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GEOLOGIC REPORT NO. 30

Geology of the Upper Slana-Mentasta Pass Area

By

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ABSTRACT

The upper Slana-Mentasta Pass area covers approximately 275 square miles in the eastern Alaska Range between the Chistochina and Tok Rivers.

The map area includes a 30-mile long segment of the Denali fault zone, a major strike-slip feature extending from the Bering Sea through southcentral Alaska into northwest Canada. The trend of the Denali fault in the map area is No.62°W. Evidence of recent right lateral and relative south-side-up movement can be observed locally along the trace of the fault.

South of the fault a series of sedimentary and volcanic rocks ranging in age from Permian to Lower Cretaceous dip at moderate angles to the northeast. North of the fault metasediments and metavolcanics, probably of Devonian age or older, dip steeply, principally to the southwest. In the non-metamorphosed bedded rocks south of the fault the following four distinct stratigraphic units, in order of decreasing age, have been recognized: Permian Mankomen Formation, Slana basalt, Jack limestone, and Mentasta argillite. The Mentasta argillite is believed to be of Upper Jurassic-Lower Cretaceous age. The metamorphic rocks north of the fault are quartz mica schist, phyllite, slate, and greenstone with subordinate limestone, marble, and serpentinite.

Small stocks of diorite, granodiorite, and quartz monzonite intrude all the bedded and metamorphic rocks in the area with the possible exception of the Mentasta argillite. A lenticular body of dunite, associated with a larger mass of amphibolite and amphibolite-pyroxenite gneiss, is exposed in the Denali fault zone. One stock of anorthosite is present in the Mankomen rocks south of the fault.

Copper mineralization occurs in scattered localities generally near the top of the Slana basalt and gold has been placered along one stream draining the basalt-diorite contact. Bands of disseminated chromite and small segregations of massive chromite occur in the dunite body. Nephrite has been found in association with serpentine and tremolite in the metamorphic unit north of the fault. A green magnesite marble has been quarried for ornamental stone.

Strong geochemical anomalies, principally in zinc, occur in a number of drainages north of the Denali fault.

INTRODUCTION

The upper Slana-Mentasta Pass area covers approximately 275 square miles in the eastern Alaska Range between the Chistochina and Tok Rivers. It includes most of the drainage area of the upper Slana River, west of Mentasta Pass, and a limited part of the drainage of the Little Tok River east of Mentasta Pass (figure 1). This report is the third of a series describing the geology, mineral deposits, and geochemistry in the eastern Alaska Range since studies were initiated in that region in 1963 by the Division of Mines and Minerals. Earlier reports cover the Slana district (Richter, 1966) south of the present report area and the upper Chistochina area (Rose, 1967) to the west.

Accessibility

The Tok cut-off of the Glenn Highway runs through the extreme eastern part of the area between milepost 76 and 86. A well-maintained secondary road leaves the Glenn Highway at about milepost 82 and continues westerly six miles to Mentasta Village (see figure 2). West of Mentasta Village a tractor trail follows the Slana River valley to beyond Alteration Creek where it leaves the river and heads overland to Mankomen Lake. In dry weather, ordinary vehicles can drive on the tractor trail as far as the first Slana River crossing near Jack Creek about 11 miles northwest of Mentasta Village. Beyond that point and up to the headwaters of the Slana River, the trail and river bottom can only be traveled by swamp buggy or tracked vehicle.

No suitable landing areas for fixed wing aircraft have been cleared in the area. Float planes can use Mentasta Lake but the water is shallow and caution should be exercised on landing and take-off.

Previous work

The only previous geological investigations in the area are those of the U.S. Geological Survey. These reconnaissance studies were undertaken during the period 1929-1942 and have been the subject of three local reports (Moffit, 1932, 1933, 1938) and one comprehensive report on the eastern Alaska range (Moffit, 1954).

Present investigation

The 275 square miles of the upper Slana-Mentasta Pass area were mapped in 34 days during the period July 14-August 31, 1966. Field mapping was done at a scale of 1 inch = 1 mile along traverses ranging from one to two miles apart. A total of 98 stream sediment samples were collected from most of the larger streams and many of the smaller tributaries, for field testing and laboratory analyses. A large group of fossils and fossil-bearing samples were collected from the limestones throughout the area, however, the results of the fossil examinations were not yet available when this report was written.

The writer was assisted by Joe M. Britton throughout the investigation. Special thanks are again due the Duffy family, owners and operators of Duffy's Travern, milepost 63 on the Glenn Highway for their generosity in the use of their roadhouse facilities as headquarters camp and to the Frey family of Slana for use of their cabin on Lost Creek.

GEOLOGY

Setting

The upper Slana-Mentasta Pass area covers a 30-mile long segment of the Denali fault zone, a major strike-slip feature in southcentral Alaska. South of the fault at least four distinct non-metamorphosed sedimentary and volcanic rock units ranging in age from Permian to Lower Cretaceous dip at moderate angles to the northeast. North of the fault the rocks are a series of low grade regionally metamorphosed sediments and volcanics of Paleozoic age that dip steeply to the southwest.

The oldest of the rock units south of the fault is the Permian Mankomen Formation. Above the Mankomen Formation are a thick series of basaltic lava flows (Slana basalt[1/])

a thin and locally discontinuous limestone (Jack limestone), and a thick assemblage of argillite, graywacke, conglomerate and minor limestone (Mentasta argillite).

The following table gives a brief lithologic description of the non-intrusive rocks in the map area arranged in order of stratigraphic position.

Age	Formation or rock type	Lithologic character	Thickness
Pleistocene to Recent	Stream and glacial deposits, landslides, and rock glaciers.	Unconsolidated sand and gravel, breccias, unsorted morainal material, etc.	0-300?
Upper Jurassic to Lower Cretaceous	Mentasta argillite	Argillite interbedded with graywacke, siltstone, shale conglomerate, and minor limestone. Includes subunit of massive conglomerate and conglomeratic sandstone.	9000
-- unconformity --			
	Jack limestone	Massive thick bedded reef(?) limestone with minor thin-bedded limestone, limy siltstone and sandstone.	0-600
	Slana basalt	Dark green, grayish-green brown, maroon, and purple amygdaloidal basalts. Top of unit locally consists of basalt - limestone breccia or conglomerate.	6000-8000
-- angular (?) unconformity --			
Permian	Mankomen Formation	Argillite, shale, limestone, chert, and porcellanite.	>2500
-- Denali fault --			
Paleozoic, possibly Devonian	Metamorphic rocks	Quartz mica schist, phyllite limestone, marble, serpentinite, serpentine-chlorite schist, and greenstone.	Probably >10,000

1/ The terms Slana basalt, Jack limestone, and Mentasta argillite are informal names, after local geographic features.

Small stocks of diorite, granodiorite, and quartz monzonite, intrude the bedded and metamorphic rocks with the possible exception of some of the younger strata of the Mentasta argillite. A lenticular body of dunite and a larger mass of amphibolite and amphibolite-pyroxenite rock occur in the Denali fault zone. One intrusive body of anorthosite is associated with diorite south of the fault zone.

Metamorphic rocks (msp, mg, ml, msc, mm)

North of the Denali fault throughout the entire upper Slana-Mentasta Pass area, is a thick series of low-grade regionally metamorphosed sediments with interbedded volcanic rocks and lesser amounts of a variety of schists, serpentinites, and marbles of questionable origin.

Description

The principal rocks in the metamorpnic unit are buff, tan, and gray quartz mica schists, dark gray to black phyllites, dark slate, brown to gray quartzite, and green quartz-mica-chlorite schists (msp). With the possible exception of some of the chlorite-bearing schists all are of sedimentary origin. The quartz mica schists appear to be mostly sandstones and/or graywackes and pebble conglomerate containing slightly stretched clasts of chert, limestones, and other sedimentary rocks. The phyllites and slates represent original carbonaceous argillites, shales, and siltstones. Bedding is generally discernible in many of the rocks and all exhibit a relatively strong foliation. In thin section, bands of foliate white mica and cataclastic quartz are the chief constituents in most of the rocks. Other minerals, some of which are locally predominant, are tremolite-actinolite, chlorite, biotite, albite, carbonate, and graphite (carbonaceous material).

One large band of greenstone probably as much as 5,000 feet thick and a number of thinner and less extensive bands have been delineated on the geologic map (mg). These rocks are dense, generally massive dark green or greenish gray volcanic flows, and probably shallow intrusives. Locally they are highly fractured, with serpentine often present as a fracture filling, but nowhere are they foliated to the extent shown by the metasediments. In thin section the rocks consist chiefly of fine-grained felty tremolite-actinolite with interstitial albite and varying amounts of chlorite, epidote, and opaque minerals. Albite and epidote often appear segregated in bands or veins. A few coarse-grained greenstones consist of laths of highly saussuritized plagioclase, partially enclosed by fresh to altered hornblende (chlorite) with minor ilmenite, leucoxene, and magnetite. The original rocks probably ranged in composition from andesite to basalt with the former predominant. Analyses of three greenstones (see table 2) disclosed only trace amounts of nickel (less than 0.01%) and chromium (less than 0.3% Cr_2O_3) suggesting a composition less basic than basalt.

A number of thin bands of recrystallized limestone (ml) occur throughout the metamorphic unit, especially in the eastern part of the map area. The largest limestone band is as much as 500 feet thick and can be traced for over seven miles. The limestones are light gray to gray in color and weather to a very light gray. Bedding has generally been obliterated but occasionally a crude banding, which may represent original bedding can be observed. A thin platy structure, apparently due to metamorphic recrystallization, is also locally developed in the limestone. A few poor bryozoan-like remains were the only fossils noted in the limestones. Along the ridge west of Station Creek the south contact of the large limestone band is complexly interlayered with thin greenstone and phyllite bands and contains a variety of coarsely crystalline metamorphic minerals. Northward from the main quartz mica schist, across approximately 100 feet of contact zone, the rocks are dark phyllite, greenstone, quartz mica schist, serpentine-magnesite, greenstone with fibrous actinolite-serpentine-talc, and recrystallized limestone.

In the same Station Creek-Mentasta Pass area, a 100 to 200 foot thick band of serpentine-chlorite schist and massive serpentinite, with minor nephrite and tremolite-rich zones (msc) occurs 400 to 1,000 feet stratigraphically above (to the south) of the major limestone band discussed above. The rock is generally soft and weathers to a conspicuous light green color. The serpentine ranges in color from black to yellow and in form from massive to platy or schistose, especially where chlorite is present. Nephrite was found in one locality (locality 7, figure 2) where it occurs associated with white fibrous tremolite and black serpentinite. The nephrite is dark green to apple green in color and generally schistose. Analyses of the nephrite and of the serpentinite from the same band farther to the west show an abnormally high nickel and chromium content (samples 12 and 13, table 2) suggesting an ultramafic origin.

Another unique and striking rock type in the metamorphic unit is a thin band of green, white, and cream magnesite marble (mm) 10 to 30 feet thick that is intermittently exposed for almost a mile north of the big bend in Lost Creek. The rock consists of irregular thin laminae and lenses of magnesite, quartz, dolomite, white mica, and an unidentified green nickel-bearing(?) mineral, cut by numerous veinlets of quartz, magnesite, and dolomite. Blebs and streaks of pyrrhotite are scattered throughout. Locally the band is in contact with a gray dolomite marble but in general it appears to be enclosed by schist and phyllite. Like the serpentine rocks described above, the magnesite marble also contains abnormal amounts of nickel (0.3%, sample 9, table 2) and may represent an altered ultramafic rock.

Structure and thickness

The foliation in the metamorphic rocks strikes northwesterly, parallel to the Denali fault, and generally dips steeply to the southwest. Where observed, the bedding appears to parallel the foliation. Lineations, formed by crinkles and minor fold axes, plunge at shallow angles (0-30°) to the southeast. Most of the rocks are also strongly fractured or jointed with the fractures and joints filled with white quartz and quartz-calcite veins.

The thickness of the metamorphic unit is probably greater than 10,000 feet. The rocks crop out across their strike for over 30 miles north of the Denali fault but probably are repeated by folding and faulting.

Age and correlation

Based on the presence of fossils in the limestones, the youngest (southernmost) rocks in the metamorphic unit are certainly not older than Paleozoic in age. Limestones in similar rocks from the Cheslina River area to the southeast have been dated by fossils as Devonian in age (Moffit, 1954, p. 98-99). Hence on the basis of the extremely thick section present and the general appearance of higher grade metamorphism to the north, it is likely that the rocks represent a number of geologic periods possibly as old as the Precambrian.

Mankomen Formation (Pm)

Rocks of the Mankomen Formation, as originally described by Mendenhall (1905) are exposed in two localities in the upper Slana-Mentasta Pass area. One of these is along the west side of the Slana River, north of Mankomen Lake (see figure 1), and is part of an extensive outcrop of Mankomen Formation that includes the type section. The other locality, which has not been previously mapped, is on the east side of the Slana River, five miles south of Mentasta Pass.

Description

In the area west of the Slana River only a small part of the top of the Mankomen Formation was examined. Here approximately 850 feet of interbedded argillite, shale, siltstone, and minor limestone form the uppermost unit in the Mankomen. The clastic rocks are dark gray and thinly bedded; no fossils were observed. Massive , recrystallized, light gray to white limestone apparently occurs as discontinuous lenses in the clastic rock unit and locally may be upwards of 100 feet thick.

The clastic unit overlies approximately 800 to 1,000 feet of interbedded recrystallized limestone, silicified limestone, chert, and porcellanite(?). The rocks are all light gray, buff or light green in color and extremely dense and hard. Individual beds range in thickness from a few inches to more than three feet. Fossils, predominantly brachiopods, are abundant in some beds. Most of the rocks in this unit weather white or very light-colored and because of their resistance to erosion, generally form prominent and conspicuous cliffs. In the very irregular contact zone with the small diorite intrusive on the west band of the Slana River a megabreccia of recrystallized Mankomen limestone, greenstone (altered basalt) and diorite is exposed. Blocks in the megabreccia are as much as 20 feet in diameter with sheared and brecciated margins. Large crystals of yellow-green to red-brown grossularite-andradite garnet are relatively common throughout the limestone in the breccia and locally radiating crystal clusters of wollastonite are present. Limonite-stained areas are scattered throughout the contact area and occasionally small (less than 1 inch) masses of pyrite are observed on freshly broken surfaces.

The carbonate-silica unit overlies a dark argillite-shale unit in the Mankomen of unknown thickness.

At tne other locality of Mankomen rocks in the area, 27 miles southeast of the section described above on the east side of the Slana River, a minimum of 2,500 feet of thin-bedded, cream to light green fossiliferous limestone, silty limestone, chert and porcellanite(?) are exposed. These rocks are similar to the upper carbonate-silica unit in tne Mankomen Formation to the west. However, the overlying dark argillaceous unit appears to be absent. Locally some of the beds consist almost entirely of radiating crystal clusters of wollastonite indicating close proximity to an intrusive mass. The presence of wollastonite also suggests that the wollastonite-bearing gneisses and schists exposed on the isolated mountain 1 1/2 miles across the Slana River to the west are thermally metamorphosed Mankomen rocks and not pre-Permian as suggested by the writer earlier (Richter, 1966).

Structure

In the area west of the Slana River the Mankomen rocks dip between 35° and 65° to the northeast. Further to the west the beds appear to dip more northerly suggesting a broad anticlinal fold plunging gently to the north or northeast. At the locality east of the Slana River the Mankomen rocks also dip at moderate angles to the northeast.

Age

On the basis of extensive megafossil studies the Mankomen Formation has long been established as Permian in age (Mendenhall, 1905; Moffit, 1954).

During this present study fossils were only collected from the relatively isolated Mankomen exposure east of the Slana River. Although these fossils have not yet been studied in detail, the similarity of macrofauna and lithology between these rocks and known Mankomen to the west plus their general stratigraphic setting leaves little doubt as to their assignment as Mankomen. Only the upper part of the Mankomen Formation is present in the map area. The maximum of about 2,500 feet exposed represents about one-third of the total thickness (6,700 feet) measured by Mendenhall (1905) in the type locality. East of the map area in the Nabesna area, the Mankomen Formation apparently thins (Moffit, 1954).

Slana basalt (sb)

Overlying the Mankomen Formation, with a suggestion of a slight angular unconformity, is a thick series of dark-colored amygdaloidal basalt. The basalt extends in a continuous belt, upwards of three miles wide, throughout the map area from the headwater region of the Slana River southeast to beyond Mentasta Pass. In Moffit's (1954) early reconnaissance mapping in the eastern Alaska Range, the basalt was for the most part included in his undifferentiated Paleozoic rocks or undifferentiated igneous rocks and was not recognized as a distinct and separate geologic unit.

Description

The Slana basalt in the map area consists of a series of many hundreds of basaltic lava flows with individual flow units ranging from a few feet to probably tens of feet in thickness.

Flow layering may not be too conspicuous at close range, especially in the thicker and more massive units, but when viewed from a distance the individual flows become remarkably clear. In general the basalts are predominantly dark green in color but locally, and in some areas exclusively, they may be various shades of brown, maroon, red, purple, and lighter green. Reddish-brown and maroon flows also appear to be more common in the upper part of the basalt unit west of Mentasta Lake. Scoriaceous flow tops and bottoms ranging from a few inches to many feet thick generally separate the individual flows. Pillow structures were not observed in the flows nor are any interbedded sediments present, suggesting that the lavas flowed out in a subaerial envlroment. Amygdaloidal vesicle-fillings are a characteristic feature of the basalts but may be locally absent in some of the massive flows especially at the base of the unit. The amygdules range in size from minute spherical blebs to large irregular masses as much as one inch in diameter and are filled with a variety of low-temperature secondary minerals.

The base of the basalt unit where observed in two localities in the map area, is a massive dense dark green flow or flows containing angular fragments of light-colored Mankomen Formation. Upwards from the base, the flows tend to become less massive. At the top of the unit where the Jack limestone overlies the uppermost basalt flow, limestone has filled most of the available open space in the basalts such as the scoriaceous tops and bottoms of the flows and early formed fractures. Occasionally the Jack limestone is absent or is interbedded with flows in the upper part of the Slana basalt. In these areas the basalts characteristically contain limestone inclusions and locally, such as southwest of VABM Tasta and in the headwater region of the Slana

River west of Gillett Pass, the limestone inclusions are more abundant than the matrix basalt and the rock has the appearance of a limestone-basalt conglomerate or breccia. In the latter area, a non-structural megabreccia with blocks of limestone and basalt as much as 10 feet in diameter outcrops between two distinct Jack limestone beds.

Only one rock of non-basaltic affinity was observed in the Slana basalt unit. This rock, a pink-gray banded volcanic consisting of extremely fine-grained quartz, albite, and minor potash feldspar, is exposed in a narrow band at the head of Alteration Creek.

The basalts are fine-grained, locally porphyritic or glomero-porphyritic with altered phenocrysts of feldspar. In thin section the groundmass texture is intergranular or possibly intersertal. In general, only small laths of altered feldspar are discernible in the groundmass, the remainder being a dark cloudy fine-grained mixture of chlorite, iron oxides (reddish in the maroon basalts) and probably carbonate and epidote. Equant phenocrysts of iron-stained fine-grained chlorite, probably representing original olivine are occasionally observed. Vesicles are filled with fine- and coarse-grained chlorite, coarse-grained epidote and calcite, quartz, natrolite and pumpellyite in widely varying proportions. Where quartz and natrolite are present, they invariably line the vesicle wall. Pumpellyite was only observed in amygdules from one sample of basalt float collected on lower Jack Creek. West of Jack Creek near the diorite intrusive, the amygdules consist of chlorite, pleochroic blue-green amphibole, and a pleochroic brown mineral.

Structure and thickness

The Slana basalts strike northwest, essentially parallel the strike of the underlying Mankomen rocks, and have an average dip of about 35° to the northeast. Near faults the flows may be more steeply dipping but in general it appears that they are slightly less inclined than the Mankomen strata.

The Slana basalt is approximately 7,000 to 8,000 feet thick. This estimate is based on cross sections constructed with available field data, assuming no repetition of beds by folding or unobserved faults.

Age and correlation

The Slana basalt is definitely younger than the Permian Mankomen Formation which it overlies with possible slight angular unconformity. A more definitive age assignment must await the results of the studies of fossils collected from the overlying and locally interbedded Jack limestone.

It is interesting and important to note here, however, the striking similarity in physical appearance, composition, alteration, and thickness between the Slana basalt and the Nikolai greenstone of late Middle or early Late Triassic age (MacKevett, 1964), which outcrops in the southern Wrangell Mountains south of the map area. Moffit (1954, p. 115), on the other hand, reports that the Nikolai greenstone has not been recognized in the eastern Alaska Range, and the amygdaloidal basalts he observed in the area were assigned to the Permian. This assignment is based on Moffit's (1954) interpretation that east of Mentasta Pass amygdaloidal basalts undoubtedly equivalent to the Slana basalt apparently are overlain by both Triassic limestone (in the Trail, Lost, and Chalk Creeks and Nabesna areas) and Permian limestone (in the Soda Creek area).

The Slana basalt is also similar to a Triassic basalt-andesite unit which is locally overlain by a Triassic limestone in the upper Susitna River area in the central Alaska Range (Moffit, 1912; Ross, 1933) and to the Amphitheatre basalt of Rose and Saunders (1965) near Paxson between the upper Slana River and Susitna River areas.

Jack limestone (jl)

The Jack limestone is a gray, generally massive limestone that overlies, and is locally interbedded with, the Slana basalt. It can be traced throughout the length of the upper Slana-Mentasta Pass area but appears to be absent or very thin at a number of places along its zone of expected exposure. In a few areas, discontinuous beds of massive limestone also occur lower in the Slana basalt section and are herein considered as a part of the Jack limestone.

Description

The Jack limestone is a fine- to coarse-grained gray limestone which weathers a very light color, generally forming conspicuous cliffs. It is massive, seemingly devoid of any primary bedding or fossils but highly fractured and broken, with joints and fractures filled with white calcite. Locally, it is thinly bedded and relatively fossiliferous. The strata in the bedded units contain abundant silt and fine sand and generally is buff to light tan in color. The predominant life forms appears to be corals and brachiopods, but the fossils are poorly preserved. Small zones or lenses of siliceous material which impart a hackly surface on weathered exposures, are relatively common throughout the limestone, and locally pods and lenses of gray to dark gray chert are present. These features suggest that most of the limestone is of reef origin with minor stratiform back and fore-reef clastic deposits.

Along the contact of the elongate intrusive diorite between Jack Creek and Lost Creek the limestone has been metamorphosed to a crystalline white marble. Elsewhere the Jack limestone appears to be only locally recrystallized.

Structure and thickness

Where bedding is observed in the limestone, the strata appear to be conformable with the underlying Slana basalt, dipping at moderate angles to northeast. The massive reef-like units, on the other hand, which do not exhibit any obvious primary layering, have the appearance of unconformable pods lying on the basalt. Local exceptions to the northeast dip of the limestone occur near the Denali fault west of Gillett Pass where the beds are vertical and may be overturned, and along the west of Jack Creek, in the vicinity of another but smaller fault, where the beds are very steeply dipping.

North of the west fork of Jack Creek, the geologic structure, as shown by the limestone exposure pattern, is probably more complex than indicated on figure 2 and further complicated by the probable presence of more than one limestone unit, interbedded with the Slana basalt.

The thickness of the Jack limestone is extremely variable and estimates of an average thickness are not only unreliable but misleading. Within a distance of a few hundred yards from where the limestone is apparently absent, it may be as much as 500 feet or more thick. The thickest section appears to be the massive units south of Mentasta Pass and in the area south of Gillett Pass where approximately 600 feet of limestone is exposed.

Age and correlation

Relatively abundant fossils, principally corals, brachiopods, and crinoids, occur in a number of the bedded strata in the Jack limestone. Fossil collections from the Jack limestone are presently being studied. As discussed previously in the section on age of the Slana basalt, a definitive age assignment, should diagnostic fossils be present, for both the basalt and limestone must await the results of these studies. If the limestone proves to be of Triassic age it would then be correlative to the Chitistone limestone of the southern Wrangell Mountains and the Slana basalt correlative to the Nikolai greenstone.

Mentasta argillite (ma)

The youngest bedded rock group in the upper Slana-Mentasta Pass area is a thick unit of predominantly fine-grained clastic rocks that overlies the Jack limestone or, where the limestone is missing, the Slana basalt, with apparent unconformity.

These rocks are exposed in a continuous northwesterly trending band ranging from 1/2 mile wide, in the extreme northwest end of the map area, to almost three miles wide in the Mentasta Pass area. The top of the Mentasta argillite is not exposed; throughout the entire map area the argillite is cut by the Denali fault which has brought older metamorphic rocks in contact with the non-metamorphosed argillites.

Description

The Mentasta argillite consists of thin-bedded dark gray argillite and shale, lighter gray to buff siltstone and graywacke, and minor conglomerate, limey clastic rocks, and an occasional limestone. The finer-grained beds generally average less than a few feet thick whereas the coarser-grained clastics may be as much as 10 feet thick or more. Graded bedding is common in many of the argillite-graywacke exposures with the alternating beds generally less than a few inches thick. In the conglomerates, clasts of limestone, diorite, and volcanic rocks predominate. No fossils were recognized in any of the rocks.

A distinct and relatively thick subunit of coarse-grained clastic rocks (mac) has been delineated on the geologic map (figure 2) in the area west of Mentasta Pass. The subunit is composed principally of massive conglomerate gradational into coarse-grained conglomeratic sandstone. The conglomerate contains rounded clasts of limestone, crystalline dioritic rocks, and minor argillite, as much as one foot in diameter, in a gray to greenish-gray coarse sandstone matrix.

Structure and thickness

With local exceptions, the beds in the Mentasta argillite dip moderately to steeply to the northeast. East of Mentasta Pass, immediately south of the Denali fault, movement along the fault has resulted in a marked reversal in dip to the southwest forming a narrow syncline probably plunging gently to the southeast. Smaller local folds are commonly observed throughout the Mentasta argillite and very likely minor faults are present.

The apparent thinning of the unit to the northwest is structural and due to the slight angle between the strike of the bedding in the argillite and the strike of the Denali fault. Based on exposures south and east of Mentasta Pass and assuming negligible repetition of beds by either folding or faults, the minimum thickness of the Mentasta argillite is approximately 9,000 feet. Minimum thickness of the local conglomerate subunit is approximately 600 feet.

Age and correlation

The Mentasta argillite is without doubt the northwest continuation of the argillite-graywacke sequence of Upper Jurassic-Lower Cretaceous age mapped by Moffit (1954) from the Nutzotin Mountains up to Suslota Pass two miles southeast of Mentasta Pass. From Suslota Pass northwestward, Moffit unfortunately included the Mentasta argillite in his undifferentiated Paleozoic unit, an assignment that until now precluded any understanding or synthesis of the stratigraphy and structure in the Mentasta Pass area.

The relatively young nature of the Mentasta argillite is also supported by the presence of diorite cobbles in the conglomerate facies of the argillite. These dioritic rocks of presumed Mesozoic age (Middle to Upper Jurassic?) must have been at least in part intruded prior to the beginning of deposition of the Mentasta argillite.

Intrusive Rocks

Crystalline intrusive rocks, ranging in composition from quartz monzonite to dunite occur throughout the area. The individual bodies are relatively small and do not approach the size nor complexity of the large tectonic diorite-quartz diorite complex south of the Slana River (Richter, 1966). The age of the intrusives is not well-defined. Moffit (1954) considers most of the quartz monzonite, granodiorite, and diorite rocks to have intruded during the Mesozoic. In the upper Slana-Mentasta Pass area the intrusives definitely are younger than the Jack limestone, but based on the presence of diorite clasts in the Mentasta argillite, are older than at least some of this thick series of sediments of probable Upper Jurassic-Lower Cretaceous age. No criteria exists to date the ultramafic or mafic intrusives. All occur north of the Denali fault in rocks of Paleozoic and possibly older age.

Diorite, granodiorite, and quartz monzonite (di)

The principal intrusive rocks in the area are of diorite, granodiorite, quartz monzonite, and probably quartz diorite composition. Compositional variation is common even in the same intrusive body. Diorite and granodiorite types predominate; the more silicic varieties generally occurring as small irregular phases within a larger more basic body. The rocks range from medium to coarse-grained, are locally porphyritic and locally strongly foliated especially those near the Denali fault.

Nine separate intrusive bodies are shown on the geologic map (figure 2), the largest, between Lost and Jack Creeks, is about 7 miles long and as much as 1 1/2 miles wide. Six of the bodies occur south of the Denali fault, the remaining three are within or just north of the fault zone.

In thin section, the diorites and granodiorites are subhedral granular and contain more than 50% plagioclase (An_{40-25}), between 8 and 23% potash feldspar, generally less than 10% quartz, 6-20% hornblende and minor augite, biotite, magnetite, spinel, and apatite. Modal analyses for typical rocks of this group are given in table 1, (samples 1, 2, and 4). The diorite of sample 4, table 1, is somewhat unique with an unusually high potash feldspar content and a very low Color Index of 11. In the field the entire intrusive body appears homogeneous. The quartz monzonites are generally porphyritic with some containing phenocrysts of potash feldspar up to two inches long. Quartz monzonite and granodiorite occur as an elongate "core" to the large diorite mass between Lost and Jack Creeks (sample 2, table 1), and quartz monzonite is a principal rock type in the foliated diorite body west of Station Creek (sample 6, table 1). In the diorite body east of Mentasta Pass, biotite is abundant (5-10%) especially in the fine-grained extreme east end of the intrusive where it is associated with pyrrhotite and quartz.

Ultramafic and mafic rocks (d, am, an)

A lenticular body of dunite (d) two miles long and 1/2 mile wide outcrops within the Denali fault zone just west of Gillett Pass. The dunite consists of extremely fresh, but locally cataclastic fine- to coarse-grained, medium-gray forsterite. Bands of disseminated chromite and small segregations of massive chromite are conspicuous througnout most of the body. An analysis of a number of grab samples of the dunite ran 1.2% Cr_2O_3, and 0.4% Ni (sample 5, table 2). Veins of acicular to fibrous pale green to white antigorite with minor carbonate minerals are also present in the ultramafic mass. On exposed surfaces the dunite is pale tan in color, typical of weathered olivine-rich rocks.

Partly enclosing the dunite body, and extending to the east within the Denali fault zone, are a group of amphibolites and banded amphibolite-pyroxinite rocks (am) that probably represent a complex of metamorphosed diorite or gabbro. The typical rock is coarse-grained, dark green to green in color, and consists of hornblende partly altered to green biotite and feldspar altered to relatively coarse epidote with minor augite and carbonate (sample 3, table 1). In the less common banded gneissic variety the rock is composed of dark bands of augite, hornblende, chlorite, and pyrrhotite alternating with light bands of hornblende, epidote, and chlorite. No anomalous amounts of chromium or nickel were detected by x-ray fluorescence analysis (sample 8, table 2).

A body of anorthosite (an) or leucogabbro is exposed in the extreme southeast corner of the area. It forms bold light-colored outcrops over at least one mountain and appears to continue to the southeast for possibly another mile beyond the map area. The anorthosite is in intrusive(?) contact with normal dioritic rocks but its contact with the bedded rocks is covered by surficial deposits. The rock is light gray, medium- to coarse-grained and massive with conspicuous bands and irregular clots of dark minerals. The bands range from less than an inch to over a foot in width. In thin section (sample 7, table 1) the plagioclase (calcic labradorite-sodic bytownite) occurs in very fresh anhedral crystals as much as 5 mm in diameter. The dark bands and clots are composed of augite subordinate and interstitial to the feldspar but in optical continuity over as much as 100 square millimeters. The augite is locally altered to biotite around its margin and thin films of hematite often fill cleavage and parting planes.

Surficial deposits (Qg, Ql, Qr)

Extensive deposits of recent stream-deposited sand and gravel fill most of the larger river and stream valleys in the area. Alluvial fans, some covering as much as one square mile, have formed at the base of most of the high gradient streams tributary

Table 1

Modal analyses of crystalline intrusive rocks in the upper Slana-Mentasta Pass area.

Rock Type	Diorite	Granodiorite	Amphibolite	Diorite	Dunite	Quartz Monzonite	Anorthosite
Map Number 1/	1	2	3	4	5	6	7
Field Number	S-66-4	S-66-5	S-66-12	S-66-31	S-66-37	S-66-62	S-66-86
Plagioclase-feldspar	60 (An_{40-25})	58 (An_{40-30})		56 (An_{40-30})		28 2/	80 (An_{70})
Potash feldspar	0	18		23		26	
Quartz	4	11		10		13	
Hornblende	19	8	42	9		17	
Augite	3	1	1				15
Olivine					96		
Biotite		tr.	14 3/				1
Biotite-chlorite						13	
Epidote						2	
Plagioclase-epidote			43				
Antigorite-chlorite							3
Magnetite	4	3		2		tr.	1
Chromite					4		
Sphene	2	tr.		tr.		tr.	
Apatite	tr.	tr.		tr.			
Carbonate			tr.				
Color Index	28	12		11	100	32	20

1/ Refers to geologic map in figure 2.

2/ Highly saussuritized

3/ Minor interlayered chlorite

Table 2. Chromium and nickel content of ultramafic and basic rocks from the upper Slana-Mentasta Pass area.

Map No.[1/]	Field No.	Rock Type	Weight percent Cr_2O_3	Weight percent Nickel
5	S-66-37	Dunite	1.2	0.4
8	S-66-38	Gneissic amphibolite-pyroxenite	trace[2/]	trace[3/]
9	S-66-43	Magnesite marble	trace	0.3
10	S-66-44	Serpentinized greenstone	trace	trace
11	S-66-46	Greenstone	trace	trace
12	S-66-57	Serpentinite	trace	0.5
12	S-66-57A	Chlorite-serpentine schist	trace	trace
13	S-66-66	Nephrite	1.2	0.3
14	S-66-69	Diabasic greenstone	trace	trace

1/ Refers to geologic map in figure 2.

2/ trace Cr_2O_3: $\leq$0.3 weight percent

3/ trace Nickel: $\leq$0.01 weight percent

Analyst: Namok Cho, Division of Mines and Minerals, by x-ray fluorescence to the larger low gradient water courses. Along the north side of the upper Slana River a number of these fans have coalesced to form an extensive alluvial fan plain a half mile wide and four miles long.

Remnant morainal deposits occur locally on the lower slopes of the main valley walls, but in general they have been largely reworked by recent stream action.

Two large landslides (Ql) have been mapped in the area. The largest, covering almost one square mile occurs in the valley of Jack Creek and consists almost entirely of diorite blocks derived from the top of the ridge northeast of the slide. The smaller slide occurred on a steep hillside in a small valley near the headwaters of the Slana River.

Rock glaciers (Qr) are present in the higher mountains south and southwest of Gillett Pass. The two westernmost rock glaciers still have small ice glaciers at their head.

Structure

The principal structure in the upper Slana-Mentasta Pass area is the Denali fault. This major strike-slip fault follows an arcuate path through southern Alaska from the Bering Sea to Canada. Until this present investigation, the fault was not recognized in the upper Slana-Mentasta Pass area, although from even casual inspection of small scale geological maps it was obvious that the fault must be present. The problem was due largely to the lack of detailed geologic mapping and the inclusion of a number of rock types of widely diverse ages into a single geologic or map unit.

The Denali fault in the map area follows a remarkably straight course of N63°W with only minor deviation. South and southeast of Gillett Pass the fault is complex and apparently consists of a number of parallel branches forming a fault zone as much as 1/2 mile wide. Farther to the southeast in the Mentasta Pass area only the trace of a single structure can be recognized. Movement on the Denali fault has been principally right lateral strike slip with total offset probably on the order of 150 miles (St. Amand, 1967; Grantz, 1966). Synclinal folds in the Mentasta argillite immediately south of the fault also indicate a considerable vertical component of movement with the north side up relative to the south.

The fault has been active over a long period of geologic time, probably from as early as middle Mesozoic to Recent. Most of the movement, however, probably occurred during the early Tertiary. Evidence of Recent activity on the fault has been observed at a number of localities in the upper Slana-Mentasta Pass area. Right lateral offsets of presently active streams of as much as 500 feet, are well-displayed on some of the tributaries to the west fork of Lost Creek and the east fork of Jack Creek. Recent vertical movement appears to be principally south-side-up, opposite to the long term sense of vertical movement on the fault. Two miles northwest of Mentasta Lake a recent alluvial fan on the south side of the fault has been uplifted 20 to 30 feet altering the course of the stream. Elsewhere, especially east of Mentasta Pass and northwest of Gillett Pass a subtle, north-facing scarp marks the trace of the fault.

A number of smaller faults roughly parallel the Denali fault west of Jack Creek. These faults are also apparently of strike-slip habit and complicate the already complex structure exhibited by the bedded rocks in that area.

In the bedded rocks south of the Denali fault, folding (and steeply dipping strata) is only pronounced close to the fault. Elsewhere these beds dip at moderate angles to the northeast. Slight differences in dip between the Mankomen Formation and overlying Slana basalt suggest the presence of a slight angular unconformity between these two geologic units.

North of the fault, the metamorphic rocks are steeply dipping generally to the southwest. The presence of minor folds in the rocks, with axes plunging at shallow angles to the southeast, is evidence for large-scale folding.

ECONOMIC GEOLOGY

There are no operating mines or mineral deposits under development in the upper Slana-Mentasta Pass area. Prospecting activity, however, has been high for a number of years, and during the summer of 1966 at least three prospecting parties spent most of the field season in the area. Moreover, the presence of deep structures, abundant intrusive bodies of varied composition. and host rocks such as limestones and basalts, attest to the favorable conditions for the deposition and concentration of economic minerals in the area.

Descriptions of mineral occurrences

Gold

Locality 1. A small amount of placer gold has reportedly (oral communication, J. Frey, Slana, Alaska) been mined by Mr. Newt Peterson of Tok Junction on a small tributary of the Slana River between Alteration and Jack Creeks. This stream drains the contact area between the Slana basalt and intrusive diorite just east of a strongly altered area. The gold is angular and presumably its source is very local.

The locality was not visited during this investigation.

Copper

Locality 2. Chalcopyrite and oxide copper minerals have been found in one locality in a large conspicuous altered area in the drainage of Alteration Creek, a tributary of the Slana River. The rocks in the altered area are silicified, pyritized, and locally brecciated volcanic rocks of the Slana basalt unit and probably some intrusive diorite. Most of the rocks have been so thoroughly replaced by secondary minerals that no primary textures can be seen. Oxidation of the pyrite, principally by weathering, has resulted in the formation of bright variegated hydrous iron oxides on most of the outcrops.

The chalcopyrite occurs as a minor constituent in a number of thin quartz veins in a very restricted area of 5 by 10 feet on the west bank of Alteration Creek at an elevation of 3,500 feet. Malachite and azurite occur as local oxidation products. Grab samples of rock containing chalcopyrite and/or copper oxide minerals from throughout the mineralized zone assayed 1.5% copper, 0.02 ounces of gold and 0.54 ounces of silver (sample 16, table 3). Three other samples of rocks from the altered area downstream from the copper locality contained only a trace of gold and no detectable copper (sample 15, table 3).

Table 3. Metal content of veins, altered rocks, and massive sulfides in upper Slana-Mentasta Pass area.

Locality	Map No. 1/	Field No.	Sample Description	Ounces per ton		Weight percent	
				Gold	Silver	Copper	Nickel
2	15	S-66-16	Pyritized-silicified basalt.	trace	nil	N.D. (<0.05)	
2	15	S-66-17	Limonite-silica rocks	trace	nil	N.D.	
2	15	S-66-19	Pyrite-silica rock	nil	nil	N.D.	
2	16	S-66-20	Chalcopyrite-bearing quartz veins in limonite-silica rock	0.02	0.54	1.5	
5	17	S-66-30	Massive pyrrhotite	0.02	trace	0.6	0.04
3	18	S-66-75	Bornite-bearing epidotized basalt	0.02	0.02	1.1	

1/ Refers to geologic map in figure 2.

Analysts: Gold-silver, Don Stein, Division of Mines and Minerals

Base metals, Namok Cho, Division of Mines and Minerals

Two stream sediment geochemical samples collected from Alteration Creek where it leaves the altered area contain 150 and 160 ppm copper and hence may be considered weakly anomalous (samples 12 and 13, table 4). A limonite-rich sediment from a small stagnant pond within the altered area, on the other hand, did not show any anomalous metal content (sample 19, table 4).

Locality 3. Bornite occurs as a vesicle filling and in irregular segregations scattered througnout a zone 400 feet thick in the upper part of the Slana basalt, 0.7 miles S.70°E of Mentasta Lodge on the Glenn Highway. The bornite does not appear to approach ore grade material where sampled, but the only exposures are in a small ravine and the limits of the mineralized zone are not known. The rocks are highly epidotized and locally cut by veinlets of red jasper. The bornite is generally associated with calcite and epidote; chalcopyrite is sparingly present. An analysis of grab samples containing obvious copper minerals showed 1.1% copper and minor amounts of gold and silver (sample 18, table 3). Sediments collected from the small ravine below the copper mineralization contained 190 ppm copper (sample 98, table 4).

Locality 4. A piece of massive chalcocite, two inches by two inches, was found in a talus slide at an elevation of 4,500 feet on the west side of the Slana River two miles south of Gillett Pass. The talus is composed of fragments of Slana basalt and Jack limestone, the contact between the two units occurring a few hundred feet above where the chalcocite was found. Sediments from the stream draining the general area did not show any anomalous concentration of copper or other metals (sample 33, table 4).

Locality 5. A band or pod of massive pyrrhotite with minor chalcopyrite occurs within the Slana basalt at an elevation of 3,950 feet west of the Slana River. The massive sulfides are exposed on a steep north-facing cliff and were not examined in place, but from below the band appeared to be a maximum of 10 feet thick and possibly as much as 150 feet long. Analysis of massive pyrrhotite float showed 0.6% copper and 0.04% nickel with very minor amounts of gold and silver (sample 17, table 3).

Chromite

Locality 6. The two-mile long dunite body within the Denali fault zone near Gillett Pass contains bands of disseminated chromite and occasional segregations of massive chromite. The largest chromite segregation observed was less than two inches thick and about one foot long. Limited examination of the dunite body indicates an overall grade of not more than 4% chromite; however, the body is not well-exposed and it is possible that much larger segregations of chromite are present.

Nephrite (jade)

Locality 7. A number of small prospect pits have been dug into a serpentine-rich band in the metamorphic rock unit north of the Denali fault on the steep mountain slope near the Mentasta Village road junction. The pits are 200 feet above (north) of the first house on the road (Ruth John residence) and were dug by L.L. Patten of Salt Lake City in 1956 apparently in the search for asbestos. From the appearance of the prospect, no work has been done since that time. In one pit a sample of dense, slightly schistose, green rock, much harder than the associated serpentine was collected and later identified in the laboratory as nephrite, a variety of jade.

The nephrite ranges in color from dark to light green with occasional zones of apple green color. Lenses of black serpentine occur scattered through the rock and in the sample collected, serpentine is probably more abundant than nephrite.

Although the sample collected was of poor quality due to its schistose structure and abundant inclusions of serpentine, search in the area may reveal massive serpentine-free material that might be suitable for the semi-precious gem trade.

Building-ornamental stone

Locality 8. A body of magnesite marble in the metamorphic rocks north of Lost Creek (described in geology section) has been quarried and a limited amount sold by Mr. James Frey of Slana. The marble occurs in a band 10 to 30 feet thick and probably as much as a mile long and consists of thin laminae, lenses, and veins of magnesite, dolomite, and quartz in a multicolor of various shades of apple green, cream, and white. Polished surfaces of the marble have a very striking appearance.

Geochemical anomalies

A total of 98 stream sediment samples were collected during the course of the field study. All samples were tested in the field for cold extractable heavy metals by the procedure described by Hawkes (1963). The -80 mesh fraction was analyzed by Rocky Mountain Geochemical Laboratories for total copper, zinc, lead, and molybdenum, using a hot acid leach method.

The geochemical data are presented in table 4 and in the frequency distribution graphs in figure 3. Inspection of the graphs shows a lognormal, single mode distribution for all the elements except zinc. Zinc is strongly bimodal with modes at 100 and 165 ppm, both higher than the crustal average of 70 ppm. This bimodal distribution for zinc is apparently due to the two different principal rock types in the area. The metamorphic rocks north of the Denali fault especially the phyllites, slates, and other dark argillaceous rocks, are all relatively enriched in zinc. Hence, sediments from streams draining this area are primarily responsible for the 165 ppm zinc mode. South of the Denali fault the sedimentary rocks contain much less zinc as compared to those north of the fault, but taken as a whole, they are enriched relative to the crustal average because of the locally abundant argillites.

Background or threshold values for the four elements, based on the frequency distribution graphs, are: copper, 150 ppm; zinc, 300 ppm; lead, 50 ppm; and molybdenum, 7 ppm. For copper, lead, and molybdenum, the right hand or high concentration base of the single mode curve is used for a threshold value which, in general, is between two to three times the concentration of the mode. In the case of zinc, possibly two threshold values should be used, one for the area north of the Denali fault, and the other for the area south of the fault, but for the sake of simplicity, only the higher zinc value of 300 ppm is considered. It should be kept in mind, however, that some of the zinc values in the range of 150 to 300 ppm in the area south of the fault, may represent moderate anomalies.

One of the strongest geochemical anomalies in the map area is north of the Denali fault in an area drained by two tributaries of Lost Creek. Sediments from these streams (samples 54 and 55, table 4) show as much as a ten-fold enrichment in zinc (3,200 ppm) together with moderately anomalous copper and molybdenum. Four miles downstream in Lost

Table 4. Copper, zinc, lead, and molybdenum content of stream sediments in the upper Slana-Mentasta Pass area.

Map No.	Field No.	Concentration (ppm) Copper	Zinc	Lead	Molybdenum	Field Test (ml of dye)
1	6D-205	125	80	10	5	1
2	6D-206	85	90	25	4	1
3	6D-207	90	105	15	4	1
4	6D-208	120	105	10	3	0
5 1/	6D-209	215	50	15	3	3
6	6D-210	120	90	100	3	2
7	6D-211	135	85	10	2	1
8	6D-212	100	95	10	4	2
9	6D-213	100	90	10	3	1
10	6D-214	95	120	10	2	0
11	6D-215	85	165	15	4	1
12	6D-216	150	110	15	3	5
13	6D-217	160	120	20	3	6
14	6D-218	100	90	15	6	4
15	6D-219	125	90	10	2	2
16	6D-220	100	75	10	2	2
17	6D-221	65	120	20	3	6
18	6D-222	120	85	20	1	2
19	6D-223	80	145	30	3	15
20	6D-224	25	95	20	2	0
21	6D-225	35	105	20	2	0
22	6D-226	45	130	25	2	1
23	6D-227	50	190	15	4	1
24	6D-228	40	155	15	3	0
25	6D-229	60	150	30	2	0
26	6D-230	75	115	20	3	4
27	6D-231	20	100	30	2	0
28	6D-232	65	100	15	2	1
29	6D-233	210	1800	30	9	> 25
30	6D-234	15	2100	20	100	> 25
31	6D-235	150	110	10	7	0
32	6D-236	140	140	15	7	0
33	6D-237	95	65	5	2	0
34	6D-238	60	160	30	2	0
35	6D-239	35	95	20	4	0
36	6D-240	90	125	20	3	0
37	6D-241	75	270	35	5	5
38	6D-242	90	235	30	3	0
39	6D-243	50	100	20	2	6
40	6D-244	160	80	10	5	0

Table 4. Continued

Map No.	Field No.	Concentration (ppm) Copper	Zinc	Lead	Molybdenum	Field Test (ml of dye)
41	6D-245	90	65	10	2	0
42	6D-246	130	110	10	4	2
43	6D-247	150	70	10	3	1
44	6D-248	120	80	5	4	0
45	6D-249	80	110	10	4	1
46	6D-250	170	60	10	3	0
47	6D-251	125	75	5	5	
48	6D-252	140	105	10	3	
49	6D-253	100	270	20	5	0
50	6D-254	70	160	15	4	0
51	6D-255	60	530	10	5	16
52	6D-256	85	240	25	6	4
53	6D-257	95	275	25	6	10
54	6D-258	165	3200	35	10	>25
55	6D-259	130	1600	30	6	>25
56	6D-260	100	230	20	4	1
57	6D-261	85	375	15	4	5
58	6D-262	50	105	15	3	1
59	6D-279	45	160	10	3	4
60	6D-280	60	155	15	4	1
61	6D-281	70	150	10	3	1
62	6D-282	75	180	15	4	4
63	6D-283	85	260	20	4	4
64	6D-284	50	135	20	1	0
65	6D-285	50	155	20	3	2
66	6D-286	45	155	15	1	3
67	6D-287	125	105	10	1	1
68	6D-288	90	460	20	5	15
69	6D-289	45	165	20	3	3
70	6D-290	50	125	20	4	0
71	6D-291	55	165	20	2	3
72	6D-292	75	175	15	2	1
73	6D-293	70	130	20	2	3
74	6D-294	200	500	30	2	3
75	6D-302	35	110	10	2	2
76	6D-303	60	185	15	4	4
77	6D-304	30	70	5	1	3
78	6D-308	55	140	10	3	3
79	6D-309	40	120	10	1	3
80	6D-310	50	235	20	2	6

Table 4. Continued

Map No.	Field No.	Concentration (ppm) Copper	Zinc	Lead	Molybdenum	Field Test (ml of dye)
81	6D-311	80	380	20	2	8
82	6D-312	55	135	20	4	3
83	6D-313	65	170	20	1	4
84	6D-314	60	60	5	2	3
85	6D-315	30	55	5	1	1
86	6D-316	60	105	10	2	1
87	6D-317	60	150	15	3	3
88	6D-318	35	95	5	1	3
89	6D-319	35	90	10	2	0
90	6D-320	60	125	10	5	3
91	6D-321	45	70	5	3	3
92	6D-322	30	30	5	2	2
93	6D-323	45	55	5	2	2
94	6D-324	105	65	5	2	2
95	6D-325	45	80	5	3	1
96	6D-326	40	190	25	3	5
97	6D-327	40	55	5	2	1
98	6D-328	190	75	5	2	11

1/ Underlined map number indicates anomalous sample.

All analyses on dried -80 mesh fraction by Rocky Mountain Geochemical Laboratories Salt Lake City, Utah.

Creek the sediments are still anomalous with 375 ppm zinc (sample 57, table 4). The two anomalous tributaries are fast-running streams, 3-5 feet wide and up to 1 foot deep, with a total drainage area of about 1 square mile. The water in the streams has a yellowish-murky appearance and the stream bed is coated with conspicuous reddish-brown iron oxides. This anomaly, although exceedingly strong, could be due to a relatively high zinc background in the phyllitic and slatey host rocks in the drainage area.

Other anomalies of this same type and of questionable significance occur north of Gillett Pass (samples 29 and 30, table 4), on upper Station Creek (sample 68 and 74, table 4), and on Snowshoe Creek (sample 81, table 4). All of these are characterized by moderate to strong zinc enrichment. Sample 30, which is from a seep in the glacial stream flats below sample 29, is also high in molybdenum. Copper in moderate amounts is present in samples 29 and 74.

None of the copper anomalies detected south of the Denali fault contain more than 215 ppm copper. Most of these weak to moderate anomalies appear to drain altered areas (samples 12, 13) or the Slana basalt (samples 5, 43, 46, and 98). Anomalous samples 12, 13, and 98 have been discussed previously in the section on description of deposits (localities 2 and 3).

Only one stream containing anomalous lead (sample 6, 100 ppm) was detected in the area. The stream, a small tributary of Jack Creek, drains the Slana basalt-Jack limestone contact. This could possibly indicate lead mineralization along the contact.

ECONOMIC CONCLUSIONS AND RECOMMENDATIONS

The upper Slana-Mentasta Pass area warrants exploration and prospecting for a variety of metallic and nonmetallic minerals. This optimistic outlook for the area is based on the presence of (1) favorable host rocks for the deposition of economic minerals, (2) a number of intrusives ranging in composition from acid to ultramafic, (3) strong structures, and (4) scattered mineral occurrences and hydrothermal alteration area.

The two most promising features of possible economic significance in the area are the scattered copper occurrences in the upper part of the Slana basalt and the local high zinc stream sediment anomalies north of the Denali fault. The similarity in host rock, rock alteration, and type and habit of mineralogy between the copper occurrences in the Slana basalt and the northern Michigan copper deposits justifies continued search for concentrations of copper minerals in the area. Particular attention should be given the area of scattered copper mineralization east of Mentasta Lodge (locality 3), weak anomalies 5, 12, and 13, and areas where the Slana basalt is poorly exposed.

The contact between the Slana basalt and overlying Jack limestone, especially in the neighborhood of intrusive rocks, should be thoroughly prospected. This contact may prove to be correlative to the Nikolai greenstone-Chitistone limestone contact, which in the southern Wrangell Mountains has been a favorable zone for the deposition of rich massive copper sulfide minerals. In the map area, a suggestion of this type of mineralization was seen in a piece of sulfide float found below the basalt-limestone contact at locality 4.

The extremely high stream sediment zinc anomalies at the headwaters of Lost Creek (samples 54 and 55) and on the north side of Gillett Pass (samples 29 and 30) should be investigated further. As mentioned earlier these anomalies may be due entirely to a high zinc content in the phyllite and slate country rock and not significant, but the possibility of a mineral deposit should not be ruled out. With the zinc, which runs as high as 0.32% in the stream sediments in sample 54, are anomalous amounts of copper and molybdenum. The drainages of all these anomalous streams are relatively small and above timber line and should be easily prospected.

Also of interest in the area is the chromite-bearing dunite body in Gillett Pass and the nephrite occurrence in Mentasta Pass. Although no massive chromite was observed in the dunite during this investigation, the possibility of economic concentrations of this mineral should not be overlooked and a careful examination of the dunite is recommended. The nephrite occurrence may prove to contain material suitable for the semiprecious gem and stone industry.

REFERENCES CITED

Grantz, A., 1966, Strike-slip faults in Alaska: U.S. Geological Survey Open File Report.

Hawkes, H.E., 1963, Dithizone field tests: Ec. Geol. v. 58, p. 579-586.

MacKevett, E.M., Jr., 1964, Nikolai Greenstone of Wrangell Mountains near Kennicott, Alaska: Abst. Program 60th Annual Meeting, Cordilleran Section, Geol. Soc. Am., Seattle, Washington.

Mendenhall, W.C., 1905, Geology of the central Copper River region, Alaska: U.S. Geol. Survey Prof. Paper 41.

Moffit, F.H., 1912, Headwater regions of the Gulkana and Susitna Rivers, Alaska: U.S. Geol. Survey Bull. 498.

---------------, 1932, The Slana district, upper Copper River region, Alaska: U.S. Geol. Survey Bull. 824, p. 111-124.

---------------, 1933, The Suslota Pass district, upper Copper River region, Alaska; U.S. Geol. Survey Bull. 844-C, p. 137-162.

---------------, 1938, Geology of the Slana-Tok district, Alaska: U.S. Geol. Survey Bull. 904.

---------------, 1954, Geology of the eastern part of the Alaska Range and adjacent area: U.S. Geol. Survey Bull. 989-D, p. 65-218.

Richter, D.H., 1966, Geology of the Slana district, Southcentral Alaska: Alaska Div. of Mines and Minerals, Geologic Report 21.

Rose, A.W. 1967, Geology of the upper Chistochina River area, Mt. Hayes quadrangle, Alaska: Alaska Div. of Mines and Minerals, Geologic Report 28.

Rose, A.W., and Saunders, R.H., 1965, Geology and geochemical investigations near Paxson, northern Copper River basin, Alaska: Alaska Div. of Mines and Minerals, Geologic Report 13.

Ross, C.P., 1933, The Valdez Creek mining district, Alaska: U.S. Geol. Survey Bull. 849-H, p. 425-468.

St. Amand, P., 1957, Geological and geophysical synthesis of the tectonics of portions of British Columbia, the Yukon Territory, and Alaska: Geol. Soc. Am. Bull. v. 68, p. 1343-1370.

Taylor, W.R., 1964, Abundance of chemical elements in the continental crust. A new table: Geochem et Cosmochem, Acta., v. 28, p. 1273-1285.

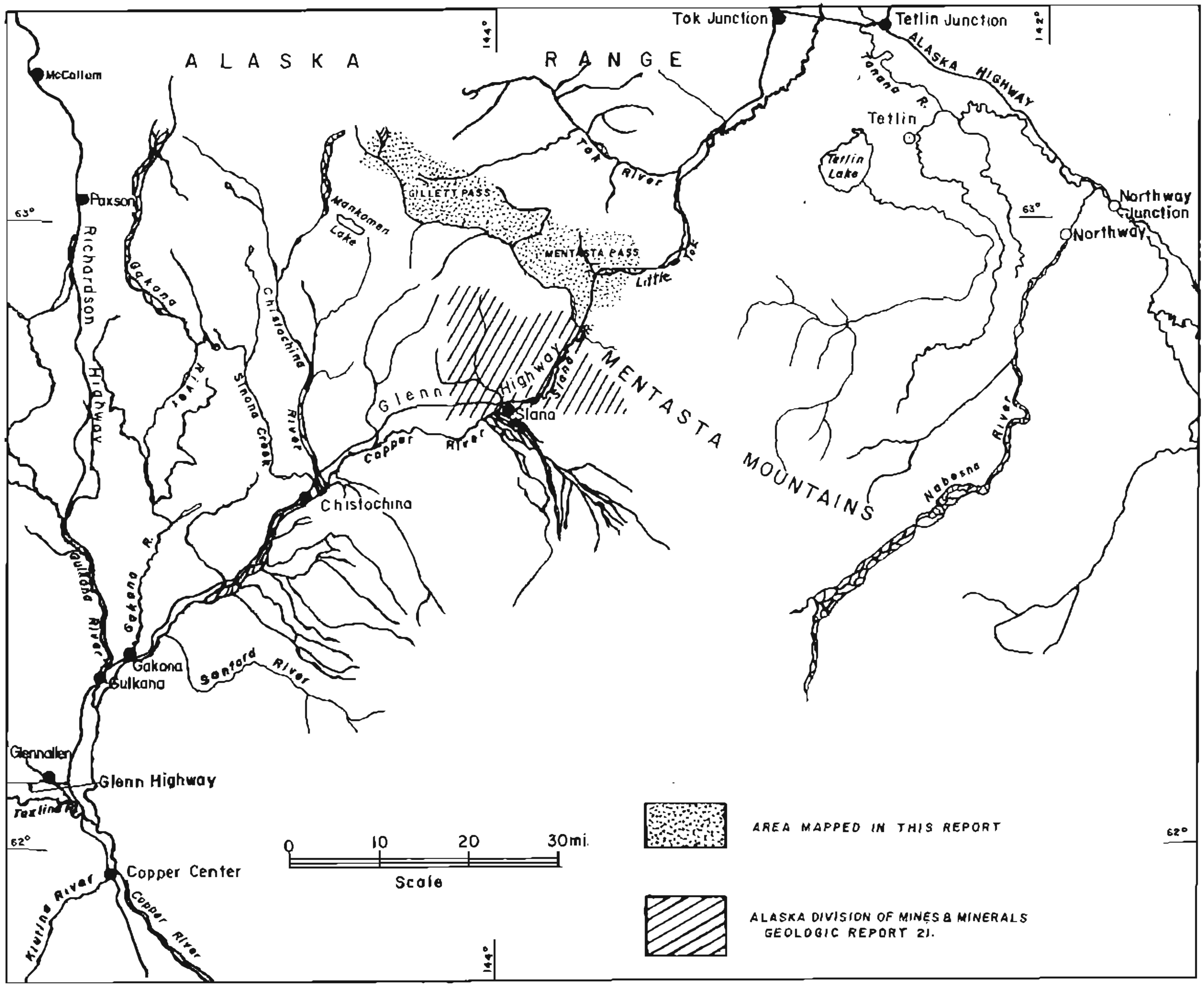

Figure 1. Index map of the upper Slana-Mentasta Pass area.

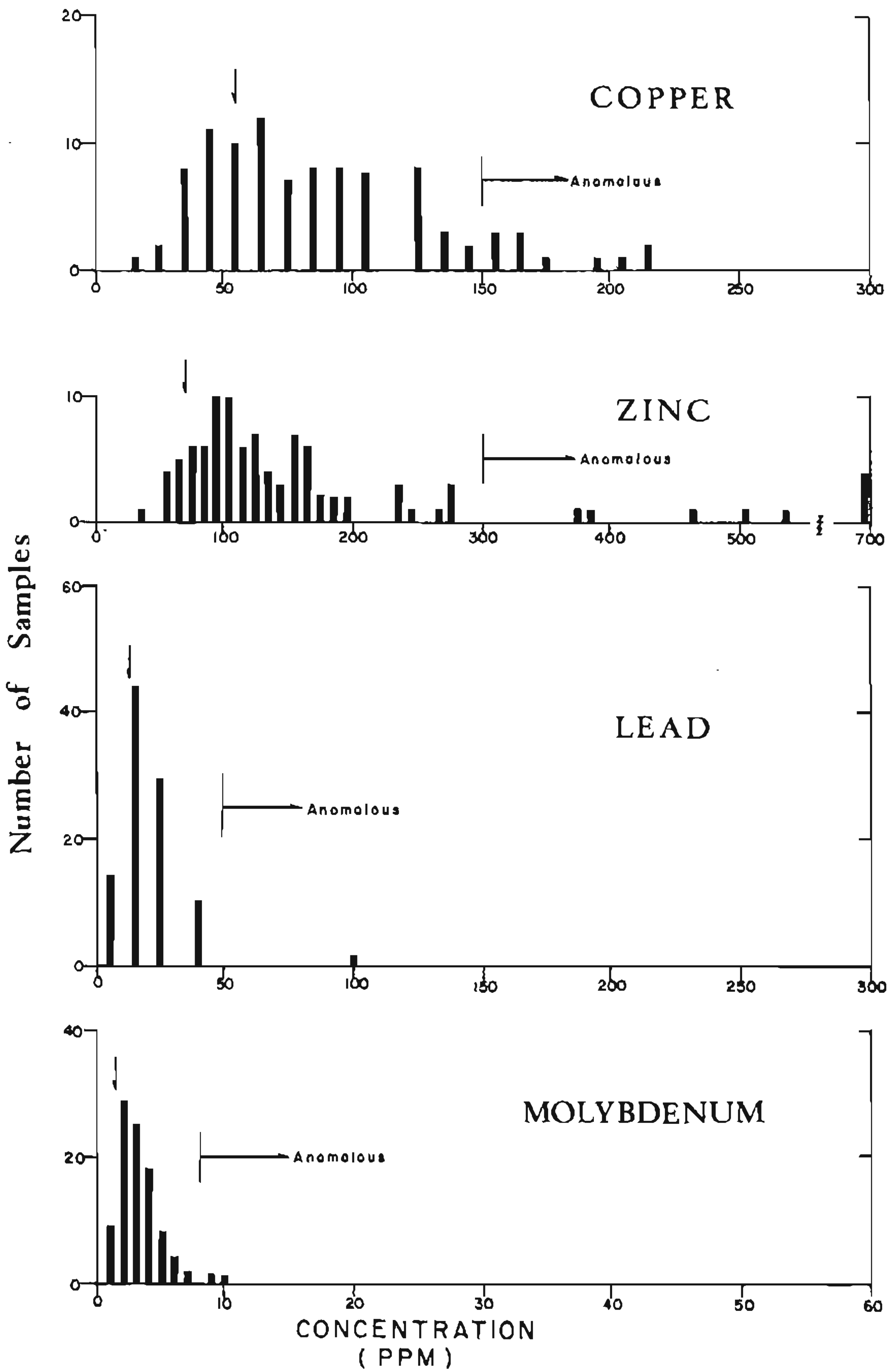

Figure 3, Frequency distribution graphs for copper, lead, zinc and molybdenum in the upper Slana-Mentasta Pass area, Alaska. Vertical arrow denotes crustal average after Taylor (1964).