deposits of Mt. Eielson or in the Slippery Creek area. Inferred resources classes are in the IV - V range.

The Dall trend has essentially no detailed information, but it has class V resource values, primarily in contact areas between Yentna-type intrusives and limestone or lime-cobble conglomerate. Based on existing information, copper-rich massive sulfide-tactites and chromite deposits have some material rich enough to be classed as ore reserves.

At Shellabarger Pass, work done by industry since Reed and Eberlein's report (1972) has resulted in other discoveries. The semi-quantitiative data available is still based on the U.S. Geological Survey discovery which indicates relatively small (>100,000 tons, <1,000,000) bodies of massive sulfide with about three percent valuable (copper and zinc) metal content.

The Golden Zone deposits of the north part of Chulitna district has more available exploration data than any other deposit in the Mt. McKinley region. It has measured reserves of about 580,000 tons, and an identified resource value of about 6,000,000 tons measured in the low 0.0X ounces/ton gold range. There is a hypothetical resource of gold in the > 100,000,000 class in the .0X - .X ppm gold range.

Within the Chulitna district, resources of disseminated type , where relatively large deposits are possible, are located at Nim, Nimrod, Lookout Mountain (table 6.3), and also at the Silver King and Long Creek occurrences.

The most significant resource potentials of the southern part of the Chulitna belt appear to be: (1) massive gold-bearing skarn (Partin Creek); (2) tin-silver veins (Ready Cash, Ohio

Creek granite stock, and Coal Creek; and (3) disseminated tin-tungsten deposits (Ohio Creek granite stock and Coal Creek). There are apparent ore reserves in Class II-III levels.

The Yentna district contains ore reserves in the Cache Creek, Peters Creek, Twin and Mills Creek systems at a class IV level. There are significant smaller reserves (class II-III) in high-channel deposits, and resource or speculative reserves in Dutch, Bear, Camp, and Cottonwood Creeks.

In the Boulder Creek or Tonzona area, besides a major anomalous situation in Paleozoic layered rocks, there are apparent class I ore reserves at the Mespelt (?) and Purkey tin prospects, and at least class II reserves in vein systems. Locally the geology of the Tonzona stock is permissive for low-grade disseminations of tin and related metal or small high-grade deposits of beryllium, tin, tungsten, or uranium.

6.4 Other Resources

Coal is a major resource in peripheral areas, with reserves and resources in the Nenana field alone measured in hundreds of millions of tons of strippable coal, and over three billion tons as a potential reserve above 1,000 feet. The part of the Susitna field near Collinsville could have significant reserves, as could the Broad Pass lignite area. Coal of great thickness (>100 feet) also exist in the poorly known Little Tonzona area.

Cement quality limestone also exists in commercially signficant quantity in several areas, including Foggy and Windy Passes and Upper Long Creek. Clay appears to be present in significant amounts in the Healy Creek area, but perlite deposits found to date are of subcommercial size.

6.5 An Overview

The Mt. McKinley region is, when compared with most other terranes or areas, strongly mineralized, and if it existed in a more accessible or climatically hospitable region, would almost certainly have had much more extensive mineral production.

Its future as a mineral region is uncertain. Alaska has not been a major mineral producer since World War II, however, until the Trans Alaska pipeline costs of operation and existence in Alaska had been inching toward those of the lower '48. The future for mineral development seems to continue to recede in Alaska, but the mineral potential remains factual--only needing mostly human desires and ingenuity for it to be realized.

Because so much of the data is from only three sources, the format of references is generalized. U. S. Geological Survey reports are cited as:

B 862	(USGS)	Bulletin 862
PP 70		Professional Paper 70
C 252		Circular 252
MF 366		Misc. Field Studies Map 366
USGS OF 310		Open-File Report 310
GQ 805		Geological Quadrangle Series Map 805
USGS Ann. Report		Annual Report (prior to 1900)

If maps or reports are from the U. S. Bureau of Mines, they are given in this and subsequent sections as:

		READ:
BM IC 7379	(U.S. Bur. Mines)	Information Circular 7379
BM TP 682		Technical Paper 682
BM RI 3748		Report of Investigations 3748

If the reports are from the present Alaska Division of Geological and Geophysical Survey (AK DGGS), or its predecessors, the Division of Mines and Minerals or the Territorial Survey, the reports are cited as:

	READ:
AK DGGS OF 19	Open-File Report 19
SR 7	Special Report 7
GR 38	Geologic Report 38

Other references are cited in conventional fashion.

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