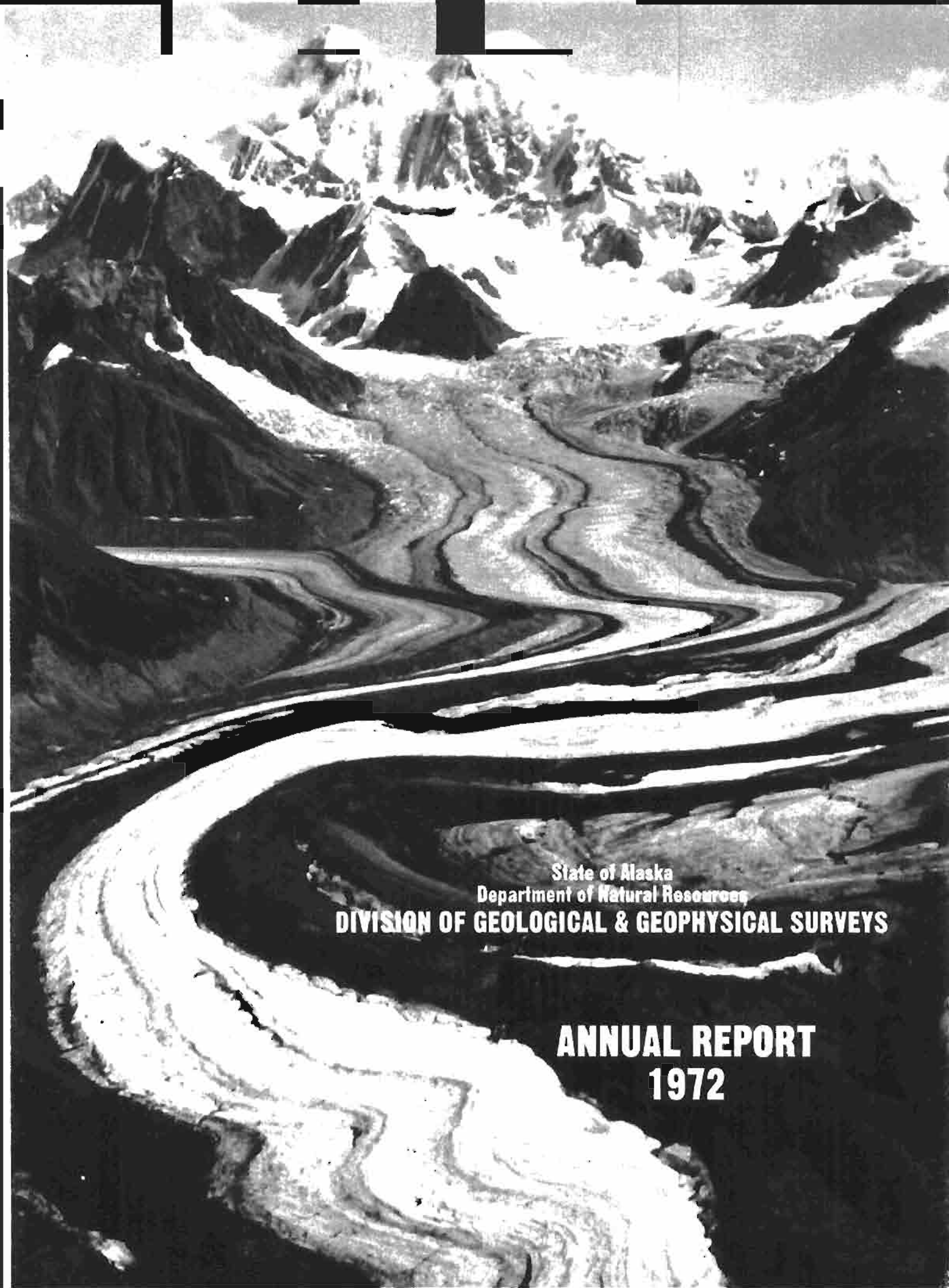

State of Alaska
Department of Natural Resources
DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS

ANNUAL REPORT 1972

STATE OF ALASKA

WILLIAM A. EGAN, GOVERNOR

DEPARTMENT OF NATURAL RESOURCES

Division of Geological and Geophysical Surveys

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February 28, 1973

The Honorable Charles F. Herbert
Commissioner
Department of Natural Resources
Pouch M
Juneau, Alaska 99801

Dear Commissioner Herbert:

It is my pleasure to submit this report of the Division of Geological and Geophysical Survey's activities during 1972.

Alaskan's mineral production in 1972 was $317.2 million; $267.3 million attributable to oil and gas and $49.9 million to minerals.

Division field mapping programs included the west–central Brooks Range, central Alaska Range and Prince of Wales Island. A total of approximately 2,000 square miles were mapped. Summaries of these and other projects will be found in Section II of this report.

The Division continued the airborne magnetometer program, begun in 1971, mapping an additional 20,000 square miles. Coverage is illustrated in Figure 6, the Aeromagnetic Survey Map, of Section II.

Most of the Division staff contributed data to the land selection and classification of the Joint Federal–State Land Use Planning Commission.

The Division of Geological and Geophysical Surveys will continue to advance the geological knowledge of Alaska, contributing to the best use of Alaska's resources.

Respectfully submitted,

William C. Fackler

William C. Fackler
State Geologist

WILLIAM A. EGAN

GOVERNOR
State of Alaska

CHARLES F. HERBERT

COMMISSIONER
Dept. of Natural Resources

WILLIAM C. FACKLER

STATE GEOLOGIST

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Division of Geological and Geophysical Surveys

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Donald M. Triplehorn, *Geologist*
Donald L. Turner, *Geologist*

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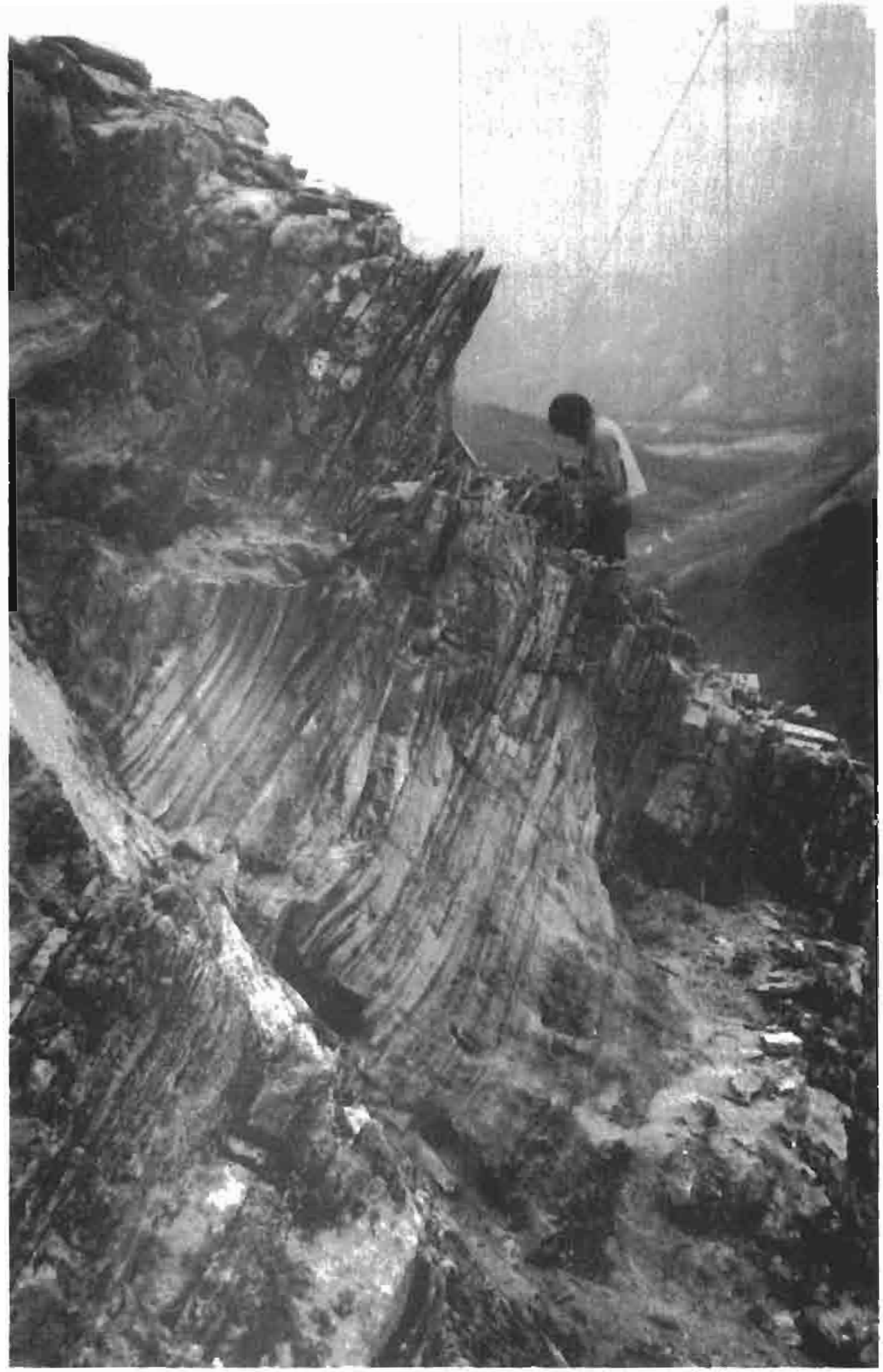
Cover photograph: Northeast view over medial moraines of Susitna Glacier, Mt. Hayes and tributary glaciers. Photo by T. E. Smith

Photos by: G. R. Eakins, G. H. Pessel, T. E. Smith, and B. E. Britch

SECTION I



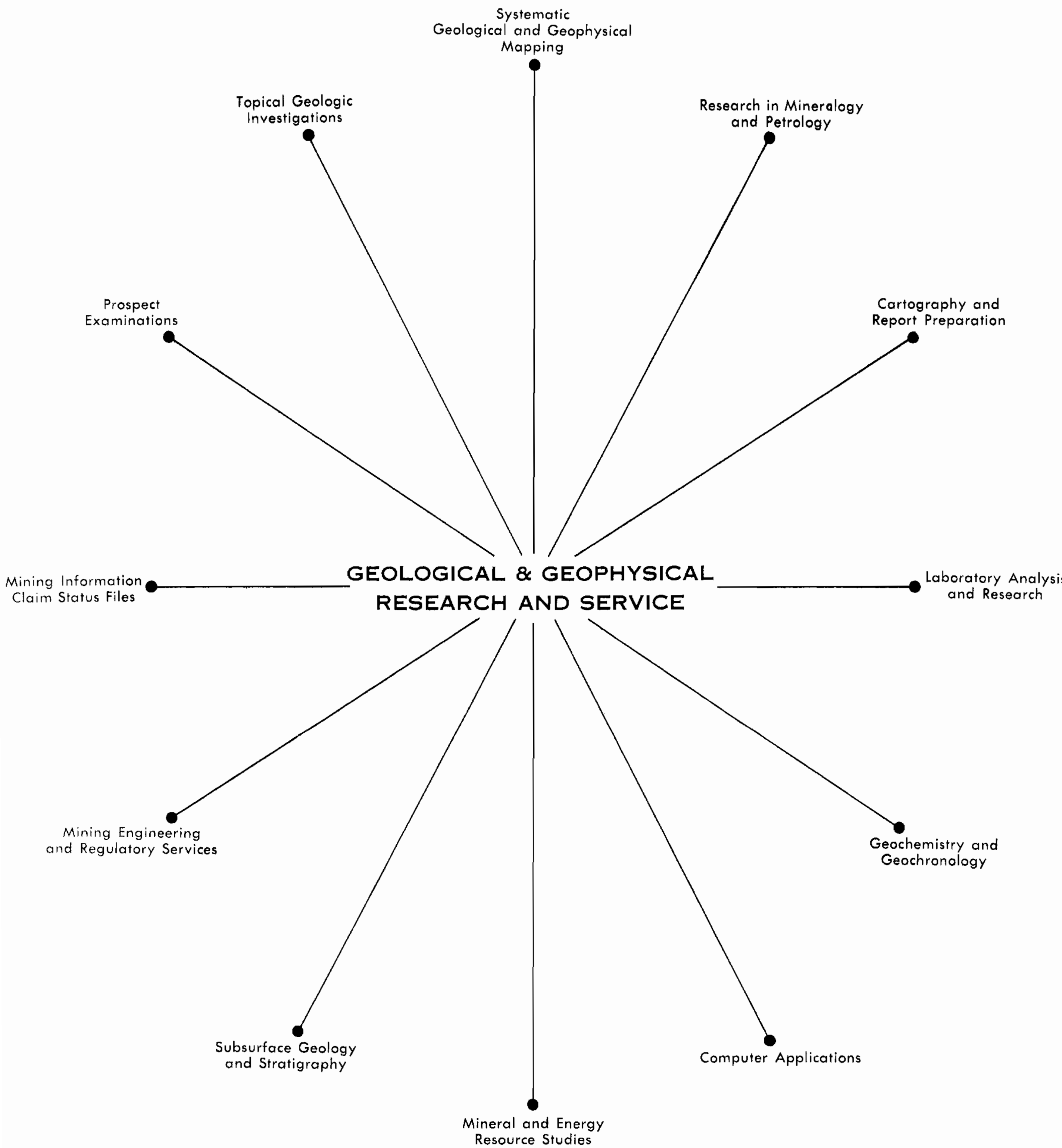

Systematic Geological and Geophysical Mapping
Topical Geologic Investigations
Research in Mineralogy and Petrology
Prospect Examinations
Cartography and Report Preparation
Mining Information Claim Status Files
GEOLOGICAL & GEOPHYSICAL RESEARCH AND SERVICE
Laboratory Analysis and Research
Mining Engineering and Regulatory Services
Geochemistry and Geochronology
Subsurface Geology and Stratigraphy
Computer Applications
Mineral and Energy Resource Studies

Figure 1

Introduction

The Division of Geological and Geophysical Surveys maintains offices with scientific and technical personnel in Anchorage and Fairbanks. Offices of Mining Information Specialists are located in Anchorage, Fairbanks, Ketchikan, and Juneau. Formerly named the Division of Geological Survey, legislative enactment established the new division on July 1, 1972.

Duties of the Division

The Division of Geological and Geophysical Surveys is charged with conducting "geological and geophysical surveys to determine the potential of Alaska lands for production of metals, minerals, and fuels; the location and supplies of ground waters and construction materials; the potential geologic hazards to buildings, roads, and bridges and other installations and structures; and shall conduct such other surveys and investigations as shall advance knowledge of the geology of Alaska." In accordance with this charge, geologic and geophysical mapping, economic geology studies, and geochemical sampling are carried out during the summer field seasons. The maps and reports resulting from these activities are one of the principal products of the Division.

Property examinations and technical assistance are available to Alaskan miners and prospectors. The Division laboratory at Fairbanks provides mineral analyses and identifications as well as studies of rocks and minerals. Files of all known Alaskan mining claims and claim holders, since 1953, are maintained at Mining Information Offices in Anchorage, Fairbanks, Ketchikan, and Juneau.

Organization

The Division of Geological and Geophysical Surveys is organized in five sections: Office of the State Geologist, Mining Geology, Conservation, Mineral Analysis and Research, and Energy Resources. The Division's changing role in response to State needs, plus the difficulties of procuring, maintaining, and transporting personnel and equipment, require Division personnel to be extremely flexible in their assignments and to be competent in several areas.

Personnel Changes

An increase in activities and responsibilities of the Division is reflected by further changes in organization and personnel in 1972. William C. Fackler, former Assistant Commissioner for Minerals, stepped into the legislatively created position of State Geologist, and maintains his offices in Anchorage.

New personnel in the Fairbanks office, since 1971, include Barbara E. Britch, publication specialist; William W. McClintock, mineral lab technician; Thomas Welsh, lab assistant; and Carol Zdanovec, lab assistant. William M. Lyle, stratigrapher, and Garnett H. Pessel, petroleum geologist, joined the Anchorage staff.

Crawford E. "Jim" Fritts, acting Chief Geologist and member of this Division since 1968, drowned in a canoeing accident on the Kogoluktuk River, July 4, 1972. A tribute was paid to Fritts in a recent memorial, "His untimely death stands as a mute testimony to the often harsh challenge of the arctic wilderness and leaves an irreplaceable void in the ranks of Alaskan field geologists."

Mining Information Specialists

The processing of 6,657 claim location notices, 1,236 affidavits and mineral documents, assisting visitors, and answering information requests from around the world kept these four mining information specialists busy during 1972.

Located in four Alaskan cities, they are (l–r, top): Mildred E. Brown, Fairbanks, Ulrika O. McBride, Anchorage; (bottom) Geraldine M. Zartman, Ketchikan; and Agnes M. Burge, Juneau.

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Anchorage, Ak. 99501

Ketchikan
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Pouch M
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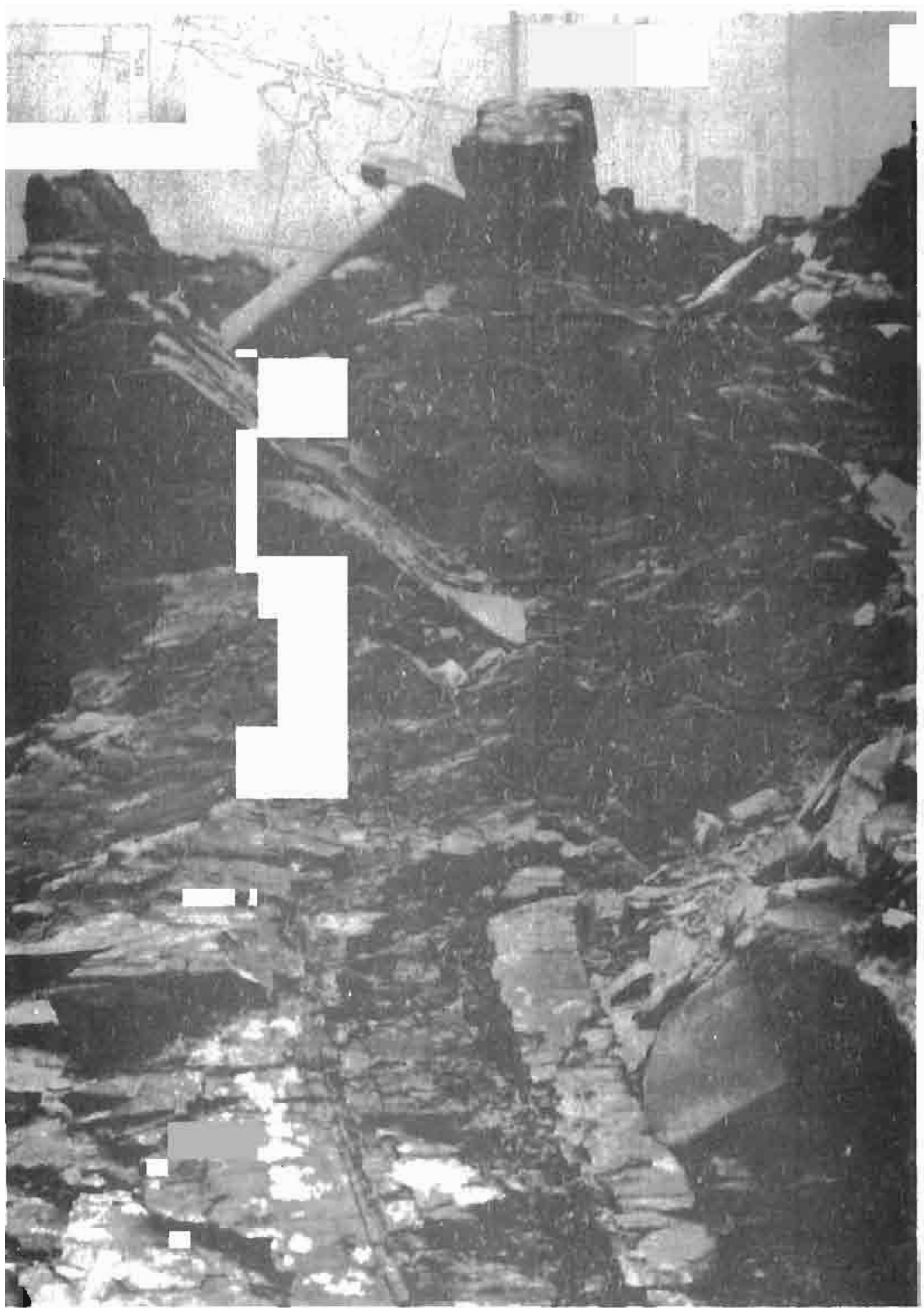
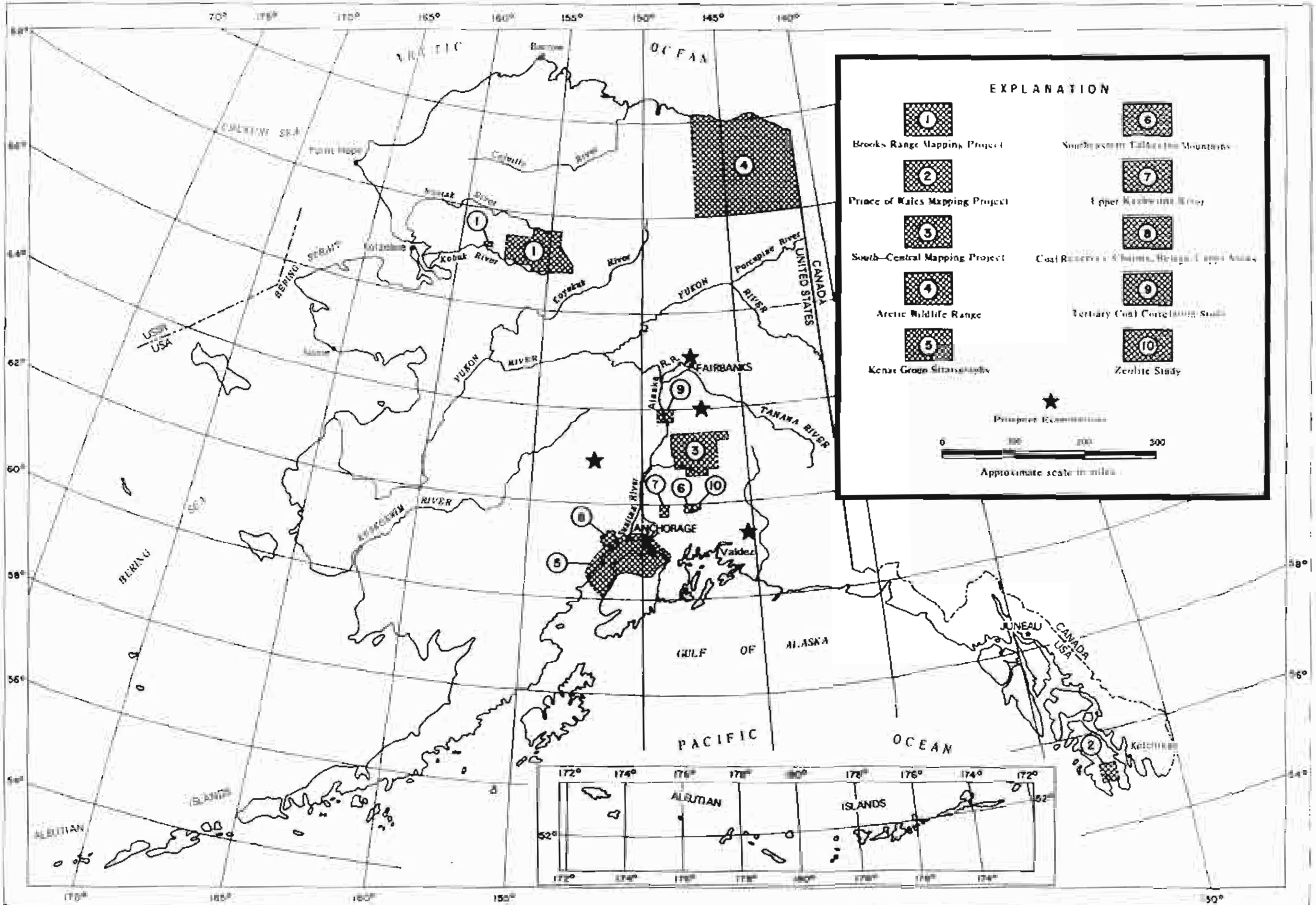
SECTION II





Field Studies by Division Personnel, 1972

Figure 2

1972 Geological and Geophysical Programs

Geology and Geochemistry of the Southeastern Ambler River Quadrangle

Field work in the southern Brooks Range during 1972 was part of a continuing program of geologic mapping and geochemical sampling between Walker Lake and the Jade Mountains. The project was initiated by C. E. "Jim" Fritts in 1971, as a logical extension from his previous work in the Cosmos Hills and Angayucham Mountains. R. E. Garland and G. R. Eakins assisted Fritts with the geologic mapping. In 1972, the project continued under the direction of Fritts until his death in a canoe accident, on July 4, 1972. Field work was resumed on July 13, 1972 by Garland, Eakins, and G. H. Pessel of the State Division of Oil and Gas. Field assistants in both 1971 and 1972 were J. M. Zdepski, W. S. Roberts, and J. T. Larson, all undergraduate geology students at the University of Alaska, Fairbanks. I. L. Tailleur of the U. S. Geological Survey worked with the field party for three weeks in July and August, 1972, and assisted with the geologic mapping. The project during the 1971 and 1972 field seasons was conducted with the aid of helicopter support. Hiller 12E and 12E4 models were used under a contract won by Merric, Inc., of Fairbanks.

The southeast quarter of the Ambler River quadrangle and a small part of the adjoining Survey Pass quadrangle were mapped at a scale of 1:63,360 (1 inch = 1 mile). (See fig. 2) Geologic mapping at the same scale was also done in the Jade Mountains. Reconnaissance stream sediment sampling for geochemical analysis was conducted throughout the mapped areas.

Structural and stratigraphic belts extend across the mapped area on an approximate NW–SE trend. See Fig. 3. The southernmost structural belt, the Kalurivik Arch, is a broad fold in a unit consisting mainly of quartz–mica schists. Other units in this belt include a varied assemblage of glaucophane–bearing schists, quartzites, porphyroblastic schists and tabulate intrusive(?) granitic rocks.

A complex synclinorium is separated from the Kalurivik Arch by the Walker Lake fault. Rock units within the synclinorium consist of chloritic quartzites, calcareous quartzites, calc–silicate schists, and thin discontinuous marbles.

The most prominent structural feature in the area is the Redstone–Shishakshinovik Arch, a broad complex uplift with a core of Cretaceous granites. The Redstone pluton, in the northwestern portion of the mapped area, intrudes a large mass of carbonate rocks presumed to be a part of the Skajit Limestone. The contact between the granite in the pluton and the carbonates is marked by a thin (less than 15 feet) skarn zone. To the east, near the headwaters of the Kogoluktuk River, the Shishakshinovik pluton intrudes a complex of metamorphic rocks, including schists, quartzites, and phyllites. This pluton is irregular in outline and the contact zone is lit–par–lit in many places. A contact aureole of varying thickness surrounds the pluton, and there are several roof pendants.

The Walker Lake Fault is a major structural feature in the area, and forms a boundary between two differing sequences of metamorphic rocks. The fault was mapped and named by C. E. Fritts in the vicinity of Walker Lake. It can be traced westward as far as Kalurivik Creek, in the Ambler River quadrangle. The fault either dies out in this vicinity, or the displacement is taken up along bedding planes, obscuring the structural discordance noted to the east.

North of the Redstone–Shishakshinovik Arch, the structure is characterized by flat thrust sheets of Devonian and Mississippian carbonates over schists, carbonates, and clastic rocks of probably Paleozoic age. Recumbent folds and bedding plane faults also are common. The thrust sheets are apparently part of the thrust sequences seen elsewhere in the Brooks Range, where displacements of 100 to 300 miles can be demonstrated.

A total of 450 stream sediment samples were collected during the 1972 field season. These were analyzed by the Division laboratory for copper, lead, and zinc. Preliminary examination of the results indicate that 96 of the samples were anomalous in one or more metals. The maximum values reported, in parts per million, were copper 740, lead 400, and zinc 1660. A definite trend of anomalous copper values was revealed in the "schist belt", the southernmost structural belt previously described. This zone of copper anomalies averages five miles wide for a distance of 30 miles in the Ambler River quadrangle. It can be followed 30 additional miles eastward into the Survey Pass quadrangle. Bear Creek Mining Company has several prospects along this zone.

A number of the stream sediment samples having anomalous values were collected from near the borders of the Shishakshinovik pluton. Scattered lead anomalies were found near the margins of the massive carbonates between the Shishakshinovik and Redstone intrusives.

Copper mineralization, occuring as malachite, azurite, and chalcopyrite, was found by the Division field party at several locations in or near the western part of the largest pluton. Hand samples from small occurrences of galena and molybdenite were collected in the same area. Also in the same area, a sericite schist boulder from a contact zone was found which contained thin coatings of metatorbernite (a uranium phosphate mineral) along cleavage planes. A hand specimen produced up to ten times the background count on a scintillometer.

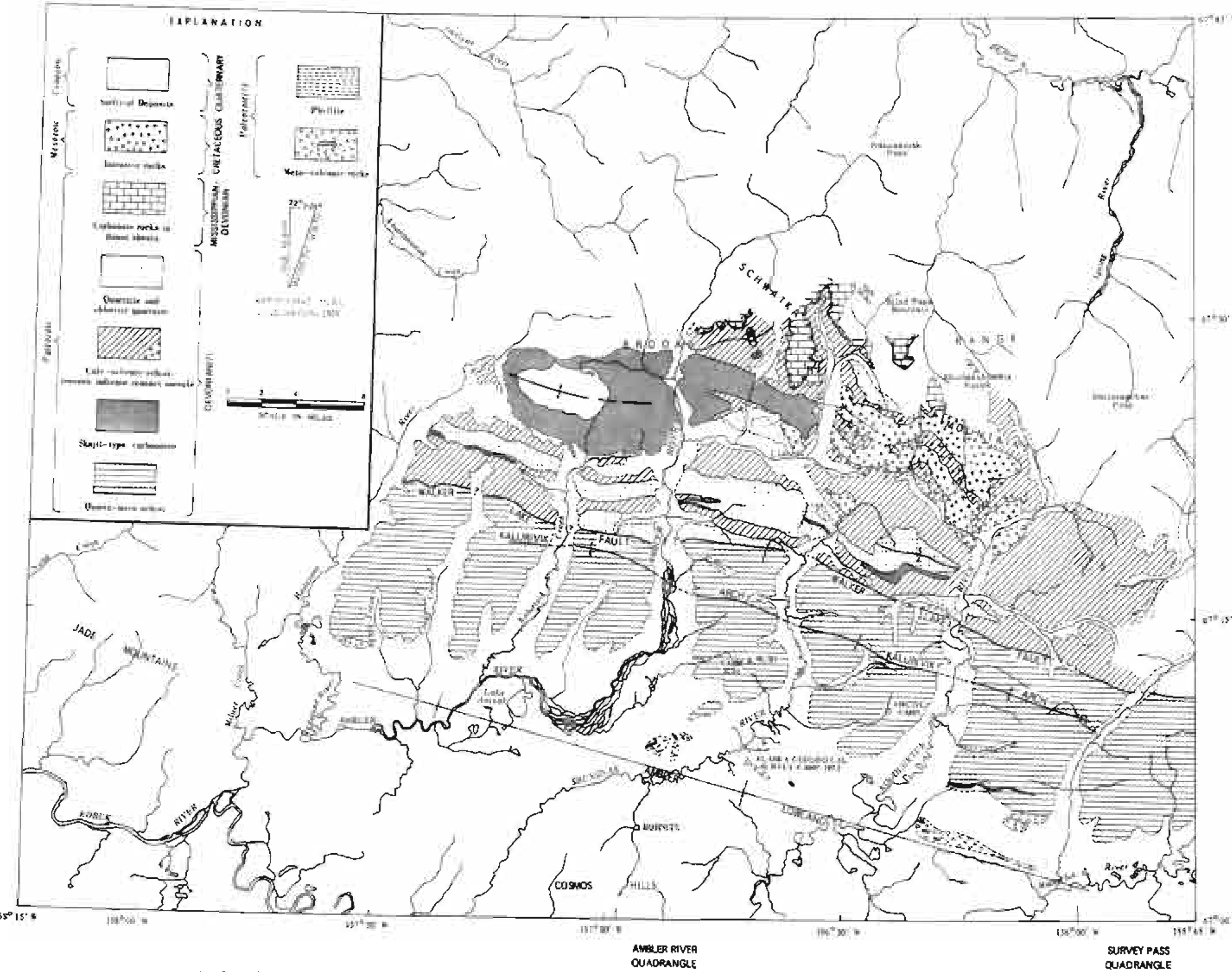
Analysis of the data collected during the 1972 field season is currently underway. This includes air photo interpretation, various geochemical analyses, mineral assay, petrographic evaluation, and geochronologic determinations. Fossils are extremely scarce throughout most of the project area and the age of many of the rock units is not well established. However, radiometric age determinations on suitable minerals in selected rocks from the various "belts" are in progress. D. L. Turner, of the University of Alaska Geophysical Institute, is performing the Potassium – Argon (K–Ar) age determinations on mineral separates prepared by T. Welsh, of this Division. R. B. Forbes, also of the Geophysical Institute, is assisting with the petrographic analysis of rock thin sections. Analysis of mineralized samples utilizing X–ray emission spectrometry and atomic absorption spectrophotometry techniques are being conducted in cooperation with the Division laboratory staff. It is expected that analysis of the data will be completed by late spring, 1973. A geologic report covering this work will then be published.

The Maclaren Metamorphic Belt, South–Central Alaska

Continued field work in South–Central Alaska by T. E. Smith and G. L. Kline during the 1972 season has resulted in geologic maps covering some 1200 square miles. This coverage spans the metamorphic terrane south of the Denali Fault between the Delta River in the Alaska Range and the Susitna River in the northern Talkeetna Mountains. Previous studies by Smith have resulted in detailed geologic maps of the Healy A–1 and Mt. Hayes A–6 quadrangles. Detailed work was continued into the Healy A–2 quadrangle last season, supported by a weasel on loan from the USGS and by fixed–wing aircraft. The remainder of the 1972 mapping was of a reconnaissance type, following the main geologic units into adjoining areas, utilizing helicopter support. Results of this work will be made available as reconnaissance geologic maps of all or parts of the Healy A–3, B–1; Mt. Hayes B–5, B–6; and Talkeetna Mountains D–2 quadrangles. Geochemical reports summarizing stream sediment sampling programs in the Healy A–2, Talkeetna D–2, and Mt. Hayes B–6 quadrangles will also be released when analytical data become available.

The mapping program has shown that the Maclaren metamorphic belt is continuous for over 80 miles between the Talkeetna Mountains and the Alaska Range, where it is apparently truncated by the McKinley strand of the Denali Fault[1]. The metamorphic belt consists mainly of

1 Stout, J. H., 1972, Regional metamorphism and structure along the Denali Fault, east–central Alaska Range [abs.]: Geol. Soc. America Abs. with Programs, v. 4, no. 7, p. 678



Simplified Bedrock Geologic Map, Brooks Range Project Area, Alaska, 1972

Figure 3

pelitic metasediments deposited in Jurassic time and regionally metamorphosed in Late Cretaceous time. It appears to be structurally separated on the northwest from feebly metamorphosed limestones, argillites, and volcanic rocks which may correlate with the Devonian section near Cantwell. The contact zone between the differing terranes is concealed beneath the West Fork Glacier and surficial deposits of Monahan Flat as far south as Brushkana Creek. Inasmuch as high grade metamorphic rocks of the Maclaren belt are unreported west of the Jack and Tsusena Rivers, the low grade sedimentary section to the west is interpreted as being thrust over the metamorphic terrane, thus terminating the Maclaren belt on the west.

Pelitic metasediments along the southern part of the Maclaren belt are also structurally separated from adjoining Triassic lavas of the Amphitheatre Group, an elongate terrane of tholeiitic basalts, basaltic andesites, and minor intercalated sediments which extends over 100 miles westward from Paxson Lake near the Richardson Highway to Watana Lake in the Talkeetna Mountains. The structural boundary between the Maclaren belt and Amphitheatre Group trends northeasterly up Watana Creek, through Butte Creek and Windy Creek valleys, and across prominent interdrainage divides between Clearwater Creek and the Maclaren Glacier. Where exposed over these divides, a complex fault zone as much as one-half mile wide with numerous subsidiary faults and fracture zones marks the discontinuity. Most of the rocks along this zone, regardless of relative mechanical integrity, have developed a schistose or slaty fabric and have since been heavily sheared. Some are silicified or otherwise hydrothermally altered. Many of the well known copper occurrences of the region cluster along this tectonic zone for a distance of over 30 miles. The eastern extremity of the zone, not yet mapped in detail, appears to pass into the Broxson Gulch thrust fault system in the area near Eureka Creek[2].

Internal zoning across the Maclaren metamorphic belt and also along its length, observable in index mineralogy and degree of textural advancement, provides a three-dimensional view of pressure(P) – temperature(T) conditions during progressive metamorphism. Previous studies by Smith[3] have emphasized the remarkably complete high P – high T facies series from pumpellyite-bearing argillite to kyanite-sillimanite gneisses exposed in the Clearwater Mountains. Stout[4] has shown that the pelitic metasediments of highest grade near the Delta River contain the mineral assemblage, andalusite-sillimanite, indicative of a low to intermediate P – high T facies series. This may be interpreted as a pressure transition across the Al_2SiO_5 triplepoint, with the deeper or higher pressure segment of the belt being exposed at the southwest end.

The plutonic rocks found along the Maclaren belt may be conveniently divided by age and chemistry into three dissimilar magmatic series. An intermediate magmatic series of Late Cretaceous age comprises most of the larger intrusive bodies. A small alkali gabbro stock of Late Jurassic age and a felsic intrusive series consisting of porphyritic granites and equivalent(?) extrusives of possible mid-Tertiary age form less extensive bodies. Most rocks of the intermediate series are well foliated or contain contorted compositional layering suggestive of a paragneiss origin. These portions of the metamorphic terrane were apparently very near the igneous-metamorphic boundary and gave rise to zones of near-molten material that was subsequently autointruded into less mobile areas.

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2 Rose, A. W., 1966, *Geological and geochemical investigations in the Eureka and Rainy Creek areas, Mt. Hayes Quadrangle, Alaska*: Alaska Div. Mines and Minerals Geol. Rept. 20, 36 p.
3 Smith, T. E., 1971, Geology, economic geochemistry, and placer gold resources of the Western Clearwater Mountains, east-central Alaska: Dissert. Abs., v. 32, no. 3
4 Stout, J. H., 1965, Bedrock geology between Rainy Creek and the Denali Fault, eastern Alaska Range: M. S. Thesis, Univ. of Alaska, 75 p.

Prince of Wales Island, Southeastern Alaska

Field mapping during the past three years in the Craig A–2 quadrangle by Gordon Herreid, assisted by J. G. Pray and T. K. Bundtzen has disclosed many of the geological details of this well mineralized region. D. L. Turner spent several days in the field, during 1972, collecting potassium–argon (K–Ar) age dating samples.

In the 290 square miles underlain by Wales Group rocks and associated granitoid intrusives, at least 70 mineral deposits are known from early day prospecting. The richest of the known deposits are small contact metamorphic copper lodes near gabbroic through syenitic intrusives in the Copper Mountain district. However, most of the known mineral deposits in the region are small vein occurrences distant from these large granitoid bodies. These veins carry gold, copper, lead and zinc. Some have been mined for gold and copper. The entire area is favorable for the discovery of new deposits.

Schist and interlayered marble on southern Prince of Wales Island have long been considered to be the oldest rocks in the area and have been named the Wales Group. These rocks are interbedded keratophyre tuff, volcanic mudstone, mixtures between the two, and other rocks that have undergone low grade metamorphism and deformation that included at least two periods of folding. Near Eek Inlet, Wales Group green schist grades into the overlying volcanic mudstone of the Descon Formation by a gradual lessening of: (1) penetrative deformation caused by the two foldings and, (2) the percentage of keratophyre tuff beds. Donald Eberlein (personal communication, June 1972) believes, on the basis of faunal evidence, that the Descon in this area is probably of Middle or Upper Ordovician age. This would imply that the Wales should be considered pre–Middle Ordovician(?) in age.

During 1972, actinolite–bearing samples were collected in the Eek area from the Wales Group and from the base of the Descon by D. L. Turner. K–Ar ages of these samples should give significant information on the age of regional metamorphism in this area.

On Klakas Inlet probable Descon Formation rocks consist of conglomeratic graywacke and argillite, overlain by thinly laminated mudstone, overlain by metabasalt. The whole section is several thousand feet thick, right side up, and dips moderately to the southwest. The section is unconformably overlain by dark mudstone, graywacke, arkose, and andesitic breccia dated in its lower portion as Early Devonian by Churkin and others[5]. Granitoid rocks, intrusive into the metabasalt at Max Cove, have shed large boulders into the conglomerate at the base of the Lower Devonian rocks. Similar granitoids have been dated as latest Ordovician (about 440 m.y.) by the K–Ar method at Kendrick Bay, 12 miles to the east. It seems likely that the intrusive rocks at Max Cove are Late Ordovician and the metabasalt is pre–Late Ordovician.

The intrusives around Max Cove range from albite granite to albite–hornblende diorite, typically with altered plagioclase. Samples collected for K–Ar dating in 1972 will probably yield minimum ages due to mineral alteration. One mile west of Max Cove the Lower Devonian mudstone is cut by Mesozoic(?) diorite plutons. A scattering of Mesozoic(?) plutons extends northwest toward Copper Mountain. These intrude both Devonian and older rocks.

The intrusives at Copper Mountain range from gabbro to granodiorite to syenite and are unaltered. The body at Hetta Lake has been dated by the K–Ar method at 103.1 ± 3.1 m.y. for biotite (D. L. Turner, personal communication).

A major normal(?) fault of irregular northeasterly strike separates the Descon(?) at Klakas Inlet from the Wales terrane. This fault is offset left–laterally about 1.6 miles by the nearly vertical

5 Churkin, Michael, Jr.; Jaeger, Herman; Eberlein, G. C., 1970, Lower Devonian graptolites from southeastern Alaska: Lethaia, v. 3, no. 2, p. 183–202

northerly–trending Klakas Inlet fault (new name), which extends along Klakas Inlet and the South Arm of Cholmondeley Sound. To the north, this fault is cut off by a major fault that extends along the West Arm of Cholmondeley Sound and Hetta Inlet. This fault is offset right–laterally by a northwest–trending fault at the head of West Arm. Along the South Arm of Cholmondeley Sound other faults that parallel this one are bounded by a silicified zone more than one square mile in area. Both on a large scale and on smaller scales the map area is a complex shuffle of fault blocks bounded by high angle faults of widely differing orientations.

Along Hetta Inlet, the Corbin and Copper City copper mines are on north–trending faults. Along the South Arm of Cholmondeley Sound, there are old prospects in a wide zone of silicification and pyritization associated with the northwest–trending faults mentioned above.

Stream–sediment sampling in the mapped area permits evaluation of the ore potential of the various geological features. The Copper Mountain plutons are marked by strong copper anom–alies[6].

The fault controlled mineralized zone along the South Arm of Cholmondeley Sound, is marked by zinc and lead rock–chip and stream–sediment anomalies. The intrusives east and west of Klakas Inlet in the vicinity of Max Cove are marked by scattered zinc anomalies in the stream sediments.

Cook Inlet Report Published

D. C. Hartman, G. H. Pessel, and D. L. McGee recently prepared and published Special Re–port No. 5, "Preliminary Report on Stratigraphy of Kenai Group, Upper Cook Inlet, Alaska," in July 1972. The study involves detailed correlations of surface and subsurface expressions of each of the six formations of the Tertiary Kenai Group in the Cook Inlet Basin. Included is a brief text, isopachous maps on each formation, a sand–shale percentage map of the Tyonek formation, and a set of four stratigraphic cross–sections in the northeastern part of the Kenai Peninsula. The study suggests a predominating influx of sediments from the north, outlines a structural and sedimentary history of basin development, and suggests guides to future oil and gas exploration.

Arctic Wildlife Range Minerals Noted

At the request of the U. S. Fish and Wildlife Service, D. C. Hartman submitted a report and geologic map of the Arctic Wildlife Range in northeastern Alaska as a part of the USF&W pro–posal to convert the Range to a wilderness area. The map, at a scale of 1:500,000 (1"= 8 miles), shows the presently known regional geology with outlines of potentially important mineral occurrences which include the following:

(1) Marsh Creek anticline, adjacent to Camden Bay, is a major structure in marine Tertiary rocks which contain some oil stains at the surface. Assuming a length of 20 to 46 miles and a width of two miles, potential oil reserves could amount to as much as 20 billion barrels in this field, comparable in size to Prudhoe Bay.

(2) The Romanzof Granite has intruded an area of about 200 square miles between the Hula–hula and Jago rivers in the northern Brooks Range. Due to extreme ruggedness and snow cover, the granite has never been examined in detail, but altered zones along the granite margin contain minor metallic sulfides. Stream sediment samples from the granitic area contain significant amounts of copper, lead, zinc, mercury, tin, beryllium, antimony, and nickel.

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6 Herreid, Gordon, 1971, Analyses of rock and stream–sediment samples, Hetta Inlet Area, Prince of Wales Island, Craig quadrangle, Alaska: Alaska Div. of Geological Survey, Geochemical Report No. 24

(3) Bear Mountain, in the southern part of the Range, just east of the Coleen River, is a 100 square–mile area with mineralized quartz veins and greenstone sills associated with a granite–rhyolite intrusive body. Only minor prospecting has been done here, but metallic sulfides are known to be present, and geochemical sediment and rock samples show high amounts of copper, lead, zinc, silver, beryllium, and niobium.

(4) West of Bear Mountain, at Double Mountain on the Sheenjek River, a rock sample from a mafic intrusive area contains abnormally high amounts of copper, lead, gold, and silver. No serious prospecting is known to have been done in the vicinity. A number of other mafic intrusive bodies have been mapped in the southern part of the Range, but no systematic study of them has been made.

(5) Nonmetallic minerals seem to be limited to extensive medium–grade phosphatic deposits in black shales of the Shublik formation, which crops out across the northern Brooks Range.

Mapping Commenced in Southeastern Talkeetna Mountains

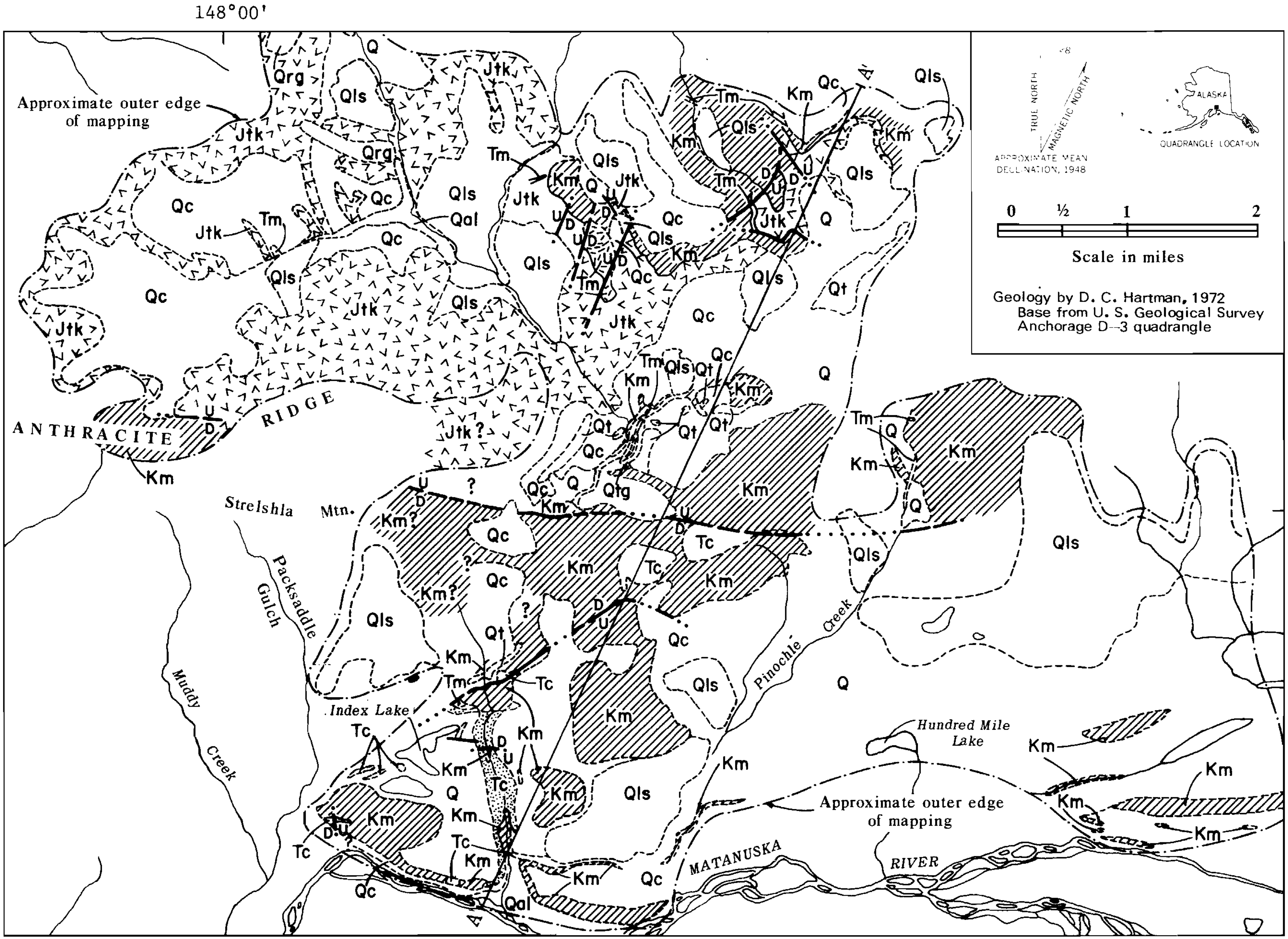
Beginning in late July, about 25 days were spent in reconnaissance and in detailed, (scale: 1 inch = 1 mile), geologic mapping of about 21 square miles in the Hicks Creek area of the Anchorage D–3 quadrangle by Hartman, assisted by T. R. Ottley. Initial work was by car along the Glenn Highway, and the final two weeks were from tent camps with limited helicopter support. Three days were spent with R. W. Imlay and R. L. Detterman in sampling USGS fossil localities in the vicinity. The mapped area covers the southern edge of the Talkeetna Mountains, a rugged area with a relief of more than 5000 feet (see fig. 4).

The oldest rocks exposed are about 3,000 feet of thick–bedded marine volcanics and minor sediments of the Talkeetna formation, bearing fossils of early Jurassic age. At least 4,000 feet of Late Cretaceous marine shales and sandstones of the Matanuska formation overlie the Talkeetna formation with a slight angular discordance. The early Tertiary Chickaloon formation, about 500 feet thick in this area, overlies the Matanuska rocks with a pronounced erosional and angular unconformity. Subsequent faulting, intrusion of mafic dikes, sills, and small stocks, and modification by erosion, glaciation, and extensive landslides have produced the present outcrop distributions as shown in figure 4.

No occurrences of economic minerals were noted. Small concentrations of pink zeolites, probably laumontite, were found in agglomerates of the Talkeetna formation, but as yet no commercial use for laumontite is known.

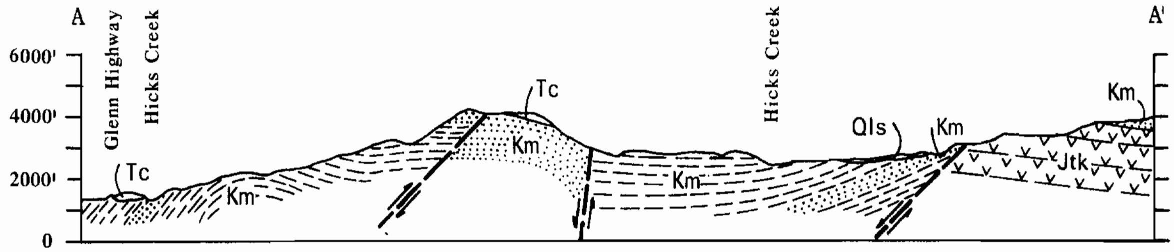
The Upper Kashwitna River, Anchorage Quadrangle

A part of the Anchorage D–6 quadrangle was mapped by D. L. McGee, assisted by Mitch Henning, during the first week of September, 1972. The area is east of Bartholf Creek which drains into the Kashwitna River and consists essentially of the north quarter of T. 21 N., R. 3 E., and the south quarter of T. 22 N., R. 3 E. (see fig. 5). Mapping was on a scale of 1:63,360 (1 inch = 1 mile) and is a combination of photogeology and surface traverses from a base camp. Access to the area was by chartered helicopter.



Preliminary Geology of Lower Hicks Creek, Anchorage Quadrangle, Alaska

Figure 4



EXPLANATION TO FIGURE 4

Qal	Qrg
Qls	Qt
Qc	Q

Qal, *Recent alluvial sediments*
Qls, *Landslide debris*
Qc, *Colluvial deposits, includes talus slopes and soils*
Qrg, *Rock glaciers*
Qt, *Quaternary terrace deposits*
Q, *Undifferentiated deposits, including glacial*

QUATERNARY

Unconformity

Tm

mafic and related dikes, sills and stocks

Tc

Chickaloon formation; sandstone, mudstone, siltstone and coal. Plant fossils.

TERTIARY

Late Cretaceous

Unconformity

Km

Matanuska formation: mudstone, siltstone, shale and sandstone, with concretions and marine fossils

Early Jurassic

Unconformity

Jtk

Talkeetna formation: massive agglomerate, tuff, few thin shales. Marine fossils.

MESOZOIC

Contact
dashed where alluvial or approximate

U
D
Fault
dashed where approximate, dotted where concealed. D on downthrown side.

The predominant rock type in the mapped area is a medium-grained light gray quartz diorite. Gneissic texture is locally developed and most prevalent in finer grained rock. Pegmatite and aplite dikes are common and generally parallel the most prominent joint system which strikes approximately 140°. The age of the Talkeetna batholith was considered by Paige and Knopf[7] and Capps[8] as middle Jurassic. Smith[9] considered that some of the intrusive rocks in the Talkeetna Mountains may be as young as late Cretaceous.

Mapping has included a part of the contact between the quartz diorite and a zone of ultramafic rocks. The extent and geometry of this zone is unknown. Samples of the ultramafic rock collected near the contact were examined macroscopically and, in fresh hand samples, are fine grained, dark gray and dense with visible olivine crystals. Microscopic examination indicated that the rock is predominantly olivine with the alteration minerals antigorite and chrysotile.

Only one sample (sample location number 27) was obtained from the east side of the Kashwitna River. This sample is an altered quartz diorite with abundant sericite and chlorite.

Cross-section AA' (see fig. 5) shows the apparent relationship of the ultramafic rocks to the unaltered quartz diorite west of the ultramafic zone and the altered quartz diorite east of the Kashwitna River.

Float containing pyrite and minor chalcopyrite were found on the Kashwitna River flood plain below the major stream forks. Minor copper staining and samples of float containing chalcopyrite were collected near sample location 13b (fig. 5) near an east-west trending fault. Thin quartz veins containing scattered sulfides, predominantly pyrite and chalcopyrite, were examined near sample location 20 (fig. 5).

Kodiak Island Minerals Report

A study and compilation of the geology and mineral resources of Kodiak Island was completed by D. L. McGee during 1972. This report was written following the proposal to create a wilderness area that includes most of Kodiak Island. This study consists of a geologic map showing all known mineral deposits and claims. The text summarizes existing literature and concludes that much of the area has not been adequately explored for minerals and that relatively favorable conditions for ore deposition exist around the centrally located igneous bodies.

Coal Reserves Study, Beluga, Chuitna Rivers, and Capps Glacier Areas

This literature study outlines the major known coal reserves of the Beluga and Chuitna River drainages and the area south of Capps Glacier, Alaska. The area covered by this investigation, about 468 square miles, is that area between the Beluga River and Nikolai Creek bounded on the north by Beluga Lake and on the south by the northwest shoreline of Cook Inlet. The report by D. L. McGee consists of a geologic map with known coal outcrops and five cross-sections drawn to aid in determining the reserves of strippable coal. The reserves are within a few percentage points of those previously determined by the United States Geological Survey and approach 2.3 billion tons of strippable coal.

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7 Paige, Sidney, and Knopf, Adolph, 1907, Geologic reconnaissance in the Matanuska and Talkeetna Basins, Alaska: U. S. Geol. Survey Bull. 327, 71 p.
8 Capps, S. R., 1915, The Willow Creek district, Alaska: U. S. Geol. Survey Bull. 607, 86 p.
9 Smith, P. S., 1939, Areal geology of Alaska: U. S. Geol. Survey Prof. Paper 192, 100 p.

Aeromagnetic Survey Program

Aeromagnetic surveys by the State of Alaska are managed by Norman Veach, Division geophysicist, under the direction and supervision of the Commissioner, Charles F. Herbert, and the State Geologist, William C. Fackler. The work is supported by appropriations of the State Legislature as part of the budget of the Department of Natrual Resources. The amount made available in July 1, 1970 was $500,000, and on July 1, 1971 was $100,000. The work is contracted by competitive bidding to established companies in the aeromagnetic survey business. The contracting company flies the survey, compiles the data, and prints the final maps of magnetic contours on detailed base maps. The contract amount of the 1971 work was $398,000 and of the 1972 work was $193,000.

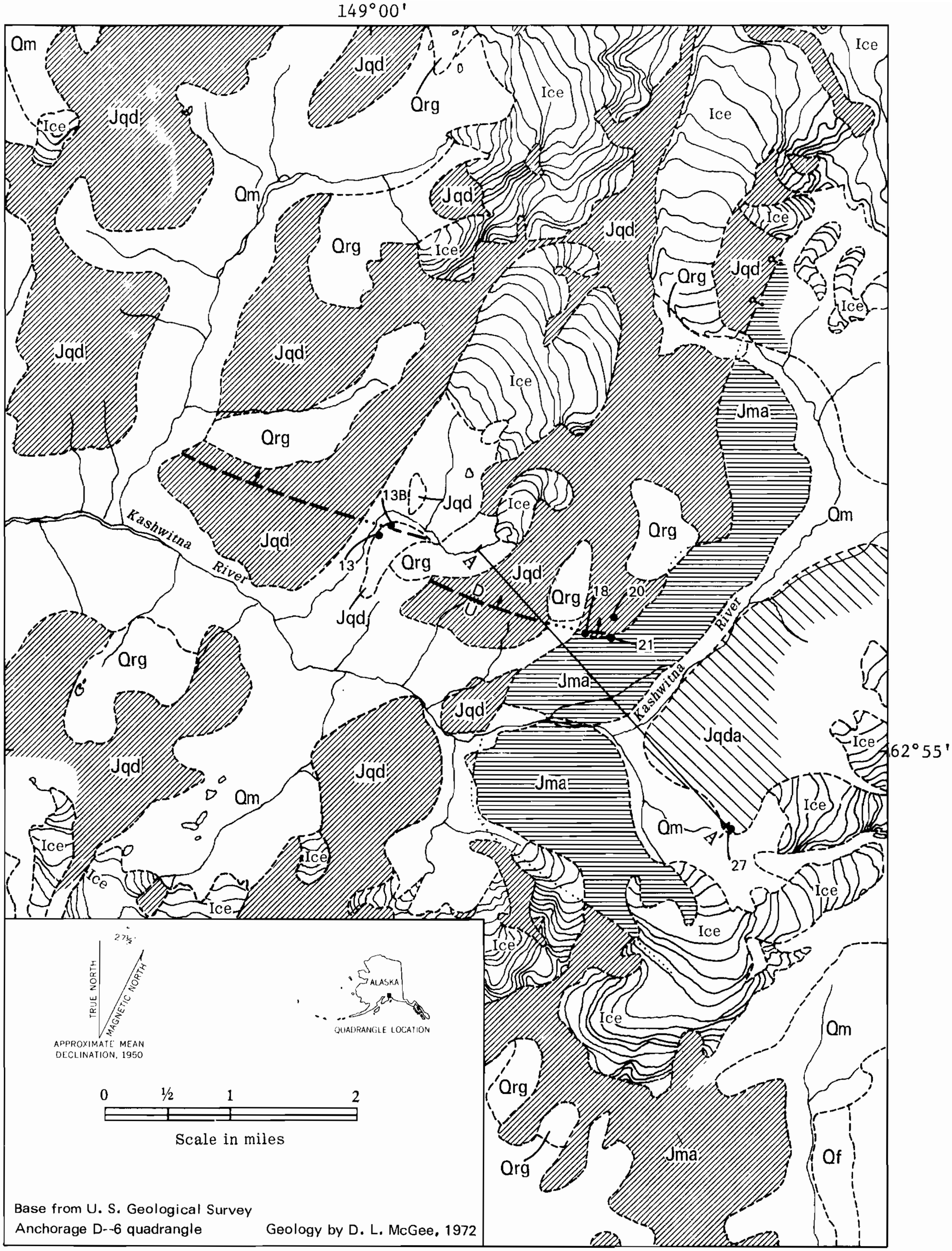
The areas for survey are selected by the Commissioner, the State Geologist, and the Geophysicist. Area selections are based on the need for the geophysical information to add to basic geologic knowledge and to encourage additional orderly planned development of Alaska's natural resources. Magnetic surveys by others have shown that the value of mineral discoveries following a magnetic survey far exceed the relatively small cost of the survey.

The completed maps at a scale of 1:63,360 (1 inch= 1 mile) of the magnetic contours are placed on sale at an announced time at the College office. Money received from the map sales goes into the general treasury of the State. Composite maps at a scale of 1:250,000 (1 inch= 4 miles) are placed on open file at our College, Anchorage, Juneau, and Ketchikan offices. Sales of maps produce a small amount of revenue to the State. About 10,000 sheets at one dollar were sold from the 1971 survey. The return to the State on the investment is expected in future development of mineral and surface resources, and in the form of benefits to land use planning teams.

The airborne data system consists of a continuously recording magnetometer, a continuously recording radar altimeter, a recording camera and a recording timer. In addition a magnetic recording ground station was established and maintained near the survey area at a location approved by the State.

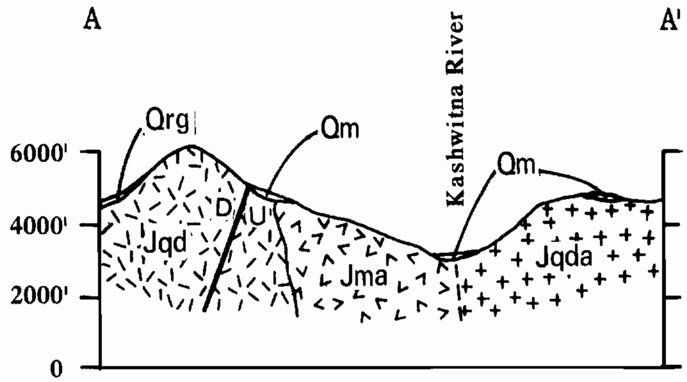
Flight line spacing is three–fourths mile. Flight altitude is 1000 feet above ground level. Flight line directions are selected by the State and indicated on the invitation–to–bid as "N–S" or "E–W". Control lines roughly perpendicular to flight lines are required approximately every seventeen miles. Positioning of the control lines is selected by the contractor to be in areas of low magnetic gradient.

Data and flight records in chart form are available for inspection by the Division immediately after completion of the flight. Photographs of aircraft track are made available within seven days after the flight first recorded on each roll of film. The location at which flight records and photographs are made available is subject to approval by the Division. The raw data records are identified and clearly marked with identification of the survey flight line, direction of the flight, instrument ranges, locations, data, and initials of the equipment operator. At least once each hour of flight the time of day is entered on the airborne magnetometer recording. Timing marks are recorded on the magnetometer recording for time correlation with the records of the magnetic ground station. The time of day to the nearest minute is recorded each time the airborne magnetometer recorder is turned on or off. Where spacing between adjacent lines is greater than 1½ times the specified spacing, these gaps must be filled at contractor's expense unless permission is given otherwise by the Division. Clouds, ground fog, darkness, or other factors which prevent obtaining good clear photos for determining aircraft track are cause for rejection of data.



Preliminary Geology of Upper Kashwitna River, Anchorage Quadrangle, Alaska

Figure 5



EXPLANATION OF FIGURE 5

QUATERNARY

Qm
Morainal deposits

Qrg
Rock glacier

Qf
Alluvial fan deposit

JURASSIC & CRETACEOUS(?)

Jma
Ultramafic rocks

Jqd
Quartz diorite

Jqda
Altered quartz diorite

Contact

Long dashed where approximately located, short dashed where inferred or interpreted from aerial photographs, dotted where concealed.

U
D
Fault

Long dashed where approximately located, short dashed where inferred or interpreted from aerial photographs, dotted where concealed. D on downthrown side. Attitude shown where known.

Selected samples

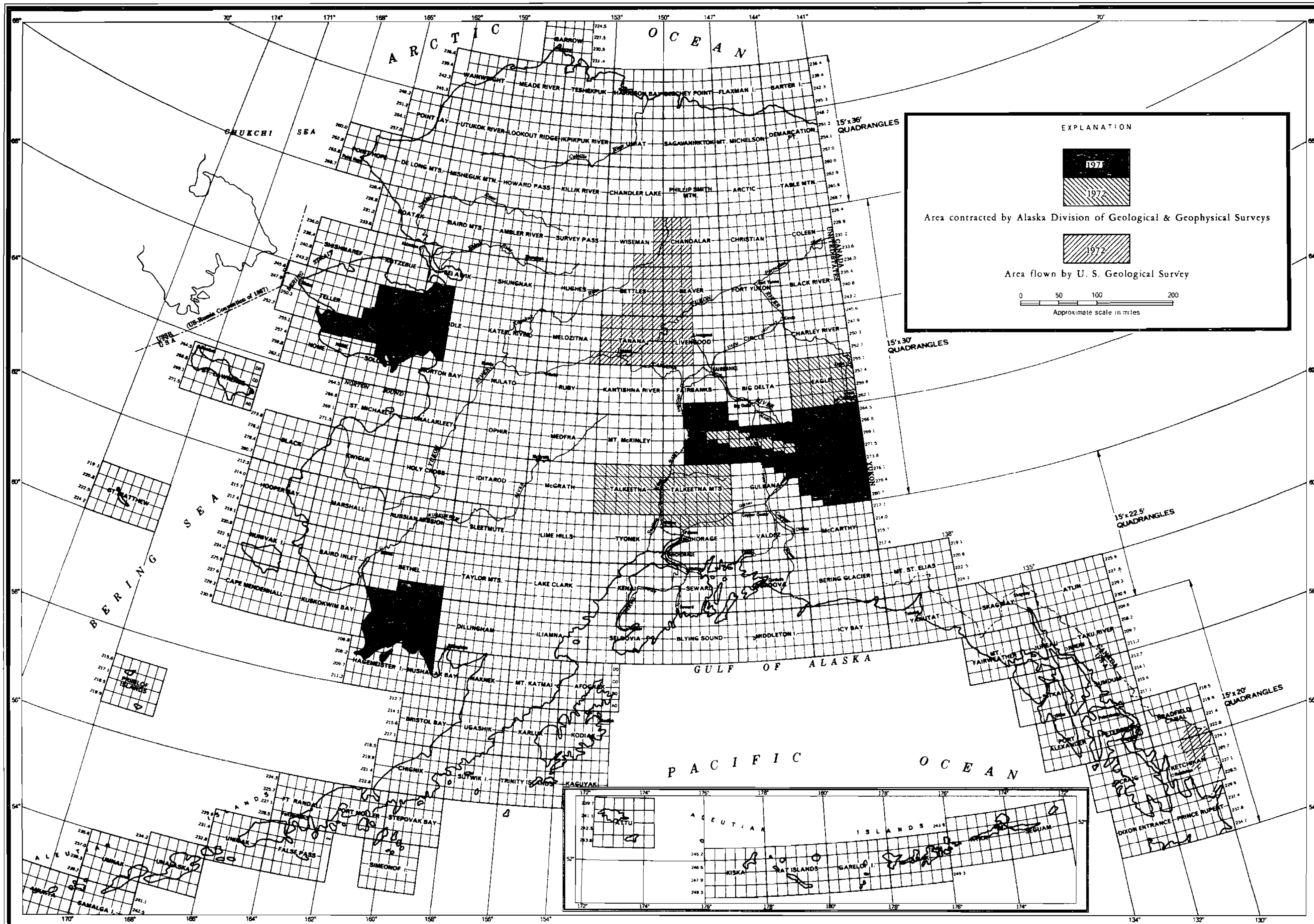
The ground station magnetometer operation and recording are required for this contract only when survey flight lines are flown or magnetometer testing is required for the performance of the contract. Once each calendar day that survey flight lines are flown the magnetometer ground station chart is marked with the instrument range, time of day, date, and initials of the observer. Before and after each days flying, the time of the ground station clock is checked with the clock in each aircraft and the time of day, aircraft identification, and operator's initials recorded. Data recorded during periods of excessive diurnal variation is rejected and must be reflown at the contractor's expense. For the portion of a line between two control lines, or between a control line and the boundary of the survey, the maximum deviation of the diurnal record from the best straight line does not exceed ± 20 gammas. The State also obtains daily records of magnetic change from the U. S. Coast and Geodedic Survey Magnetic Observatory in College. The information from these daily magnetograms is compared with the contractor data in evaluating daily magnetic changes (diurnal variation) and magnetic storms which affect the survey records.

The magnetic contours referred to are lines of equal total magnetic field intensity in gammas. The data from the airborne magnetometer are corrected by removing the diurnal variation, before compiling, and by removing a standard regional field. Contour lines are identified in accordance with good mapping practice. Hachures are used on contour lines to indicate closed areas of lower magnetic intensity. The contour interval is 10 gammas. Ten–gamma contours are shown as dotted lines, twenty–gamma contours as dashed lines, one hundred–gamma contours as heavier solid lines, and five hundred–gamma contour as still heavier solid lines. Flight lines are shown as light solid lines. Every fifth flight line is numbered to facilitate identification. Direction of each flight is indicated. Each flight line or segment of a flight line is identified. Spot values of magnetic highs and lows are shown within closed contours in small letters. Tracking film frame number or other fiducial identification are shown at two places on each flight line, near the map boundaries.

In addition to other material required in the 1972 contract, the contractor furnishes digital magnetic tapes of the survey data. The nine track tapes contain edited data, formatted and blocked, in which each file contains residual total magnetic field and such other information as the contractor believes necessary for computerized data processing. The method selected by the contractor (and approved by the State for the 1972 contract) for digitizing the information is to draw a grid on the completed maps with three–eighths mile grid spacing. The values of magnetic intensities at the grid line intersections are then punched on computer cards and recorded on magnetic tape.

The contractor for the 1972 work was also the successful bidder for the 1971 work, Lockwood, Kessler and Bartlett. The 1972 bid price of $8.27 per square mile was only 2¢ per square mile under the next lowest bid. Figure 7 shows how bid prices vary with the size of the survey.

The State of Alaska 1971 Aeromagnetic Survey was a cooperative program with the USGS. Don Mabey and John Henderson, USGS, assisted in the formulation of the program, writing specifications, and in evaluating the bids. Magnetic intensity contour lines are overprinted on USGS topographic maps. Mylar reproducibles of the 1:250,000 composites are given to the USGS for use in their regional mapping program. In the summer of 1972 the State continued surveying in the East Alaska Range area and the USGS contracted with Aero Services Company for survey in the Brooks Range area northwest of Fairbanks, and in a small area of Southeast Alaska known as the Granite Fiords area (fig. 6). It is possible that the 1 inch = 1 mile maps from this 1972 USGS survey will be distributed by the State for the convenience of customers who already ordered 1 inch = 1 mile maps from the College office of the State Division of Geological and Geophysical Surveys.



Recent Aeromagnetic Surveys by State of Alaska and U. S. Geological Survey

Figure 6

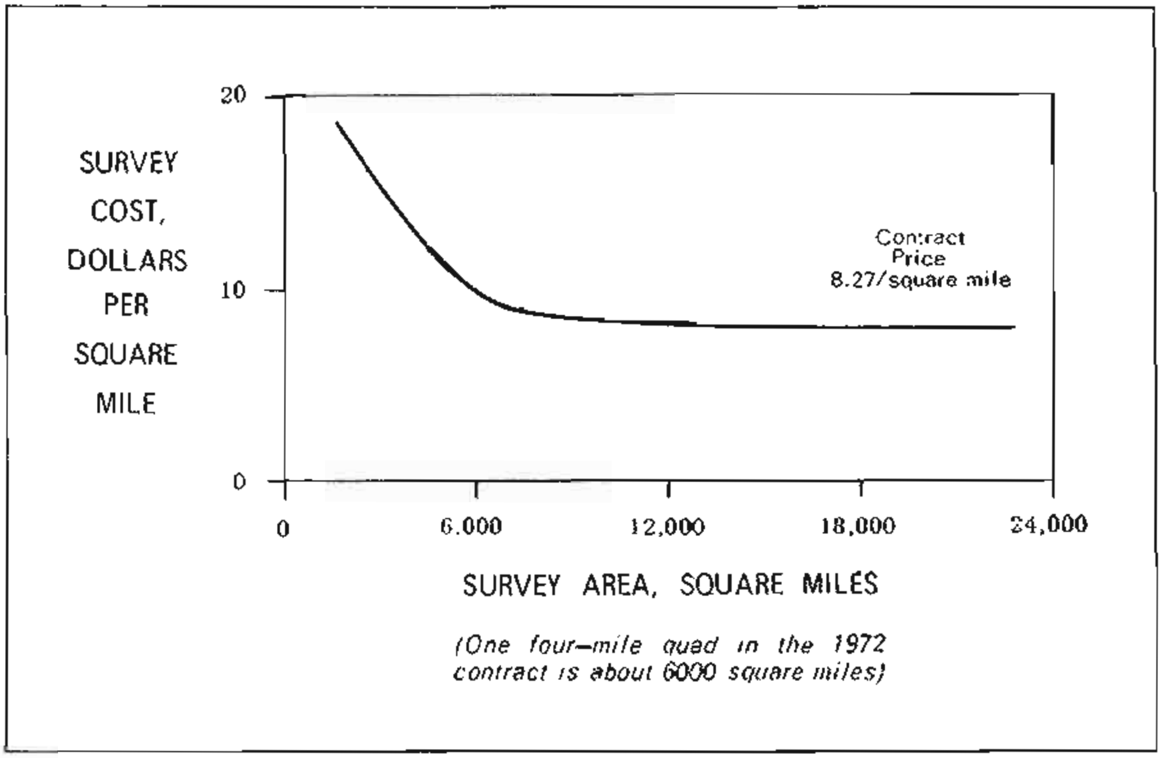


Figure 7. The 1972 bid price decreased with the increasing contract price.

Aero Commander aircraft used by LKB for the 1972 Aeromagnetic Survey program.

Cooperative Programs

The Alaska Division of Geological and Geophysical Surveys and the United States Geological Survey have three cooperative projects financed by state–federal funds on a 50–50 matching basis.

Cook Inlet Stratigraphic Study

The objective of this project is detailed study of the stratigraphy and petroleum potential of the Cook Inlet basin to aid in the evaluation of unexplored lands and stimulate exploration of the area. The study, under the direction of J. C. Maher, is in the second year of a probable four or five year effort.

Products of this project to date are:

(1) Correlation of subsurface Tertiary rocks, Cook Inlet, Alaska, by R. D. Carter and W. L. Adkison, July 1972, USGS open file report.
(2) Geological Literature on the Cook Inlet Basin and Vicinity, Alaska, by J. C. Maher, and W. M. Trollman, 1969.
(3) Geological Literature on the Gulf and Southeastern Coastal Regions of Alaska, by J. C. Maher, 1971.
(4) Geological Literature on the Alaska Peninsula and Adjacent Areas, by J. S. Kelley and J. M. Denman. (in press)

During the 1972 field season, W. L. Adkison, J. S. Kelley, and J. M. Denman conducted detailed stratigraphic studies and sampling of the Tertiary outcrops on the southern part of the Kenai Peninsula from Clam Gulch to Fox River.

Gravity Map of Alaska

During previous years the United States Geological Survey has made approximately 19,000 gravity observations throughout Alaska. Several large areas remained unworked and it was estimated that about 7,000 additional stations would furnish sufficient control to complete a gravity map of Alaska at scales of 1:2,500,000 and 1:1,000,000.

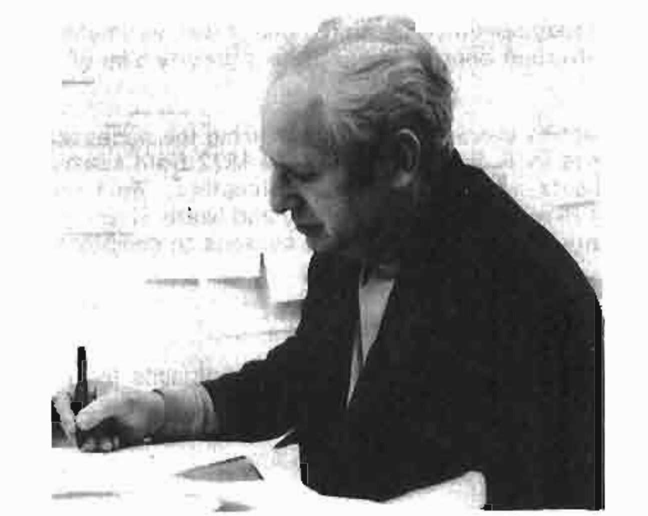
The Division entered into a cooperative contract to share the cost of acquiring the necessary data to complete the gravity map. The project leader is D. F. Barnes. During the 1972 field season about 3,000 field observations were made using boats, small planes, and helicopters. Work was done in portions of southeastern Alaska, Copper River area, Brooks Range, and North Slope of Alaska. It is estimated that the project will require one or two more field seasons to complete.

Geology of Alaska

During 1972, a new cooperative contract was made to produce a manuscript and maps for a proposed one volume summary of the geology of Alaska.

For many years Alaskan geologists have realized the desirability of a summary of the geologic knowledge of Alaska in a single source book. Presently the information is contained in hundreds of separate bulletins, books, periodicals, maps and so forth, many of which are out of print and difficult to obtain. The advantage of a synthesis of all this knowledge in one source with appropriate revised maps, all reflecting the latest geologic interpretations, is obvious.

The vast size and difficult logistics of Alaska have made the acquisition of geologic data a slow and costly process. Prior to this time a scarcity of geologic information in substantial portions of Alaska rendered such a project impractical. Increased exploration activity, use of helicopters and airborne techniques by Federal, State and industry explorationists, has resulted in the addition of a large body of geological knowledge of Alaska. With the belief that this is the most opportune time for this undertaking, the Division and the Branch of Alaskan Geology, USGS, have initiated a joint project to produce a synthesis of the geology of Alaska. A manuscript is scheduled for completion in three to four years. Maps produced as part of the project will be released without delay to the public as they are completed. They will also be included in the final product to make a complete package.



Anchorage office Division members include: William L. Lyle, Stratigrapher (lower left), Donald L. McGee, Petroleum Geologist (upper left), and Donald C. Hartman, Petroleum Geologist (above).

Contractual Programs

Geochronology Laboratory

Scientific liaison has increased significantly during the past year between Division geologists and earth scientists of the Geophysical Institute at the University of Alaska. This has resulted in the development of a number of new cooperative projects aimed at best utilizing existing facilities of both groups. Among these is a geochronology program utilizing the facilities and staff of the new Geochronology Laboratory at the Geophysical Institute.

In discussions with Division geologists over the past year, it became apparent that our new dating capability could be of considerable value to several ongoing Division geological projects. It was also apparent that some of the geochronological investigations could provide data useful to present and future Division projects and programs. Accordingly, the following joint programs of sampling for K–Ar and fission track dating were carried out this summer using Division logistic support.

Division participation in the laboratory work on these samples, during the winter, included the employment of a part–time minerals technician, the loan of a Frantz magnetic separator, funds for thin sectioning and expendable laboratory supplies.

Prince of Wales Island

The objectives of the Wales Project are discussed elsewhere in this report. During 1972, Turner spent several days in the field with Gordon Herreid obtaining dating samples. Several samples of actinolite–bearing greenschist from the Wales Group and Descon Formation have been determined to be datable by subsequent petrographic study. These samples should allow us to place a date on the regional metamorphism in the area.

Numerous intrusive bodies were also sampled and will be dated this winter. One of these, the body at Hetta Lake has just been dated at 1.03.1 ± 3.1 m.y. on hornblende and 105±3.1 m.y. on biotite from the same sample.

South–Central Alaska

Recent K–Ar age determinations on samples collected by T. E. Smith, J. H. Stout, University of Minnesota, D. L. Turner and Florence Weber, USGS, from the Maclaren metamorphic belt described elsewhere in this report, indicate that synkinematic metamorphism occurred between 65 and 70 m.y. ago, and that the pelitic gneisses in the eastern part of the belt were thermally overprinted in the mid–Tertiary.

The Maclaren belt is cut by the McKinley strand of the Denali Fault. To the north, a crescent shaped block bounded the by McKinley and Hines Creek strands of the Denali Fault contains slightly metamorphosed Devonian sediments, which have been intruded by a small granitic pluton dated at 90 m.y.

The relatively young synkinematic age and compressed isograds of the Maclaren metamorphic belt do not correlate with the regional greenschist facies terrane, which characterizes the Birch Creek Schist Formation north of the Denali Fault and muscovite K–Ar ages of 112–115 m.y. determined for quartz–mica schists north of the fault near Canwell Glacier.

The Maclaren belt thus provides a major linear feature over 80 miles in length that strikes NE into the fault and is truncated by it. Clearly, this belt must have formerly extended across the fault and, if its offset segment can be found, a unique solution can be provided to the problems of magnitude and timing of offset along the Denali Fault System. Such a solution would place significant constraints on possible plate tectonic models for this part of the crust, as well as providing a basis for correlating mineral belts and other linear features of pre-late Cretaceous age across the fault.

R. B. Forbes, D. L. Turner and J. H. Stout have been searching for the offset segment of the Maclaren belt on the north block of the Denali Fault. At the present time, there are two possible candidates for this offset segment. One of these is the Coast Range metamorphic belt in the Juneau area. Isograds in this belt are compressed in a pattern similar to those in the Maclaren belt. Previously reported K-Ar ages reinforce this correlation, as Coast Range synkinematic metamorphism appears to have occurred during late Cretaceous or early Tertiary time[10].

A second possible correlation involves a northwesterly trending metamorphic belt on the east shore of Kluane Lake, Y.T., Canada which is also cut by the Denali Fault, near the Alaska-Canada Boundary. Forbes and Turner completed a sampling program in the Kluane Lake area during the summer of 1972; and it is hoped that the K-Ar dating and petrologic study of these samples and those collected during cooperative work this past summer with Smith using Division helicopter support in the Alaska Range and Clearwater Mountains will produce a defensible solution to the Denali offset problem.

A Maclaren metamorphic belt-Coast Range metamorphic belt correlation would imply a right-lateral displacement of approximately 450 miles. If the Kluane metamorphic belt is the offset segment, the displacement would be about 250 miles since latest Cretaceous time.

Joint geochronological and mapping studies by Turner, Smith and Clyde Wahrhaftig, USGS, promise to enable a date to be placed on the cessation of movement along the Hines Creek strand of the Denali Fault System. A granitic pluton cuts this strand in the vicinity of the west fork of the Little Delta River. The pluton is well exposed and field relationships show clearly that the pluton post-dates all movement along the strand. Several excellent dating samples were collected from the pluton this summer using a Division helicopter. Mineral separations from these samples have been completed and they will be dated in the near future.

Brooks Range

The purpose and progress of the Brooks Range project is described elsewhere in this report. The Geochronology Laboratory first became involved in the project in 1972 by dating biotite from a granitic intrusive submitted by Fritts at 90±2.7 m.y.

Since that time Turner and Forbes have begun a systematic study of the chronology and petrology of blueschists and related rocks from the schist belt along the south flank of the range. Preliminary data suggest the possibility of a Precambrian age for the blueschists and work is now in progress to further evaluate this possibility.

Future plans include a joint field sampling program in the summer of 1973 and continued work with Division geologists involved in this project.

The projects discussed above are the beginnings of what we hope will be a continuing program of cooperative investigations between Division geologists and the Geophysical Institute Geochronology Laboratory staff.

10 Forbes, R. B. and Engels, J. C., 1970, K^{40}/Ar^{40} age relations of the Coast Range Batholith and related rocks of the Juneau Ice Field area, Alaska, Bull. Geol. Soc. Amer., V. 81, p. 579-584

Sedimentary Zeolite Deposits of the Upper Matanuska Valley

Preliminary studies by D. B. Hawkins indicate that zeolitized tuff beds of possible economic importance occur within the Talkeetna and Matanuska formations at Sheep Mountain and vicinity in the upper Matanuska Valley, Alaska. The occurrence of zeolites principally as vug fillings was noted by Capps[11] and more recently by Grantz[12].

The zeolitization appears to be a result of burial diagenesis of the tuffs in a marine environment; an origin similar to the zeolite deposits of Japan and unlike the sedimentary zeolite deposits of the contiguous United States.

Zeolites recognized to date in the tuffs are laumontite, analcime, mordenite and heulandite. The ion-exchange and gas-sorbent properties of the tuffs are now being investigated.

Tertiary Coal-Bearing Group in the Healy Area

D. M. Triplehorn has found major differences in clay mineral composition in mudrocks associated with Tertiary coals at Healy. The lower part of the section, from the base of the Healy Creek Formation up through the No. 1 coal seam is characterized by abundant kaolinite and only traces of montmorillonite. Above the No. 1 seam, mudrocks are characterized by abundant montmorillonite.

The lowermost abundant montmorillonite occurs in a six inch clay parting near the top of No. 1 seam. The composition and continuity of this parting suggests its origin as an ash fall. Although this suggestion needs further verification, the possible utility of such a bed for regional correlation warrants further investigation.

An aqueous solution of benzidene dye proved to be a useful field tool for distinguishing the upper, montmorillonite-bearing rocks from the lower part of the section containing little or no montmorillonite. When wet with the dye, montmorillonite bearing rocks quickly turned a bright bluecolor; those without montmorillonite showed no color change.

Bulk densities of clay and mudstone beds associated with the coals on Lignite Creek range from about 2.00 to 2.20. According to D. M. Triplehorn, this suggests burial between 3000 feet and 5500 feet, using the compaction curves of Baldwin[13]. There is also some tendency for bulk densities to decrease eastward within a given stratigraphic interval, posisbly the result of greater depth of burial (and thus greater subsequent uplift) of the western area.

Along Healy Creek bulk densities are notably greater, ranging from about 2.15 to 2.40. Using Baldwin's composition curves, this would correspond to burial between 4500 feet and 9500 feet. Such large differences in depths of burial between Healy Creek and Lignite Creek seem unlikely. The greater densities of mudrocks along Healy Creek are possibly related to their greater deformation, as indicated by their steeper dips in comparison with beds along Lignite Creek.

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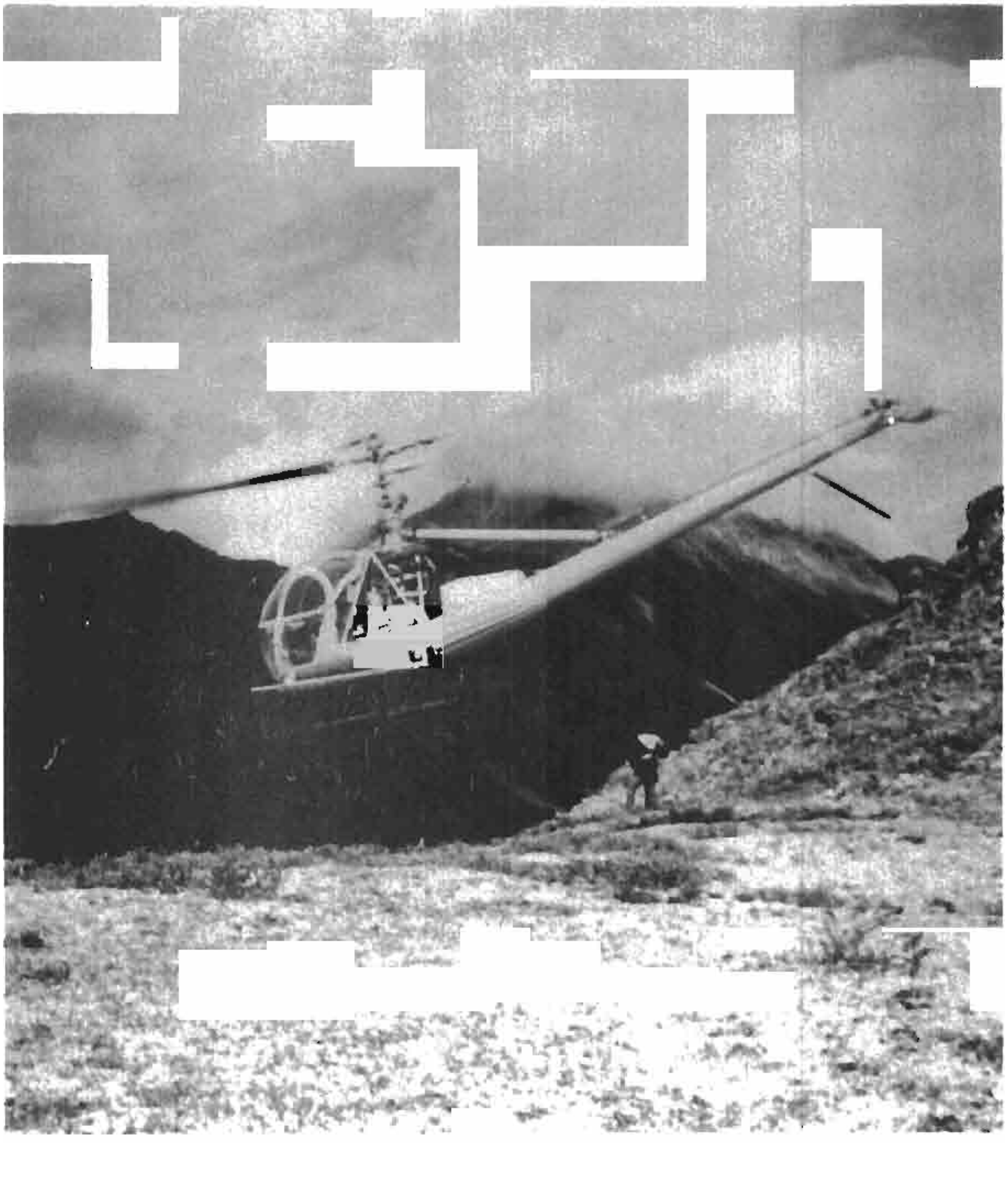
11 Capps, S. R., 1927, Geology of the Upper Matanuska Valley, Alaska: U. S. Geol. Survey Bull. 791, 92 p.

12 Grantz, A. M., 1965, Geologic Map and Cross Sections of the Nelchina Area, South-Central Alaska: U. S. Geol. Survey Open File Report

13 Baldwin, Brester, 1971, Ways of deciphering compacted sediments: Jour. Sed. Petrology, v. 41, no. 1, p. 293-301

SECTION III



Programs Planned for 1973

Brooks Range Project

Geologic mapping, geochemical sampling, and topical investigations in the west–central Brooks Range will continue in 1972. One of the specific areas of interest is the "schist belt" along the south flank of the range and the now partially delineated zone of copper anomalies therein. This zone, the site of several prospects of Bear Creek Mining Company, has been found to be associated with some very distinct metamorphic and igneous(?) rocks. Continued investigation, aimed at clarifying the structural and stratigraphic relation of these rocks to the other rocks of the schist belt, will aid in determining the geologic history and regional geologic setting of this potentially economic area.

Several topical studies are anticipated as outgrowths from the geologic mapping and geochemical sampling programs. One such study, which will be conducted in cooperation with T. C. Mowatt, Division Laboratory Supervisor, is an examination by X–ray diffraction methods of the thermal state of the feldspars in the granitic rocks. This investigation, which will aid in determining the role and time relation of the granitic rocks in the geologic history of the area, will be initiated shortly. Another topical study expected to be pursued involves detailed sampling of the carbonate rocks in this region for geochemical analysis of their potential as host rocks for copper, lead, and zinc mineralization.

Livengood Mining District

A new study of the Livengood mining district will be undertaken by G. R. Eakins. All previous geological work will be combined and additional studies made to aid in an understanding of the geologic history and controls for the mineral deposits. An effort will be made to determine the best indicators for outlining ore deposits within the district and to see if extensions of the ore zones can be found. Geochemical, magnetometer, and radiometric surveys may be employed.

This type of program will be continued in future years and include other old mining districts in the interior of Alaska. Two of the goals will be to better define the metallogenic provinces and determine the mineral potentials of the districts.

South–Central Alaska

Projects conducted by T. E. Smith over the past five years have resulted in geologic map coverage of nearly 1700 square miles in the northern Talkeetna Mountains, Clearwater Mountains, and Alaska Range. Stream sediment sampling programs are completed over about 1000 square miles. A brief description of the bedrock geology is included in this report under "1972 Programs". This project will be continued south and west of existing coverage during the 1973 field season with an objective of better defining how the Maclaren metamorphic belt is terminated on its southwest end. Reconnaissance geochemical programs will also be continued in selected parts of the area, as a rapid method of appraising mineral potential.

Statewide Ore Deposits Study

A long term project to examine ages of known ore deposits will be started this year by Smith. Samples collected from a variety of hydrothermal deposits will be dated by K–Ar methods in collaboration with D. L. Turner, Geophysical Institute, and by the fission track method. This will be the first systematic attempt to establish a temporal distribution of ore deposits in Alaska.

Tertiary Coal–Bearing Group

Future studies of coal–bearing Tertiary rocks will continue to be centered around the well–known shaly section at Healy. This will primarily be an expansion and refinement of work in progress with additional clay mineral investigations supplemented by petrographic and geochemical studies. Particular effort will be made to find datable components in thin clay partings believed to be ash beds. The area of investigation will be expanded north and east of Lignite Creek and possible ash beds will be examined in Tertiary coals from the eastern part of the Alaska Range and in the Cook Inlet area.

Anchorage D–2 Quadrangle

Future mapping will be extended to the south, north, and west so as to form an extension of previous mapping by Arthur Grantz in the Anchorage D–2 quadrangle, and of older work by S. R. Capps et al. in the Anthracite Ridge area of Anchorage D–3.

Geophysics

The Aeromagnetic Survey is a continuing program and the mapping in 1973 will be an extension of the 1971 and 1972 work. The maps are in demand by both industry and government scientists. The specifications of 10 gamma contour interval and 3/4 mile flight line spacing will remain unchanged.

Geothermal Exploration Progress

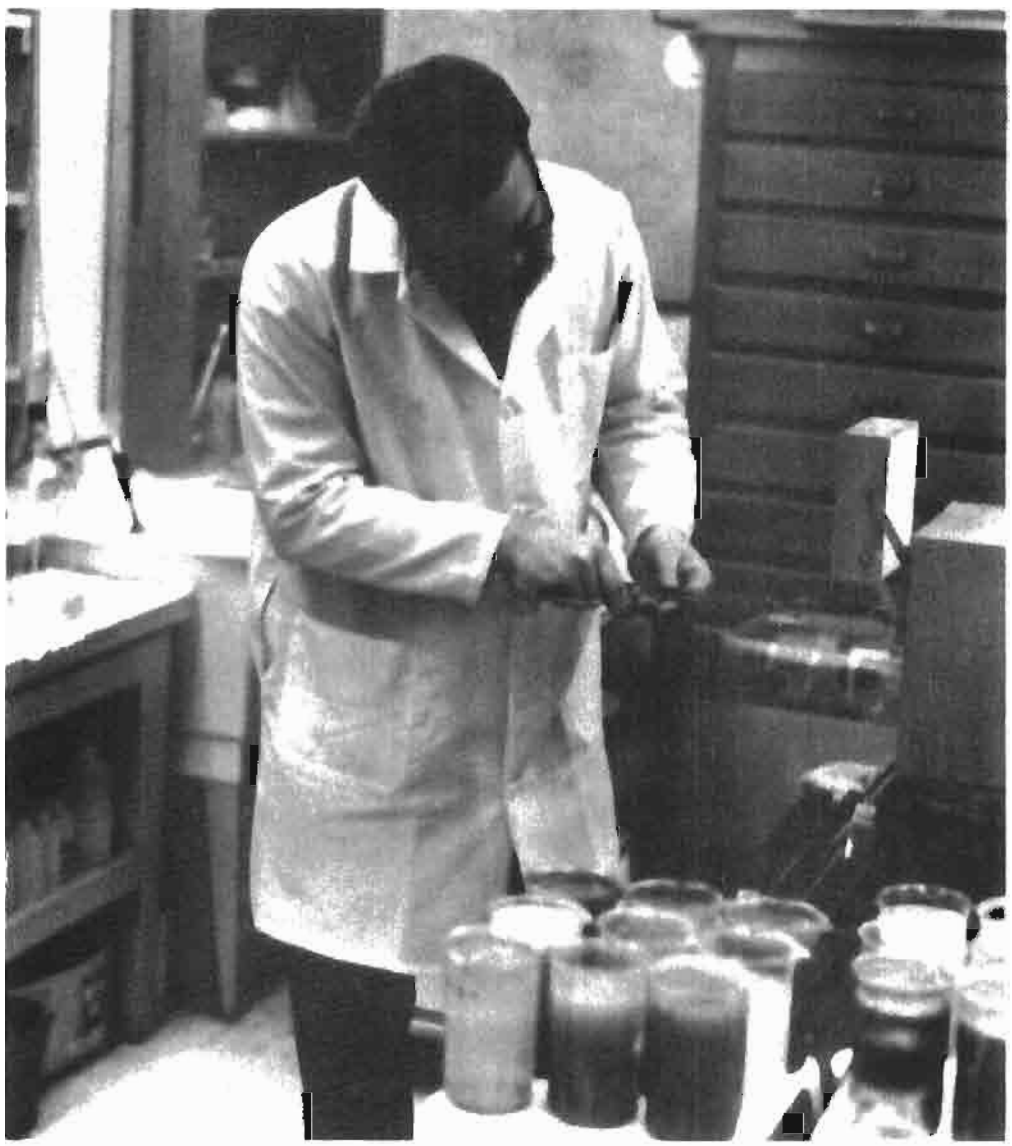
At least 53 warm or hot springs have been documented in Alaska, and a number of them have been used for recreational purposes for many years. With the recent resurgence of interest in pollution–free energy sources, the possibility of exploiting these thermal areas for power generation is being researched, and some systematic investigation has commenced.

The University of Alaska did some preliminary mapping and sampling of water and biota at several hot spring sites in 1971, and R. B. Forbes outlined a program of detailed geological, geophysical, geochemical, and engineering studies for determination of energy potential of selected thermal areas.

T. P. Miller and Ivan Barnes of the USGS, examined and sampled water from various thermal sites across Alaska in the summer of 1972.

As availability of funds and personnel permit, the State Geological Survey will join the University and the USGS in systematic studies of this potentially important energy source.

SECTION IV



Mineral Analysis and Research

1972 Analyses

The Division laboratory staff performed mineralogic, petrologic, and geochemical analyses on 633 public and 3,035 Division samples during the period January 1, 1972 through November 30, 1972. This effort included qualitative identifications, service assays, and detailed quantitative studies as well as considerable advisory work for the public. Additional specific investigations are discussed below.

Method Development

Computer Processing of Geochemical Data

In collaboration with Norman Veach, Division geophysicist, the processing and handling of the Division geochemical reconnaissance survey data by computer has been made available on a routine basis. Norman Veach and N. C. Veach are primarily responsible for the computer programming aspects of this work.

X-Ray Emission Spectrometry

A computer program for matrix correction of raw x-ray emission analytical data is available.[1] This is the basis for a scheme being developed by T. C. Mowatt and N. C. Veach to facilitate the rapid and precise quantitative chemical analysis of geologic samples. The main objective is to provide a relatively inexpensive means of obtaining major constituent chemical analyses of geologic materials. With such data in hand, it will be fairly straightforward to obtain other useful information, e.g. trace element quantitative analyses, structural formulas, and normative calculations, by means of additional computer data-processing methods currently being developed. N. J. Veach and D. B. Hawkins, University of Alaska, are collaborating in this work.

Tin Analysis by $LiBO_2$ Fusion

Tin analysis by atomic absorption spectrophotometry utilizing anhydrous lithium metaborate to bring silicate material into solution has been investigated by T. C. Trible and W. W. McClintock. Analysis of tin ores containing cassiterite, SnO_2, is complicated by the fact that tin oxides are difficult to bring into solution. Some investigators have reported that cassiterite is not destroyed in vigorous acid mixtures of HCL, HNO3 with HF. Many fusion techniques employing sodium car bonate or potassium hydroxide fluxes do not completely decompose cassiterite.

Other problems encountered in the analysis of tin are the relatively high volatility of tin (Sn^{4+}) chloride and the fact that tin (Sn^{4+}) readily undergoes hydrolysis and polymerizes to form insoluble colloidal particles. Unfortunately, tin (Sn^{2+}) forms insoluble oxychlorides when exposed to air.

1 Hower, J.; Schmittroth, L. A.; Perry, E. C.; Towell, D. G.; and Mowatt, T. C.; 1964, X-ray spectrographic major-constituent analysis in undiluted silicate rocks and minerals[abs.]: Geol. Soc. America Ann. Mtg., Miami Beach, Fla., 1964, Program, p. 76.

Using the alkaline flux lithium metaborate to bring the sample into solution, we have successfully analyzed tin ores containing from 0.05% to more than 15% tin. The procedure is rapid and has the additional advantage that other elements may be analyzed from the same solution.

Preliminary work has been carried out on the application of this method for use on samples containing small amounts of tin. To date, it may be concluded that the small sample size necessary for complete fusion coupled with instrumental limitations would make an HF – H_2SO_4 pressure digestion the more attractive technique.

Future work will be carried out on the effectiveness of HF – H_2SO_4 and HF – HNO_3 acid mixtures to decompose cassiterite both in open vessel and teflon–lined bombs. This sensitive analytical method will assist further studies on the geochemical behavior of tin.

Mercury Analysis

The lack of knowledge concerning the distribution and behavior of mercury in the Alaskan environment, in particular rocks, coals and sediments, has lead to the acquisition of equipment necessary for trace mercury analysis. The detection limit for conventional flame atomic absorption analysis is about 0.2 parts per million (ppm), which is not sensitive enough for most geologic samples, and therefore a specialized technique must be employed for trace analysis in the parts per billion range. Release of mercury from the sample is accomplished by two different techniques – wet oxidation and thermal release.

The Division laboratory has analyzed various materials for mercury by the familiar wet oxidation technique. In this method, sample decomposition is based on the use of oxidizing acids such as nitric with sulphuric, sometimes accompanied by hydrogen peroxide or potassium permanganate. The sample is digested with these acids at 60°C in boiling flasks attached to long Allihn condensers to prevent losses of mercury due to volatilization.

When the sample is completely decomposed, its mercury content exists in the ionic state. The sample is cooled and transferred to an aeration vessel where the excess oxidants are destroyed with hydroxylamine HCL. Stannous chloride is used to reduce the mercury in solution to its elemental state. Mercury is subsequently swept into the absorption cell of an atomic absorption spectrophotometer by passing air through the aeration vessel. The mercury absorbance is measured at 2537Å.

The method described above is quite accurate and is only limited in its detection limit by the amount of sample one can bring into solution. It has the disadvantage of requiring elaborate glassware, which in turn requires tedious cleaning and washing. To alleviate this, the laboratory is assembling and testing a thermal release method for mercury analysis.

Thermal release of mercury and its subsequent entrapment on gold is based upon the high vapor pressure of elemental mercury and its ability to amalgamate with other elements. A ground sample is placed in a quartz enclosure heated to 800°C. The vapors released on combustion are swept past gold wire which is heated to 200°C. At this temperature, only mercury will remain on the gold while interfering vapors such as CO_2, H_2O, sulphur and organics are bypassed from the system. At the appropriate time, mercury vapor is released from the gold by raising the temperature of gold–mercury amalgam. The vapor is then passed through the absorbance cell of the atomic absorption spectrophotometer. This method is attractive in that it avoids possible addition of mercury from oxidative reagents. It is much more rapid than the wet oxidation technique in that several analysis may be performed before the gold must be cleaned.

Future work by the Division will concentrate on developing the thermoamalgamative technique. This method will be applied to studying mercury as a pathfinder element for mineral exploration as well as its distribution and cycling in the Alaskan environment.

Gold Analysis

The laboratory is experiencing an increasing need for the determination of gold, from trace to ore grade concentrations. These needs include a quantitative analysis at and below the ppm level for geochemical prospecting; a quantitative analysis for ore samples which lie in the economic range, and finally, a semi–quantitative technique to determine which of the large number of ore samples submitted are worthy of further analysis.

Conventional analytical methods for gold generally depend upon sample digestion with aqua regia, and other acids, or cyanide, or by fusion, followed by some means of eliminating interfering elements and analysis by atomic absorption spectrophotometry. These methods do not provide a solution to our specific needs. For example, in the standard MIBK extraction of gold from an aqua regia solution, interfering elements, largely iron, must be removed by extraction with HCL. The literature and preliminary investigations give conflicting results concerning the necessity and effects of iron removal. Investigations are being conducted by McClintock and Trible on various techniques and on the use of other organic extractants to solve these problems. Also being studied are the effects of MIBK solubility in HCL on concentrating gold, the possible use of DIBK and Aliquat 336 as an extracting agent, and the use of cyanide. And finally, a colorimetric semi–quantitative technique, involving the use of stannous chloride will be tested for use in screening samples for gold analysis.

Geochemical Reconnaissance Survey

Niukluk River area, Bendeleben quadrangle, Seward Peninsula

In collaboration with T. K. Bundtzen, Geologic Field Assistant with the Division, the data resulting from optical emission spectrographic and atomic absorbtion analysis of 682 stream sediment, soil, and bedrock samples have been processed by Trible and Mowatt. Data interpretation is in progress, and the results of this work should become available in the near future. The project area includes portions of the Bendeleben A–4, A–5, A–6, B–4 and B–5 quadrangles. Further geologic work is not envisioned at this time in this area.

Petrologic Studies

Belt Creek–Libby River Area
Bendeleben A–5/A–6 quadrangle,
Seward Peninsula

Detailed petrographic–mineralogic work by Mowatt on a suite of 70 bedrock samples from an area previously mapped by R. R. Asher[2] is in progress. The rocks include materials representing the Kugluaik Group, Nome Group, York Slate, and a dolomitic crystalline limestone, all of which were designated as probable Precambrian by Asher. The remaining rocks of the area were tentatively assigned Mesozoic ages. They include three discernible phases of intrusive granitoids, scattered calc–silicate alteration haloes associated with some of the granitic rocks, and lesser amounts of dike and plug occurrences of porphyritic quartz diorite, rhyolite, and highly altered

2 Asher, R. R., 1970, Geology and geochemistry of the Belt Creek–Libby River area, Seward Peninsula, Alaska: Alaska Div. Mines and Geology Geochem. Rept. No. 22, 44 p.

materials now consisting of carbonate–epidote–quartz assemblages. In view of Asher's geochemical and geologic work in this area, it is felt that a more detailed study such as the one currently in progress should provide further useful information.

Boundary Area, Eagle A–1 Quadrangle, Fortymile District

This area was the subject of a Division geochemical report by Asher[3]. Additionally, H. L. Foster, USGS, and colleagues have published much informative geologic and geochemical data and maps in recent years, as a portion of their broad scale study of the region. On the basis of this previous work, it was felt that detailed petrographic study would be worthwhile. This has been undertaken by Mowatt, utilizing material collected by Asher and Bundtzen, supplemented by more recent field collecting.

The area is underlain by a sequence of metamorphic rocks of varying grades, including units designated "quartzite graphite schist, quartz chlorite muscovite schist, biotite schist and gneiss, and dark biotite–hornblende gneiss." They are all of indeterminate "Precambrian(?) and/or Paleozoic(?)" age. Apparently intrusive into this sequence is a series of ultramafic rocks, highly serpentinized, of "Paleozoic(?) or Mesozoic(?)" age. It is hoped that the petrologic studies currently in progress may aid in clarifying these relationships, and lead toward a better understanding of the overall geology of the area.

Geochemical–Petrologic Studies

Ultramafic–Mafic Associations

Current work by the Geological Survey of Canada indicates a heightened awareness of, and interest in the possible potential of various mafic and ultramafic rocks as hosts for low grade nickel–copper mineralization. As the result of recent programs carried out in Canada, many serpentinite bodies have been reappraised with respect to the possibilities of their containing internal zones of sparsely disseminated nickel–rich sulphides, in grades ranging upwards of 0.2 percent Ni. As has been pointed out by O. R. Eckstrand, "such zones should be viewed as legitimate targets for exploration. Furthermore....the sulphides can occur in more than one textural habit, with important implications for metallurgical recovery."[4] An apparently useful approach in investigating ultramafic bodies with the foregoing in mind has been discussed by E. M. Cameron and associates with the Geological Survey of Canada.[5] This method involves geochemical and petrologic studies, and appears to be readily applicable in investigating possibly analogous occurrences in Alaska. Mowatt, Trible, and McClintock have undertaken preliminary studies in this area.

At this time, the genesis of sulphide phases associated with various types of ultramafic rocks is by no means clearly understood. The traditional appeal to primary segregation of an immiscible sulphide phase from a cooling magma has not been completely satisfactory in explaining some occurrences, particularly the disseminated sulphides associated with serpentinized rocks. Suggestions regarding alternative modes of genesis have been made, and one currently in favor concerns a complex redistribution of elements attendant upon serpentinization, involving transfer of sulphur into the ultramafics from external sources, perhaps from the surrounding country rocks. It is felt that detailed studies of the sort we are now undertaking may be useful in clarifying certain points regarding this problem. Our approach includes an examination of the geochemistry of mercury in the

3 Asher, R. R., 1970, Geochemistry and Geology Boundary Area, Fortymile District, Eagle A–1 Quadrangle, Alaska: Alaska Div. Mines and Geology Geochem. Rept. No. 24

4 Eckstrand, O. R., 1971, The nickel potential of serpentinized ultramafic rocks: Canadian Mining Jour., p. 40–45

5 Cameron, E. M., Siddeley, G. and Durham, C. C., 1970, Distribution of ore elements in rocks for evaluating ore potential: nickel, copper, cobalt and sulphur in ultramafic rocks of the Canadian Shield, No. 11, p. 298–313

ultramafic—country rock framework, which, as far as we know, has received little or no attention elsewhere to date. Thus, a portion of our work is an attempt to obtain a better degree of insight into the process of serpentinization of ultramafic rocks, in order to be able to assess economic potential.

Our initial efforts have centered on several readily accessible areas in Interior Alaska, as well as on such materials as were available from other localities. Samples have also been obtained from localities of known mineralization in Canada, as reference materials. Analytical work is currently in progress, and a preliminary report is planned for the coming year. These initial results will determine the future course of this program.

Additionally, the regional geologic significance of ultramafic—mafic associations is of interest to the overall understanding of the geology of Alaska, and the geochemical—petrologic data obtained in these studies should be of value in this regard as well.

Granitic Rocks

A statement by the Geological Survey of Canada, in April 1969, that "The Geological Survey has undertaken a systematic study of granitic rocks in Canada in support of its mapping program with the hope of providing a better classification of such rocks, proper criteria for their recognition, and a more scientific basis for conclusions as to the geological evaluation and the economic potential of the regions in which they occur,"[6] was of interest to us with respect to the potential usefulness of analogous studies in Alaska.

The intensive application of classical petrographic methods, combined with detailed considerations of petrochemistry, accessory mineral associations, and feldspar mineralogies (especially x—ray crystallographic work) in some recent studies have led to an increased understanding of granitic rocks, their geologic occurrence, origins, and temporal, spatial, and genetic relationships to economic mineralization. Various aspects have been dealt with by many investigators.

In an attempt to obtain greater insight into the nature of various plutonic associations of granitoid rocks in Alaska, a program of geochemical and petrologic work has been initiated by Mowatt, Trible, N. C. Veach and McClintock. Primarily involving a broad geochemical survey of bedrock materials, it is felt that such studies will be useful as an aid to mineral exploration, as well as affording a better understanding of large—scale geologic relationships. Mineralogic—geochemical—petrologic areal variability, as well as detailed study of areas of particular interest, are concerns of this project.

Following the examples of the Geological Survey of Canada investigations[7, 8] of the granitic plutons of Yukon Territory and adjacent portions of Northwest Territories and British Columbia, we are emphasizing geochemical studies of tin, tungsten, molybdenum, uranium, copper, lead, and zinc. The elements fluorine and boron are also of interest, but present certain analytical difficulties that we hope to solve.

Given the extensive occurrences of granitoidal rocks in Alaska, along with the relative scarceness of data on fundamental geochemical and petrologic relationships, it is felt that this project offers good possibilities for yielding information of value in furthering our understanding of the economic and regional geology of the State. We hope to pursue this in a manner complementary

6 Fortier, Y. O., 1971, in preface to Reesor, J. E. and Moore, J. M., Petrology and structure of Thor—Odin Gneiss Dome, Shuswap metamorphic complex, British Columbia: Canada Geol. Survey Bull. No. 195

7 Garrett, R. G., 1971, Molybdenum, tungsten and uranium in acid plutonic rocks as a guide to regional exploration, S. E. Yukon: Canadian Mining Jour., p. 37—40

8 Mulligan, R., 1970, Lithophile metals and cordilleran tin belt [abs.]: Fall Meeting, October, The Canadian Institute of Mining and Metallurgy, Kamloops, British Columbia

to current studies by the USGS. Previously, investigations of like nature have been pursued on occasion by Division geologists as part of their field studies in specific areas. The present program entails a broader integration of the information now available, as well as more intensive investigation of samples on hand or readily available.

Work on materials from the central Alaska Range is underway in collaboration with C. N. Conwell, Division engineer; similarly we will be working with G. H. Pessel, R. E. Garland, and G. R. Eakins, Division geologists, on materials from their field study area in the southern Brooks Range. Suites of samples from other, more readily accessible areas in interior and south–central Alaska have also been obtained as part of our initial effort. Similar collaborative studies in conjunction with other Division field projects are anticipated on an essentially continuing basis. It is also planned to restudy, in more detail, other samples that may be available from previous Division work. It is anticipated that some data may be forthcoming from this program during the coming year, depending upon the course of other activities.

Geochemical–Mineralogic Studies of Holocene Sediments

As a collaborative effort with sedimentologic studies by the Institute of Marine Science (IMS), University of Alaska, we are contributing technical expertise and facilities in an effort to obtain the maximum amount of information possible on Holocene sediments in geographic areas of obvious interest and concern to the State.

The studies are directed at clarifying the sedimentologic–geochemical–mineralogic relationships, the scavenging activity of the sediments, as well as delineating currents and transport mechanisms. Of major interest are environmental concerns relative to petroleum production and transportation. Additionally, base line levels of concentration for various chemical elements are being established, again considering environmental implications.

North Slope Studies, Arctic Alaska

In collaboration with A. S. Naidu, (IMS), Mowatt, N. C. Veach and Trible are investigating the nature of sediments in the major rivers of the arctic area, as well as offshore in the Beaufort Sea. It was felt that more detailed work was merited on the Colville River and adjacent rivers, as well as on their contiguous deltas and offshore areas. Our work to date has delineated certain definite trends in mineralogy over the area, as well as demonstrating mineralogic variations as a function of particle size, within the clay–size fraction of the sediments studied. This latter information has important implications on the geochemical "activity" of a given sediment, as well as being of fundamental significance in any attempt to characterize the clay mineral composition of a given sediment sample. This, in turn, is basic to attempting to use clay mineralogic variations to clarify sedimentologic relationships.

A portion of the work to date has been summarized, and an abstract prepared, by A. S. Naidu and T. C. Mowatt.[9] This is available in preprint form at the Division office in College. A more complete paper is in preparation.

Port Valdez–Valdez Arm Studies, South–Central Alaska

In collaboration with G. D. Sharma (IMS), who is pursuing a detailed study of the Port Valdez–Valdez Arm region, Mowatt, Trible and N. C. Veach are investigating the mineralogic character of the Holocene sediments. To date, initial study of the less than four micron particle–size material from these sediments, in conjunction with D. Burbank, a graduate student with Sharma, has indicated

9 Naidu, A. S. and Mowatt, T. C., 1973, Lateral variations of clay minerals in the deltaic sediments of the Colville and adjacent rivers, North Arctic Alaska, [abs.]: American Assoc. Petroleum Geologists and Soc. Econ. Paleontologists and Mineralogists Ann. meeting, Anaheim, California

the desirability of more detailed mineralogic work. We are presently engaged in sample preparation work which will ultimately enable us to investigate several particle–size fractions within the clay–size range. It is anticipated that this will permit a more meaningful appraisal of the mineralogic–geochemical–sedimentologic relationships in these materials.

Lab personnel include: **Namok Veach**, Assayer Chemist (lower left), **William W. McClintock**, Mineral Lab Technician (upper left), and **Donald R. Stein**, Assayer (above).

SECTION V

Conservation and Regulation

Functions

The Conservation Section of the Alaska Division of Geological and Geophysical Surveys is supervised by C. N. Conwell, Division engineer. One function of the section is to conduct geologic studies on potential economic targets. This work is done by C. N. Conwell and by contract during the summer months with professional geologists. In 1972, two projects were started; mapping of the Talkeetna (D–5) quadrangle on a scale of 1:63,360 (1 inch = 1 mile), considered important because a large granite pluton located there has characteristics similar to tin granites in other parts of the world, and an attempt to correlate Tertiary coal deposits in central Alaska through a study of the mineralogy of the underclays was also started, with D. M. Triplehorn, University of Alaska.

Prospect examinations are made on request, for clients unable to afford a private consultant. During 1972, four investigations were completed, one on a tin prospect, another on a tungsten prospect, and two on lead–silver prospects.

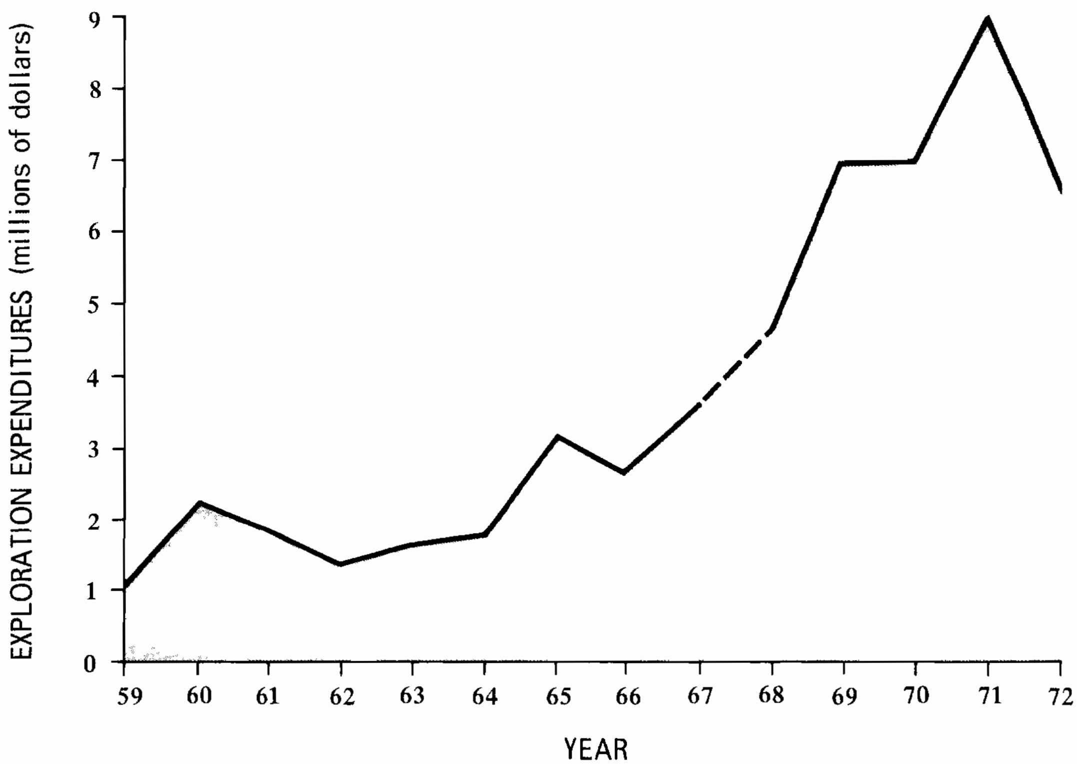
The Conservation section is also charged with administering the regulatory provisions of the Alaska Mine Safety Code, for coal, metal, and nonmetallic mining. Accordingly 18 coal mine safety investigations and six metal mine investigations were completed during 1972. In addition to these on mining activities, safety precautions on all underground construction activities are inspected and evaluated. The capability to detect toxic and explosive gases, and to measure air flow, and to detect working areas that may have an oxygen deficiency is maintained to properly evaluate health standards in mining and underground construction.

Specific commodities are studied that occur in the State's inventory of natural resources. In conducting the commodity studies, coal fields from Palmer to the North Slope were investigated during 1972. A commodity study on tin is currently being conducted to determine the availability of the metal in the State and the chance for increased tin production. Alaska is the only State that produces tin, other than as a by–product from other mining.

In a continuing effort to conserve and promote resource commodities of the State, the Conservation Section has prepared and published review articles which have appeared in national mining journals.

Labor affidavits from the Division of Lands on offshore prospecting permits and coal prospecting permits are evaluated to determine if the requirements of the law have been met. The use of lands on which there is a mineral potential or which may be subject to mineral leasing is reviewed. All State lands near potential coal deposits are reviewed to determine if the land should be held for mining purposes or if a conflict of interest would arise if the land were otherwise used. All lease–mineral mining programs are reviewed, particularly coal mining, to determine that adequate provisions are made for conservation of the natural resource and to determine that, upon completion of mining, the land will be returned to a condition that is in harmony with the environment.

The Conservation Section cooperates with the Compliance and Industrial Hygiene section of the Department of Labor in such areas as destruction of old explosives and detection of explosive gases and mercury vapor. The gas detection capacity is available on request. In 1972 an examination was made where methane reportedly existed. The hydrogen supply at a power plant was also checked.



Note: Information not available for 1967
Graph exclusive of oil and gas

Estimated Exploration Expenditures in Alaska

1959 – 1972

Figure 8

Exploration

Hard mineral investigations by major oil companies continued to dominate the exploration activities in new areas of the State. The exploration by major mining companies was concentrated on the evaluation of claims located in prior years resulting in increased expenditures for diamond drilling. The major search effort continued to be for large deposits suitable for surface mining. As in past years, the search was directed toward deposits containing copper, nickel, coal, iron, and platinum. The increase in the price of gold seemed to revive interest in that metal. Private assayers reported that the requests for gold analysis nearly doubled in 1972 over 1971.

The settlement of the Native Lands Claim undoubtedly had an effect on exploration. Approximately 100 million acres of land was withdrawn from mineral entry, and from this the Alaska Natives will select approximately 40 million acres. The full effect of the Native Lands Claim Settlement is difficult to appraise. The number of new mining claims filed in 1972 was 6,581 compared with 6,567 in 1971. The number of affidavits of labor was 1,089 for 1972 as compared with 671 for 1971. Active claims in the State increased from 16,262 in 1971 to 23,726 in 1972.

The Fairbanks office of the Division of Geological and Geophysical Surveys maintains a list showing the companies that were considered to be active in 1972. This list is available as Information Circular No. 7 and may be obtained upon request.

Exploration Expenditures

The total of expenditures for hard mineral exploration in Alaska in 1972 is estimated to be $6.5 million which is a decrease of $2.5 million from 1971 (fig. 8).

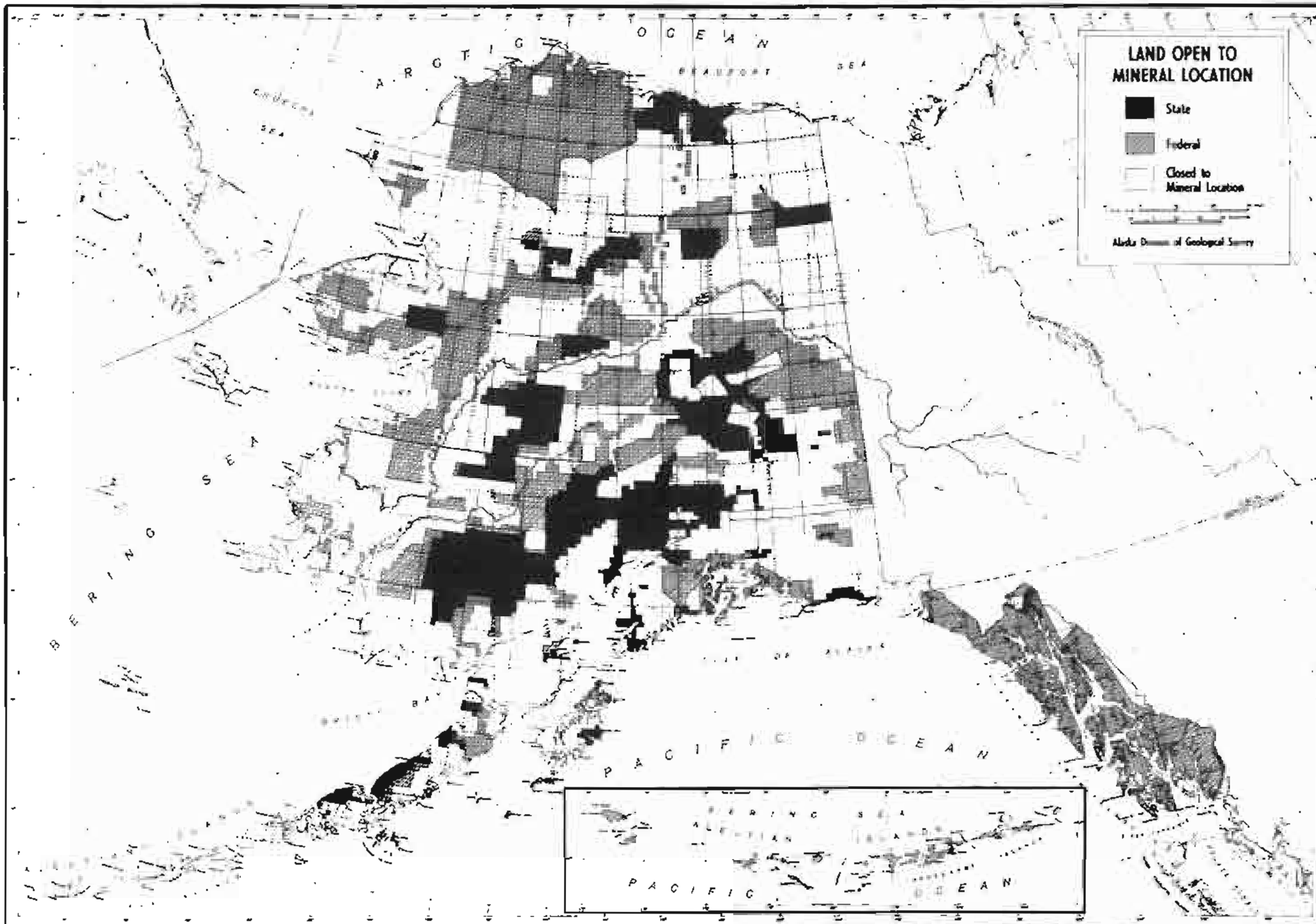
Arctic Alaska

Approximately $400,000 was expended on mineral exploration in arctic Alaska. Bear Creek Mining Company continued its effort to increase reserves by diamond drilling on its copper properties near Bornite in the Kobuk area. In addition to Bornite, another property approximately eight miles to the north known as Arctic Camp was active. Placid Oil Company maintained a helicopter-supported crew for the season, operating throughout the southern part of the Brooks Range with bases in the west near the Ambler River and in the east near Chandalar, Alaska. Other companies that were active include Cities Service and Humble Oil.

Western Alaska

The estimated expenditures on mineral exploration in western Alaska is $2.4 million, which is slightly higher than the expenditures in 1971. Of this amount, the major portion was expended by the Lost River Mining Corporation for the diamond drilling of the fluorite-beryllium deposit at Lost River, approximately 90 miles northwest of Nome. The company continued to improve the camp facilities and completed a feasibility report.

Rhiney Berg continued his exploration at the old Independence property on the Kugruk River. Exploration consisted of drifting along a limestone-schist contact. The objective is a complex lead-zinc-silver ore.



Mineral Exploration Status of Land in 1972 **Figure 9**

Active exploration and requests for offshore prospecting permits in the Norton Sound and Goodnews Bay areas continued throughout 1972. The American Smelting and Refining Company continued to explore and evaluate the gold placer deposits offshore south of Nome by drilling and taking bulk samples in selected areas to further evaluate and correlate the effectiveness of their drilling program. Exploration for offshore platinum deposits was conducted in Goodnews Bay.

Interior Alaska

Expenditures for exploration in Interior Alaska are estimated at $400,000. Activity was lightly scattered throughout the area. There were no known concentrated efforts of reconnaissance exploration in 1972. Earth Resources reportedly drilled a copper prospect near Livengood. American Exploration and the Ptarmigan Exploration Companies are each reported to have diamond drilled near Nabesna, Alaska. Other companies that are reported to have maintained exploration field parties in the interior of Alaska include Humble Oil Company, Chevron Oil Company, Cypress Mining Company, Northwest Exploration Company, and WECO.

Southcentral Alaska

Inspiration Consolidated Copper Company continued diamond drilling at the Golden Zone near Cantwell. In the McCarthy area, Gordon Burdick continued development work on the old Green Butte property. Johnny Wilson was active in the Pea Vine, Nelson and Radovin properties. Inexco planned four 1,500 foot drill holes in the area, and reportedly did drill about 5,500 feet east of the old Kennecott mine.

Southwestern Alaska

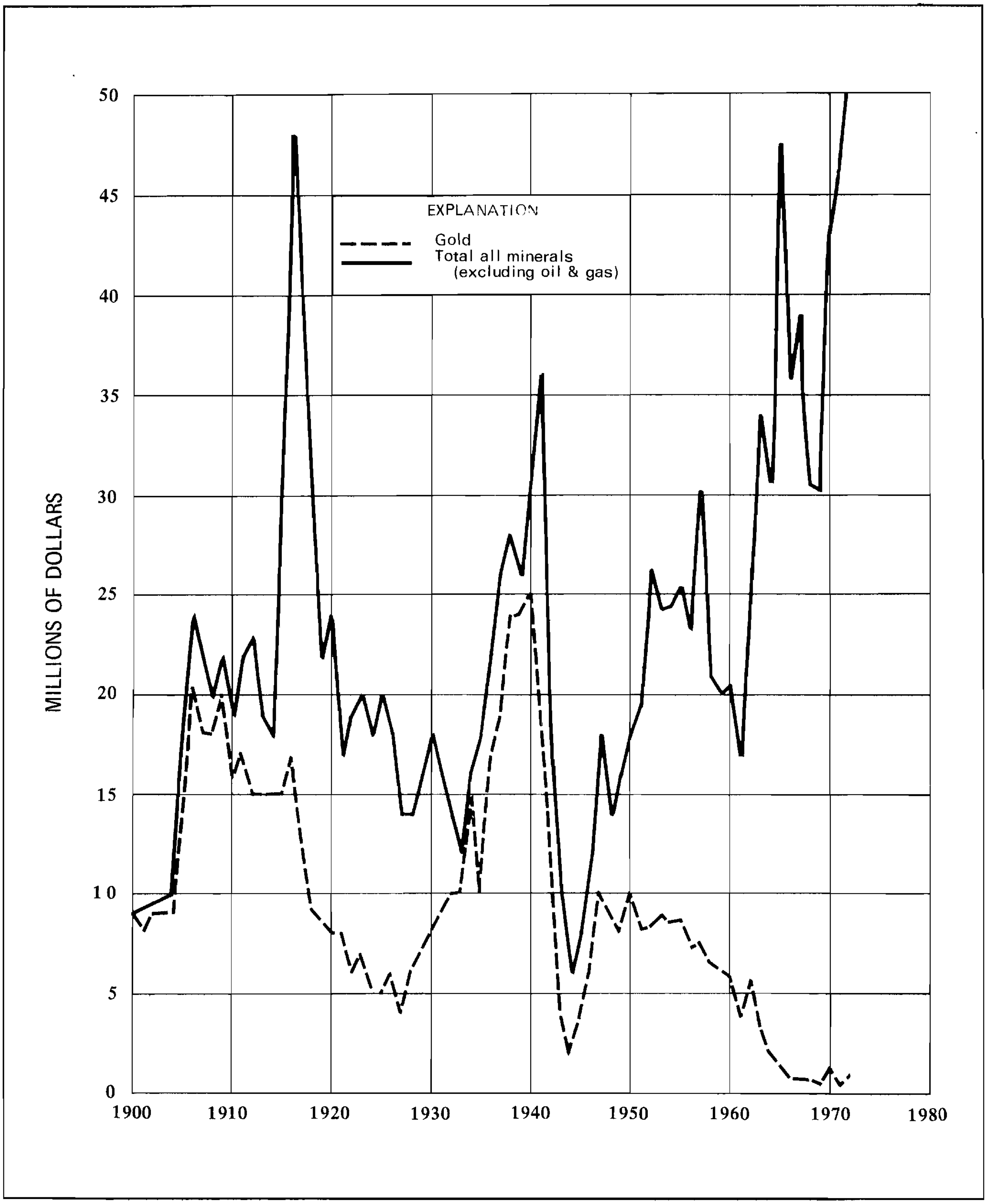
There was no known exploration for hard minerals in southwestern Alaska during 1972. Cities Service Company, Humble Oil, Texaco, and Standard Oil of California all maintained active helicopter–supported geologic field crews based at Port Moller and Port Heiden. Although this work was regarded primarily as exploration for oil, some effort may have been directed to hard minerals.

Southeastern Alaska

The expenditure for 1972 is estimated at $2.8 million. Ketchikan continued to be the center of most of the activity in southeastern Alaska. There were reportedly at least six major diamond drilling projects within a 100 mile radius of town. The areas of interest continued to be the mainland near Texas Creek, Revillagigedeo Island, Prince of Wales Island and Admiralty Island.

The Phelps Dodge corporation reportedly drilled a prospect on Coronation Island west of Prince of Wales. Alaskan Metals Ltd. continued to drill on the Red Rock property silver claims on Admiralty Island. El Paso Natural Gas Company maintained an office, geological staff and geological laboratory in Ketchikan. Other companies that continued exploration in the area were Inlet Oil Company, Cordilleran, Alaska Petroleum and Mining Company, U. S. Borax Company, Humble Oil, American Oil, Newmont, and Utah International.

The iron deposit at Klukwan continued to attract interest. The Kaiser Engineering Company continued a feasibility report for a Japanese firm on the iron rich alluvial sands.



Annual Mineral Production in Alaska
1900–1972

Figure 10

Mineral Production

The value of 1972 mineral production in Alaska is estimated at $317 million, compared with $333 million in 1971, based on statistics compiled by the U. S. Bureau of Mines. Crude oil and natural gas from the Kenai Peninsula and offshore Cook Inlet fields once more were the leading commodities, accounting for $267 million or 84 per cent of total mineral production. Other mineral commodities, in order of value, included sand and gravel, coal, stone, barite, gold and silver, platinum group metals, mercury, antimony, gem stones, and tin.

Alaska's 1972 mineral production, excluding oil and gas, reached an alltime high of $50 million—— a 8% increase over the 1971 figure of $46 million. The principle increase was in sand and gravel. Annual Alaskan mineral production and value in 1971 and 1972 are listed in Table 1. Production of major commodities since 1949 are listed in Table 2. The physical amounts of Alaska mineral production is listed in Table 3. The statistics shown in Table 1 were prepared under a cooperative agreement between the U. S. Bureau of Mines and the Division for the collection of mineral data. The production figures for 1971 are revised on the basis of information collected by the U. S. Bureau of Mines. The production figures for 1972 are the best estimate of production for the year. The figures for coal and barite were estimated by the Division.

Annual mineral production in Alaska, excluding oil and gas, from 1900 through 1972 is illustrated in figure 10. Figure 11 indicates the approximate locations of mineral deposits which were in production at least part of the year, or deposits where there was an active exploration program. There undoubtedly were prospectors and miners active in other areas, and the figure should be considered a minimum. Sand, gravel, and stone deposits were omitted.

Precious Metals

Gold

The total volume of gold production in 1972 is estimated at about the same level as 1971. With the increase of the price of gold, exploration activity also slightly increased. Assaying firms report their gold analyses were approximately double those of 1971, although there was very little change in the number of gold placer operations.

The UV Industries, Inc. continued its dredge on the Hogatza River, and small operators continued to produce from isolated areas near Marvel Creek, Flat, Livengood, Manley Hot Springs, the Seward Peninsula, Boundary, Forty Mile, Wiseman, and Ruby. There was no known lode gold production in Alaska during 1972.

Platinum

The price of platinum was down through June of 1972, at which time it increased. The increased price of platinum may have caused platinum to be the number one precious metal produced in Alaska. Goodnews Bay Company continued to operate its floating dredge and a sluicebox on the Salmon River. The volume of material produced was about the same as 1971. Several companies continued exploration for platinum in the Goodnews Bay area.

TABLE 1. MINERAL PRODUCTION IN ALASKA

NOTE: All values are in Thousands of Dollars

	1971		1972[1]	
	Quantity	Value	Quantity	Value
Antimony--short ton antimony content	XXX	XXX	XXX	XXX
Barite--thousand short tons	102	1,075	120	1,800
Coal--thousand short tons	698	5,710	712	5,696
Gold-troy ounces	13,012	537	14,000	910
Stone--thousand short tons	2,658	5,066	2,870	5,420
Natural Gas[2] --million cubic feet	121,618	28,945	124,300	28,852
Petroleum, Crude[2]--thousand barrels	79,494	257,562	73,452	238,418
Sand and Gravel--thousand short tons	23,617	32,806	25,506	35,101
Silver--thousand troy ounces	>0.5	1	1	2
Undistributed[3]	XX	1,146		961
TOTALS	XXX	332,848	XXX	317,160

[1] Figures for 1972 are preliminary and subject to revision.

[2] Gas and petroleum figures will differ from those published by the Division of Oil and Gas because of different methods of compiling and reporting. For complete details on fields, wells, etc., see the Division of Oil and Gas Annual Report.

[3] Includes uranium, gem stones, mercury, platinum group metals, and tin. Figures on these minerals have been withheld to avoid disclosing confidential data from individuals companies.

Major Base Metals

Copper

One mine in the McCarthy area reportedly produced 12 tons of copper. The ore was smelted at White Pine, Michigan. The smelter at Tacoma, Washington and the usual outlet for Alaskan ores was operating on a restricted basis because of environmental pollution controls.

Lead

One operator in the southern part of the Fairbanks quadrangle mined 14 tons of silver bearing lead ore. The mine is south of the Tanana and the operator was waiting for sufficient snow to sled the ore to the highway for marketing.

TABLE 2. PRODUCTION OF MAJOR COMMODITIES SINCE 1949

NOTE: All values are in thousands of dollars

Year	Gold	Mercury	Coal	Oil and Gas	Total All Production (millions)
1950	$ 10,125	$	$ 3,033	$	$ 17.9
1951	8,387		3,767		19.5
1952	8,420	6	5,779		26.3
1953	8,882	8	8,452		24.3
1954	8,699	277	6,442		24.4
1955	8,725	12	5,759		25.4
1956	7,325	853	6,374		23.4
1957	7,541	1,349	7,296		30.2
1958	6,525	774	6,931		20.9
1959	6,262	851	6,869	311	20.5
1960	5,887	940	6,318	1,496	21.9
1961	3,998	816	5,868	17,776	34.7
1962	5,784	711	6,409	31,657	54.2
1963	3,485	76	5,910	33,760	67.8
1964	2,045	95	5,008	35,490	66.1
1965	1,479	104	6,095	35,614	83.2
1966	956	101	6,953	50,418	86.3
1967	803	79	7,178	95,455	134.6
1968	835	78	5,034	191,083	221.7
1969	881	100	4,647	227,129	257.6
1970	835	1,260	4,059	279,132	338.2
1971	537	285	5,710	286,977	332.8
1972	910	44	5,696	267,270	317.2
Total	109,326	8,775	135,587	1,553,568	2249.1

Minor Base Metals

Mercury

The price of mercury dropped to a 20 year low, bottoming out at $150, per flask, in February. As a result of the low mercury price, there was no known exploration during the 1972 field season. The only known operatory was Robert Lyman, who continued mining and concentrating cinnabar ore at White Mountain, southeast of McGrath.

TABLE 3. PHYSICAL VOLUME OF ALASKA MINERAL PRODUCTION

Mineral	Weight	Quantity	Year	
			From	To
Antimony	(Approx. 53%Sb) short tons	4,180	1928	1971
Coal	Thousand short tons	23,555	1951	1972
Copper	Short tons	690,023	1880	1962
Chromite	(Approx. 45% Cr_2O_3 long tons	29,000	1917	1957
Crude Petroleum	Thousand 42 gallon barrels	394,441[1]	1958	1972
Gold (Total)	Troy ounces	30,030,901	1880	1972
Lead	Short tons	25,016	1906	1969
Mercury	76 lb. flasks	29,224	1902	1972
Natural Gas	Million cubic feet	581,842	1948	1972
Sand and Gravel	Thousand short tons	246,469	1958	1972
Silver (Total)	Troy ounces	19,082,512	1906	1972
Stone	Thousand short tons	23,376[2]	1921	1972
Tin	Short tons	2,452[2]	1902	1972
Tungsten	Short tons Units WO_3	7,000	1916	1958

[1] The only other crude petroleum production recorded was from the Katalla area. From 1901 to 1932, about 154,000 barrels of oil were produced there.

[2] Production data, if any, withheld in 1967, 1968, 1969 and 1970.

Antimony

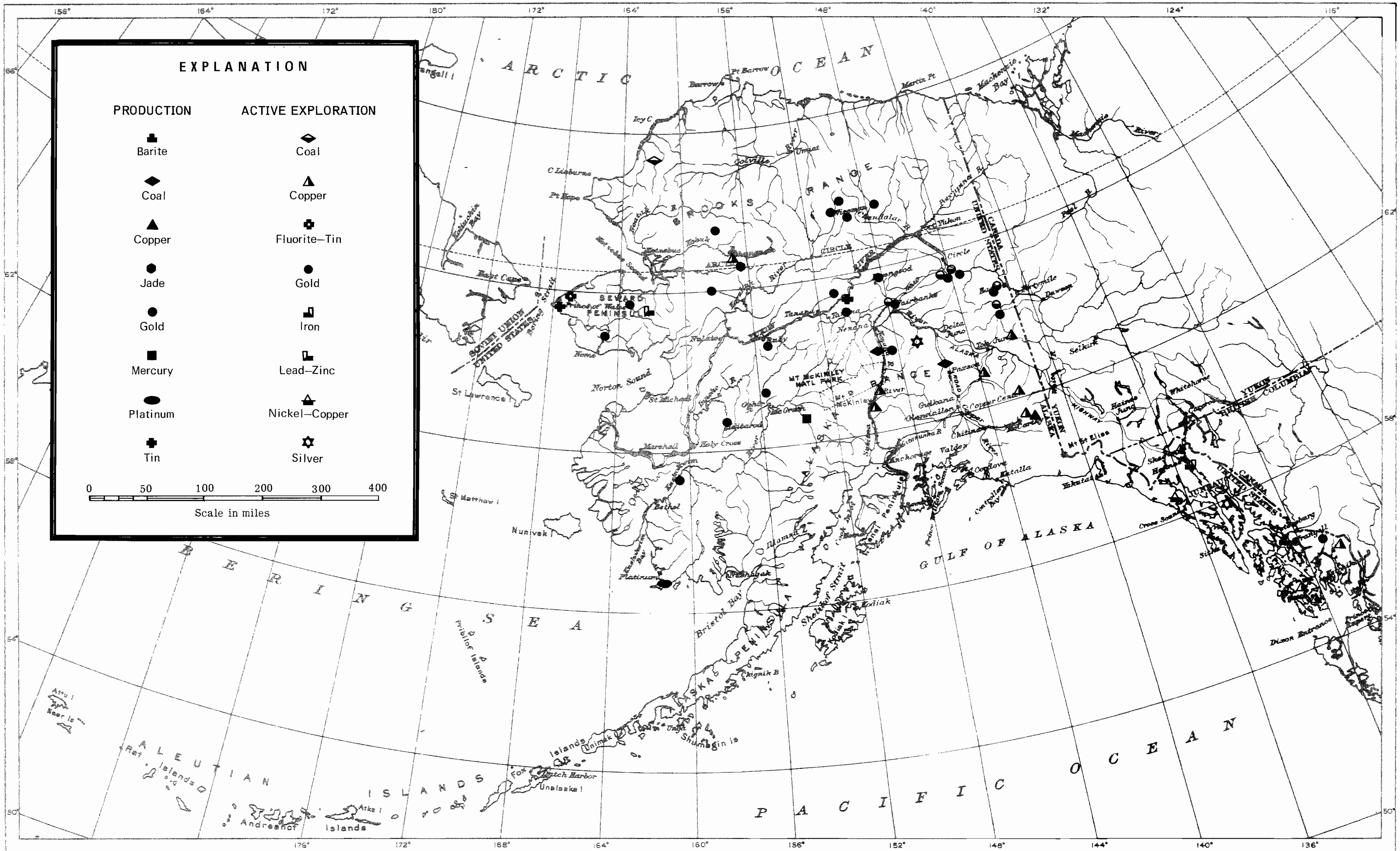
There was no known production of antimony in 1972, however, several groups were active in exploration. The centers of exploration were the Kantishna, Fairbanks area, and the Forty Mile district.

Barite

Alaska Barite Company, a subsidiary of the Inlet Oil Company, continued to operate the under–water, open pit near Castle Island about 12 miles southeast of Petersburg, Alaska. In addition to underwater mining, drilling exploration was undertaken to increase the reserves of ore and to ex–plore the barite containing sulfide zone, which could extend the life of the mine by recovering other valuable metals.

Coal

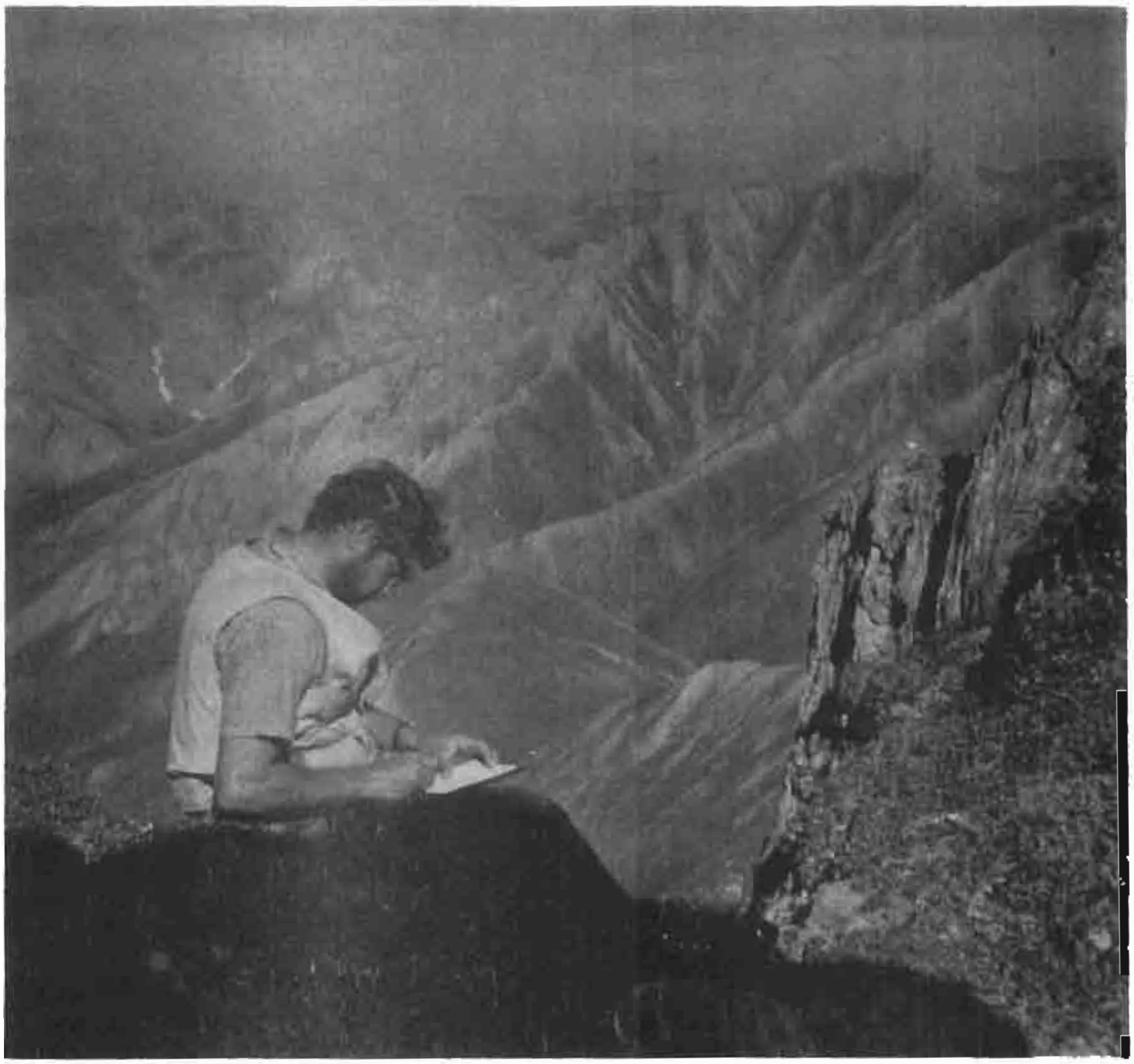
Production and consumption continued at about the same level as 1971. All coal produced in Alaska, in 1972, came from the Nenana coal field. In the winter of 1972, three mines were in operation; two near Healy, and one on Jarvis Creek, south of Big Delta. As summer approached, two mines shut down, leaving only one mine, near Healy, active during the summer and fall of 1972. The major trend of exploration of Alaskan coals continued toward development of a coal field in the Beluga area. The U. S. Bureau of Mines was active in exploration in the northern coal field. A limited amount of exploration work was completed in the Nenana area, directed toward outlying mineable coal reserves for immediate production.



Locations of Mineral Exploration and Production During 1972

Figure 11

SECTION VI



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Publications in Press

Geologic Reports

No. 36. *Geology and Geochemistry of the Sinuk Area, Seward Peninsula, Alaska,* by Gordon Herreid. (63 p., 9 figs., 5 tables, 1 map)

No. 44. *Uranium Investigations in Southeastern Alaska,* by Gilbert R. Eakins. (p., 33 figs., 11 tables)

Publications in Progress

No. *Geology of the Western Clearwater Mountains, South–Central Alaska,* by T. E. Smith

No. *Geology of the Permian Strata in the Rainbow Mountain area, Central Alaska,* by G. C. Bond

No. *Preliminary Geologic Map of the Southeastern Ambler River quadrangle,* by G. R. Eakins, C. E. Fritts, R. E. Garland, G. H. Pessel, and I. R. Tailleur

Geochemical Reports

No. 25. *Geochemical Locations in the Craig A–2 Quadrangle and Vicinity, Prince of Wales Island, Alaska,* Gordon Herreid.

No. 26. *Analyses of Rock and Stream Sediment Samples From the Mt. Hayes A–6 Quadrangle, South–Central Alaska,* Thomas E. Smith, Thomas C. Trible, and Donald R. Stein. (map and table)

No. 27. *Analyses of Stream Sediment Samples Craig A–2 Quadrangle and Vicinity, Prince of Wales Island, Southeastern Alaska,* Gordon Herreid, Thomas C. Trible.

No. *Geochemistry of Rock and Stream Sediment Samples, Southeastern Ambler River Quad–rangle,* by G. R. Eakins, C. E. Fritts, R. E. Garland, T. C. Mowatt, G. H. Pessel, T. C. Trible, D. R. Stein, and N. C. Veach.

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The monthly "Mines Bulletin," published by the Division to "accelerate the development of the mining industry," is being run off by clerk–typist, Olga Austin.

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The information listed below, formerly included as part of the Division's Annual Report, is now available as Information Circulars.

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No. 7	Alaskan Companies & Prospecters, 1973
No. 8	Consultants Available for Work in Alaska
No. 11	List of Reports Issued by the Division of Geological and Geophysical Surveys
No. 17	Companies Interested in Alaskan Mining Possibilities

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