

STATE OF ALASKA  
DEPARTMENT OF NATURAL RESOURCES  
DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS

GENERALIZED BEDROCK GEOLOGY AND MINERALIZATION  
IN MT. MCKINLEY NATIONAL PARK

By

Mitchell W. Henning

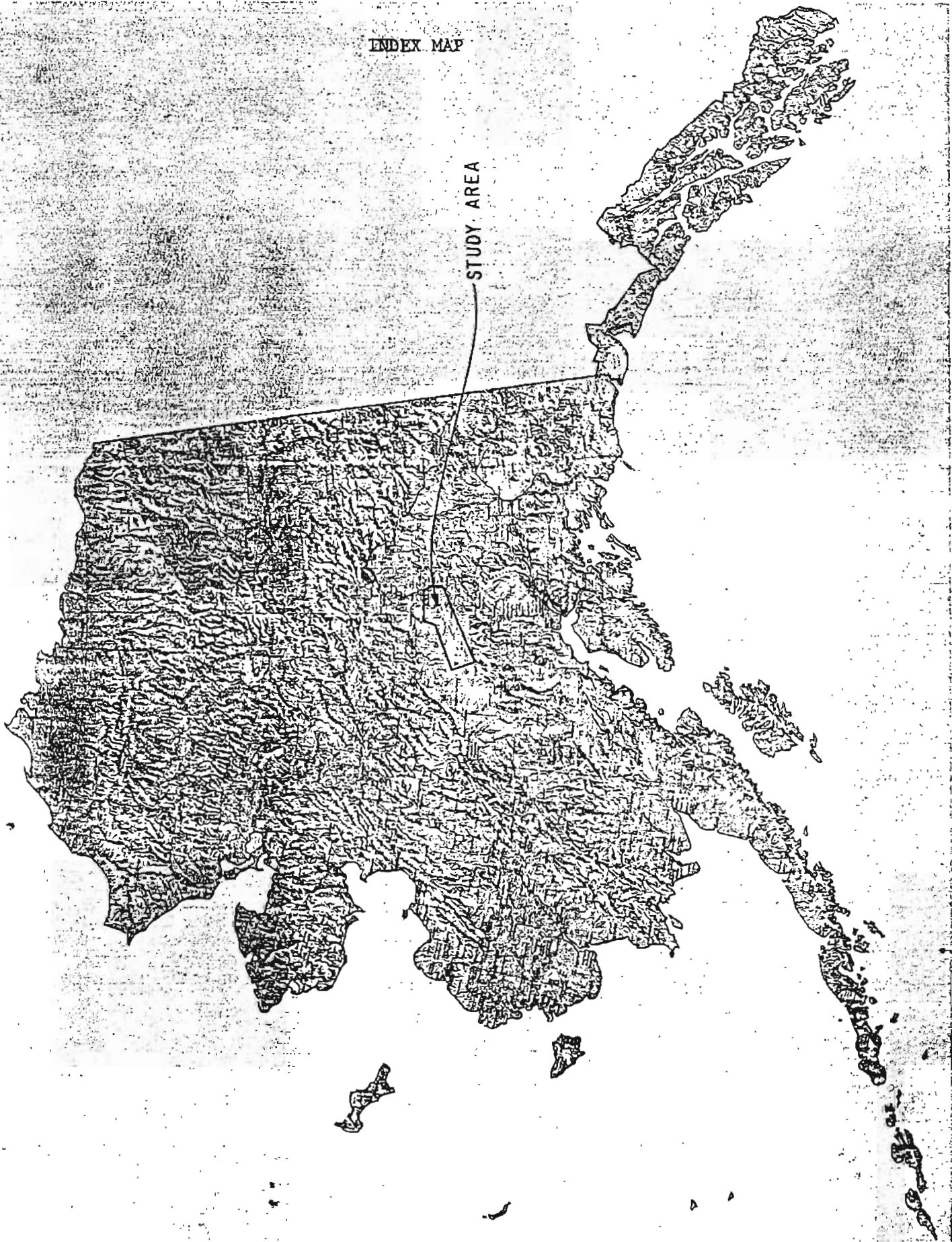
February 1974

This report is preliminary and  
has not been edited or reviewed  
for conformity with Alaska  
Geological and Geophysical Surveys  
standards.

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## INTRODUCTION

The geology of Mt. McKinley National Park is complex, with diverse rocks ranging in age from Pre-Cambrian to Tertiary. Northeastward-trending normal faults, with major lateral displacement, compose the prominent structural features in the park. Granitic batholiths, largely of Mesozoic age, intrude the Paleozoic and Mesozoic rocks in the Alaska Range. Glacial, alluvial, and eolian deposits of Pleistocene and Recent age occupy the lowlands within the park. Deposits of gold, silver, and antimony occur in the Kantishna Hills north of the park. Lead and zinc deposits are found at Mt. Eielson and copper, lead, zinc, and mercury occurrences have been reported from the foothills of the Alaska Range west of Muldrow Glacier.

## GEOLOGY

### PRE-CAMBRIAN ROCKS

The Birch Creek Schist outcrops in the northeast part of the park. The most widespread facies of the formation is a quartz-sericite schist. Other common varieties are chloritic, sericitic, and graphitic schist; calcareous schist and schistose limestone; sericite phyllite; black slate; and massive quartzite. All facies are interbedded in varying proportions. Also interbedded with the rocks of sedimentary origin are greenstone bodies, which probably represent metamorphosed basaltic sills or flows. The Birch Creek Schist is folded into a series of gentle northeastward-trending anticlines and synclines, slightly asymmetrical to the northwest and complicated by faults, minor drag folds, and cross folds.

### UNDIFFERENTIATED PALEOZOIC ROCKS

A group of metamorphosed sedimentary rocks believed to be largely of Paleozoic age crop out along the north flank of the Alaska Range.

The most continuous section of these rocks is found in the upper basin of the Toklat River, between the Denali Highway and the Denali Fault. The oldest beds are those exposed to the south, between the headwater glaciers of the Toklat River and the fault. The base of the sequence is a dark-brown to black conglomerate 200 to 1,000 feet thick overlain by 50 to 200 feet of conglomerate consisting of white quartz in a white to gray siliceous matrix. Dark-gray slate, argillite, and limestone occur in the upper part of the glacier basin at the head of the westernmost fork of the Toklat River. Overlying the sequence of dark-gray slate, argillite, and limestone is a bed of massive gray limestone, commonly intensely sheared and cut by numerous calcite veinlets. In exposures in the upper basin of the Toklat River, the limestone is 300 to 400 feet thick, but locally it wedges out entirely, owing to original variations of thickness or to deformation. The limestone is very resistant to erosion, forming rugged cliffs and towers, and capping peaks and ridges.

Along the Toklat River the massive gray limestone is overlain by a sequence of several thousand feet of thin (1 to 6 inches) alternating layers of dark-gray or blue chert, fine-grained sandstone, argillite, and limestone.

Alternating layers of chert and limestone make up most of the lower part of the sequence; upward the layering is similar but the bands are black argillite and buff cross-bedded sandstone, commonly of the graywacke type. Near the upper forks of the Toklat River the sequence is cut by many stocks and sills of greenstone. The upper part of the undifferentiated Paleozoic sequence exposed near Highway Pass is composed of banded limestone, brown sandy phyllite and argillite, and a few beds of sedimentary breccia composed of angular white and black chert pebbles. Possibly these upper beds are separated from the underlying banded sequence by an unconformity. Undifferentiated Paleozoic rocks composed of highly contorted quartz-sericite and quartz-graphite schist are exposed between Stoney Creek and Toklat River. The foliation is parallel to the bedding; lineation due to crinkling of mica flakes parallel to northwestward-trending fold axis is well developed. Quartz pods parallel to the foliation are common. This schist closely resembles phases of the Birch Creek schist, and probably should be mapped as such.

Southward and presumably stratigraphically upward, the schist grades without a sharp break into a black slate series that contains massive black resistant quartzite beds 50 to 100 feet thick. There is no evidence of structural discordance as noticeable differences in degree of deformation between the black slate and the quartz schist sequence. Near Mount Sheldon, folds in the Paleozoic sequence are truncated by the massive basal conglomerate of the overlying Cretaceous Cantwell formation.

## MESOZOIC SEDIMENTARY AND VOLCANIC ROCKS

### Triassic Greenstone

Between the Toklat River and the terminus of the Muldrow Glacier the undifferentiated Paleozoic rocks on the north flank of the Alaska Range are overlain unconformably by a series of basaltic lava flows altered to greenstone, attaining an aggregate thickness of about 3,500 feet in the mountains north of the Denali Highway. The greenstone weathers to a deep chocolate brown and forms bold cliffs. Where hydrothermal alteration has taken place the greenstone is light tan or white in contrast to its more somber shades. The most common facies of the greenstone is a dark-grayish-green aphanitic rock, cut by numerous veinlets of white calcite, green chlorite, and serpentine minerals. Pillow structure is well developed. Gabbro and dolerite dikes and sills cutting the Paleozoic rocks are probably the same age as the lava flows. The formation overlies the undifferentiated Paleozoic rocks and in its lower parts contains pod-shaped bodies of altered limestone and black shale similar in appearance to the underlying rocks.

### Undifferentiated Mesozoic Rocks

East of Mt. McKinley and south of the Muldrow Glacier the peaks of the Alaska Range are sculptured from a thick sequence of sedimentary rocks, probably largely of Mesozoic age.

Near Anderson Pass this sequence consists mostly of jet-black slate interbedded with thin sandstone layers, alternating with massive layers several hundred feet thick of coarse graywacke and breccia, composed of angular pebbles of chert and quartz in a matrix of graywacke. Black slate and coarse graywacke like those which comprise most of the sequence southwest of Anderson Pass are the predominant rock types in the moraines of the Muldrow Glacier.

## Cantwell Formation

The Cantwell formation is a sequence of continental clastic sedimentary rocks and associated volcanic rocks of Cretaceous age that have been recognized along the Alaska Range from the headwaters of the Tonzona River as far east as the vicinity of Mount Hayes.

The best exposures of the Cantwell formation are along the Toklat River north of the Denali Highway. The formation crops out in two belts separated from each other by a narrow belt of Paleozoic rocks. The basal beds are 400 to 500 feet of massive coarse conglomerate composed of pebbles of white quartz which average 2 or 3 inches, but may be as large as 8 inches in diameter. The basal conglomerate is overlain by a sequence of interbedded sandstone and conglomerate with 5 to 10 foot thick coal beds. This basal sequence is exposed in a syncline on Mount Sheldon in the northern outcrop belt of the formation, where it overlies Paleozoic shale and limestone, and along the southern edge of the outcrop belt where it overlies Triassic greenstone. In the southern outcrop belt the Cantwell formation is composed predominantly of dark shale with some beds of light-colored pebbly sandstone as much as 10 feet thick. The lateral continuity of the formation is variable, and individual beds or units may pinch out in a few thousand feet along the strike.

Volcanic rocks including flows, tuff, agglomerate, and hypabyssal intrusive bodies make up a major part of the Cantwell formation near the terminus of the Muldrow Glacier and between the Herron and Straightaway Glaciers. Similar volcanic rocks are well exposed along the Denali Highway at Polychrome Pass, in the Healy quadrangle. At least 3,500 feet of the lower conglomerate-sandstone sequence is exposed in the syncline on Mount Sheldon. The thickness of the shale-sandstone sequence exposed in the belt to the south is unknown, but it is probably several thousand feet. The Cantwell formation has been assigned to the upper part of the Lower Cretaceous (Albian) on the basis of plant fossils collected by R. W. Chaney and S. R. Capps (Imlay and Reeside, 1954, p. 235).

## MESOZOIC INTRUSIVE ROCKS

### Dolerite and Gabbro Sills and Stocks

Many stocks and sills of altered gabbro and dolerite intrude the undifferentiated Paleozoic rocks along the Toklat River. Similar intrusive bodies have been mapped in the Paleozoic rocks southwest of the Straightaway Glacier (Brooks). Except for their grain size, the rocks in these bodies are petrographically similar to the Triassic greenstone. The rocks are dark green and coarse-grained, locally containing feldspar laths as much as 6 inches long. The sills are commonly several hundred feet thick and are connected directly to stocklike bodies a few hundred yards in diameter. No evidence has been found that these bodies cut the Cantwell formation, and because of their similarities to the greenstone they are tentatively dated as Triassic.

### Granitic Rocks

Granitic intrusive rocks cut the Paleozoic and Mesozoic sedimentary rocks in many areas. Some of these intrusive bodies are stocks, dikes, and sills of small areal extent; some are of batholithic dimensions and form major

elements in the makeup of the Alaska Range. The rocks of the granitic intrusive bodies are largely granite, quartz monzonite, and quartz diorite, but some syenite, diorite, gabbro, and periodite are associated. The major intrusive bodies are clearly related to one another, but each shows variation in mineralogy. Whether the emplacement of these bodies was contemporaneous or at slightly different times is not yet known.

The McKinley batholith, which crops out in the highest part of the Alaska Range, is intruded into the black slate and graywacke of the undifferentiated Mesozoic sequence. The predominant rock in the batholith is quartz monzonite. The contacts of the intrusive body are sharp and are clearly visible on aerial photographs. Near the contacts the slate is converted to hornfels with porphyroblasts of cordierite.

The chief rock in the McGonogall batholith is light-colored coarse-grained quartz diorite that is locally porphyritic. Fine-grained hornblende diorite porphyry is widespread in dikes and small irregular bodies within the batholith.

The McGonogall batholith intrudes the undifferentiated Paleozoic sedimentary rocks, and in many areas large blocks of them are included within the granitic rocks. The country rocks are cut by many dikes and sills of granitic rocks near the contact, and widespread silicification and epidotization of certain zones in the wall rocks occurred during emplacement of the batholith. Reed (1933), reports that the intrusive mass near Mount Eielson is composed of granodiorite, some gabbro, and a few bodies of intermediate composition. In the Mount Eielson district the granodiorite is cut by basalt dikes, which probably are feeders of flows in the Cantwell formation (Reed, 1933). The contacts of the McGonogall batholith with the Paleozoic rocks are favorable loci for mineralization.

#### QUARTZ PORPHYRY ROCKS

In the foothills northeast of the terminus of the Muldrow Glacier are several small stocks and dikes of rhyolite and dacite porphyry.

These rocks are light greenish-gray, buff or white, and differ from the granitic rocks in texture, having an aphanitic ground mass with phenocrysts of clear quartz, glassy or milky sanidine, plagioclase and, in some facies, hornblende and biotite.

The quartz porphyry stocks and dikes cut the Birch Creek schist in the Kantishna Hills, the undifferentiated Paleozoic rocks along the Toklat River and the Triassic greenstone near Camp Eielson. The quartz porphyry bodies very likely may be related to the volcanic rocks of the Cantwell formation.

#### TERTIARY ROCKS

A sequence of continental sedimentary rocks of Tertiary age rests unconformably on the pre-Tertiary rocks in broad basins and structural depressions. These rocks are poorly or moderately well consolidated and include conglomerate, sandstone, shale and, in some parts of the sequence, beds of subbituminous coal. This sequence includes a Tertiary coal-bearing formation and underlies the Nenana gravel. The Nenana gravel is poorly consolidated, with interbedded mudflow deposits, thin claystone layers, and local thin beds of lignite.

A large percentage of the Tertiary rocks in Mt. McKinley National Park are buried beneath a thin veneer of stream gravel or glacial deposits, so that their presence can only be inferred from the physiographic setting, partly mantled bedding traces, and outcrops in cuts along streams where the Tertiary beds are exposed.

### STRUCTURE

The synclinal structure of the pre-Tertiary rocks of the Alaska Range and the arrangement of structural axes parallel to the range was recognized by Brooks (1911, p. 111). This pattern is complicated by minor folds within the major structure, subsequent faulting, and unconformable relations between major stratigraphic units. The faults parallel to the axis of the range are part of the Denali Fault system. Movement along some of these northeastward-trending faults began as early as Cretaceous time. Tertiary orogeny, during which the coal-bearing formation and the Nenana gravel were tilted and folded, was also marked by movement along these faults. The dips of most of these faults are not known, but their straight traces suggest relatively steep dips.

### MINERAL DEPOSITS

Zinc-lead deposits occur in the Mount Eielson district. The chief ore minerals are sphalerite, galena, and chalcopryite, which occur as replacement deposits in thin-bedded limestone, calcareous shale, and graywacke near the contacts of a large granodiorite intrusion. The sulfide mineralization has been accompanied by widespread epidotization and silicification of the sedimentary rocks. Hundreds of dikes and sills emanating from the granodiorite cut the sedimentary rocks.

The ore commonly occurs along the contacts of dikes with limestone, with a concentration of the ore at the top of headed dikes. The ore-bearing zone can be traced for about 4 miles along the contact between the sediments and the granodiorite body on the north slopes of Mount Eielson. The belt in which the mineral deposits occur is about 2,000 feet wide. Some development work has been done on claims in this district.

Several mineralized areas have been discovered along the mountain front between the terminus of the Muldrow Glacier and Straightaway Glacier. Mineralization occurs in altered sedimentary rocks adjacent to the contact with the McGonogall batholith; some may be in sedimentary rocks included in the batholith. The ore minerals that have been recognized in these deposits are chalcopryite, sphalerite, galena, native copper, and cuprite. Alteration products include malachite, azurite, chalcantinite and sooty manganese oxide. The ores occur in irregular masses, veins, and disseminated crystals in the country rock (Moffit, 1933).



## REFERENCES

Capps, S. R., 1933, Geology of the eastern portion of Mount McKinley National Park: U.S. Geol. Survey Bull. 836-D, pp. 219-300

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Gates, G. O.; Wahrhaftig, Clyde, 1944, Zinc deposits of the Mount Eielson district, Alaska: U.S. Geol. Survey Open-file report

Reed, J. C., 1933, the Mount Eielson district, Alaska: U.S. Geol. Survey Bull. 849-D, pp. 231-287


\_\_\_\_\_, 1961, Geology of the Mount McKinley Quadrangle, Alaska: U.S. Geol. Survey Bull. 1108-A, 36 p.

STATE  
of ALASKA

# MEMORANDUM

TO:  D. C. Hartman  
State Geologist

DATE : March 19, 1974

FROM:  P. L. Doby  
Chief Petroleum Geologist

SUBJECT: Review and Comments of Mt.  
McKinley National Park Impact  
Statement

The following comments and review of the Environmental Impact Statement for the Mt. McKinley National Park by Mitchell Henning, along with attached Geologic report of the area, indicate that the Impact Statement is inaccurate in its evaluation of the mineral potential of the area.

Gold and Antimony, one of the critical materials needed by the United States, are produced in the Kantishna area and it is very probable that other economic mineral deposits are present there.

It is therefore recommended:

1. THE KANTISHNA AREA BE EXCLUDED FROM ANY INCREASES IN SIZE OF THE MT. MCKINLEY NATIONAL PARK.
2. If the Kantishna area is included in the park, EXPLORATION, INVENTORY and EXTRACTION OF MINERAL AND ENERGY RESOURCES BE ALLOWED BY PERMIT AND LEASE IN THIS AREA (KANTISHNA) under suitable guidelines.

COMMENTS AND REVIEW OF THE

PROPOSED MT. MCKINLEY NATIONAL PARK (Extension)

By

Mitchell Henning

State of Alaska

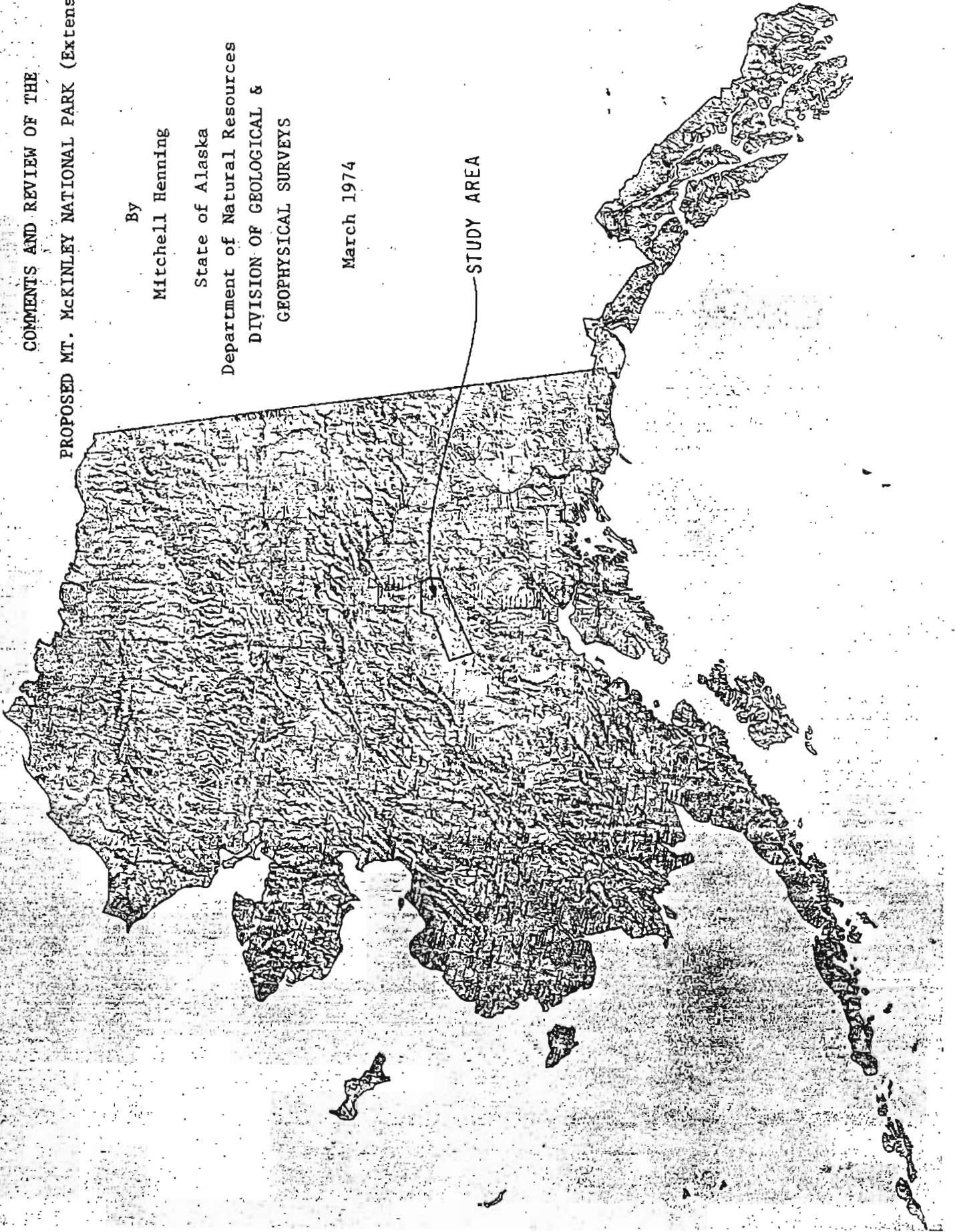
Department of Natural Resources

DIVISION OF GEOLOGICAL &

GEOPHYSICAL SURVEYS

March 1974

STUDY AREA



The collection of accurate statistics of mineral production is a task that is beset with many difficulties, even in a well settled area. In Alaska it is a near hopeless situation. The Kantishna District which lies within the proposed northern addition of Mt. McKinley Park, has been in continuous production despite economic fluctuations since 1905.

Statistics on the Kantishna mining district, gathered by the Conservation Section of the Division of Geological and Geophysical Surveys (Conwell, 1973), relate the sensitivity of mining in a small district to an increase in metal price. Table I shows the gold, antimony, and total value of metal production in the Kantishna district for the past 4 years.

Table I. METAL PRODUCTION, KANTISHNA DISTRICT

<u>Year</u>	<u>Gold \$</u>	<u>Antimony \$</u>	<u>Total Metal \$</u>
1970	6,000	43,000	49,000
1971	45,000	78,000	123,000
1972	66,000	28,000	94,000
1973	214,000	96,000	320,000

Table II shows the average price of gold, stibnite ore (antimony), and silver during the summer months for 1970 - 73.

Table II. METAL PRICES

<u>Year</u>	<u>Gold \$/Oz.</u>	<u>Stibnite /stu*</u>	<u>Silver \$/Oz.</u>
1970	36.00	38.00	1.72
1971	40.00	10.00	1.65
1972	59.52	7.00	1.61
1973	118.05	13.00	2.75

\*Standard ton unit = 20 pounds

These tables show how the production of gold increased with the increase in price. The tables demonstrate the fluctuation of metal prices against the output. Antimony ore in 1969 hit a high of \$40 per unit and sank to a low of \$7 in 1972. Table I indicates that ore was prepared for mining in 1970 with a high price.

There is a carryover of volume sale a year after the high price. In 1972, with a low price of \$7 per unit, production hit its lowest level, and then responded to the price increase. A price of \$10 per unit of stibnite seems to be the minimum for a ready market and a profitably operation of an antimony mine.

Table I shows that in 1970-72, the total metal value is from gold and antimony only, but in 1973 there is an added value: the increase in the price and production of silver enabled a lead-silver concentrate to be profitably produced from a lode mine and mill on Friday Creek. The Kantishna area is well-mineralized, containing both lode and placer gold deposits. Lead, silver, zinc, and antimony ores with commercial value have been mined and shipped at such times as price would permit a profitable operation.

As demand for metal continues, consideration must be given to finding new reserves and keeping operating districts in business. Old or new mining districts should be considered as areas of potential ore reserves. These districts should be blocked out and set aside for detailed field examination by qualified personnel.

Page 5 paragraph 2

"All major potential mineral production areas have been excluded from the proposed boundaries." I would like to know what data this statement was based on; zinc-lead deposits occur in the Mt. Eielson district. The chief ore minerals are sphalerite, galena, chalcopryrite, which occur as replacement deposits in thin-bedded limestone, calcareous shale, and graywacke near the contacts of a large granodiorite intrusion. The ore commonly occurs along the contacts of dikes with limestone, with a concentration of the ore at the top of the headed dikes. The ore-bearing zone can be traced for about 4 miles along the contact between the sediments and the granodiorite body on the north slopes of Mt. Eielson.

The belt in which the mineral deposits occur is about 2,000 feet wide. Some development work has been done in this zone.

Several mineralized areas have been discovered along the mountain front between the terminus of the Muldrow Glacier and Straightaway Glacier. Mineralization occurs in altered sedimentary rocks adjacent to the contact with McGonogall batholith; some may be in sedimentary rocks included in the batholith. The ore minerals that have been recognized in these deposits are pyrrhotite, chalcopyrite, sphalerite, galena, native copper, and cuprite. Alteration products include malachite, azurite, chalcantite, and sooty manganese oxide. The ores occur in irregular masses, veins, and disseminated crystals in the country rock.

At Copper Mountain just east of the end of Muldrow Glacier, is a mineralized area that has attracted considerable attention. It was discovered in 1921 by O. M. Grant and F. B. Jiles. The Metallic minerals, introduced as a result of the igneous intrusion, include the sulphides of zinc, lead, iron, and copper, with a varying content of gold and silver. There is no doubt that Copper Mountain is extensively mineralized and the potential of finding a high-grade ore body has to be considered high.

Page 77 paragraph 2

"There are also concentrations of claims south of the Alaska Range between the "mineral belt" and the park, but not within the National Park Service interest area."

Using the Park Service's prepared mineral map that is in the impact statement, one can observe that they have plotted the trend of the mineral belt through the southern area considered for addition to the park.

Page 143 paragraph 2

"The Kantishna district was a gold boom area just after the turn of the century. The existence of a significant metallic resource potential may possibly be credited to the Kantishna-Stampede district despite its relatively modest production record."

Based on production statistics and the infant state of Alaska's mineral industry production in the Kantishna district should not be considered modest. Antimony production will double in 74 with gold following the same trend. Economic conditions are becoming more favorable, so metallic mineral production should be on the upswing.

Page 143 paragraph 3

"Further intensive investigation would be needed to determine Kantishna's remaining production potential, however, mineral production in the area has been declining since its boom years in the early 1900's."

Again I wish to call attention to the production figures presented for Kantishna. In the last two years, mineral production has doubled, and is certainly on the increase. Based on favorable economic conditions and a pending minerals shortages in the United States within the next decade, the Park Service should take a little more care in evaluation of mineral districts, so they can make qualified statements backed up by facts and not emotions or personal philosophies.

STATE  
of ALASKA

# MEMORANDUM

TO: [ D. C. Hartman  
State Geologist

DATE : March 19, 1974

FROM: P. L. Dobe<sup>y</sup>  
Chief Petroleum Geologist

SUBJECT: Open File Report Number 43,  
Bedrock Geology and Mineralization  
of Mt. McKinley National Park

Submitting this date a copy of Open File Report Number 43 "Generalized Bedrock Geology and Mineralization in Mt. McKinley National Park," by M. W. Henning. A copy of this report with an original of the map is being sent to Fairbanks for open filing. We are also sending under separate cover a copy of the report with a review of the Environmental Impact Statement and a colored map for Senator Stevens.

Recommendations concerning the park are given in the transmittal of the review of the Impact Statement. It should be noted that Cleland Conwell and Henning both feel very strongly about the Kantishna District and do not feel that it should be included within any proposed park area.