UNITED STATES
DEPARTMENT OF THE INTERIOR
Geological Survey
Washington

ZINC DEPOSITS OF THE MOUNT EIELSON DISTRICT, ALASKA

INTRODUCTION

During the summer of 1943 members of the Geological Survey spent four weeks examining some of the zinc deposits of the Mount Eielson district, Alaska. In the latter part of July George O. Gates and Clyde Wahrhaftig spent ten days examining the more important deposits; and some were examined in detail by Clyde Wahrhaftig in the early part of August. At that time these deposits were sampled by the Bureau of Mines, under the direction of Neal M. Muir. Detailed maps of the ore deposits were made with plane table and open-sight alidade.

The zinc deposits are along the north side of Mount Eielson, a mountain between the Thoroughfare River and Muldrow Glacier, in Mount McKinley National Park (see fig. 1). The deposits are two miles south of the nearest point on the McKinley Park Highway, and are separated from it by the flats of the Thoroughfare River. From this point it is approximately 70 miles by automobile road to McKinley Park Station on the Alaska Railroad.

No timber in found within twenty miles of the zinc deposits. Clear water can be obtained near the deposits during the summer from Grant Creek and Granite Creek. Lignite suitable for fuel is found ten miles north of the deposits.

The zinc deposits that are in place are irregularly shaped bodies in which the original rock has first been converted to hornfels which was later replaced in part by sphalerite, galena, and chalcopyrite. Most of the deposits are small, but a few contain a moderate amount of zinc ore. The deposits have been developed by four short adits, three of which have caved, and by numerous pits and trenches. Most of the development work was done before 1931. Another source of ore is the talus containing several percent of zinc that covers extensive areas on the slopes of Mount Eielson. The most promising of the known deposits are covered by 18 unpatented claims, (see fig. 2) held by O. M. Grant and Mrs. Lois McGarvey.

GEOLOGY

The general geology of the Mount Eielson district has been described by John C. Reed 1/ who has summarized the general features as follows 2/:

> The most widely distributed rocks of the district include a thick series of thin-bedded limestone, calcareous shale, and graywacke of Paleozoic, probably Devonian, age. These sediments are cut by mass of granodiorite which forms most of Mount Eielson and which was intruded probably in late Mesozoic time. The intrusive has sent a number of dikes and sills into the associated sediments.

1/ Reed, J. C., The Mount Eielson district, Alaska: U. S. Geol. Survey Bull. 849-D, pp. 231-286, 1933.

2/ Reed, J. C., op. cit., p. 231.

Material given off by the granodiorite has permeated the enclosing sediments and selectively replaced them with minerals of the epidote group and to a somewhat lesser extent with sphalerite, galena, chalcopyrite, and pyrite.

South of Mount Eielson the regional strike is N. 55° E., and the dip is low toward the southeast. North of the mountain the strike of the sediments conforms in general to the curve of the base of the mountain and is about N. 65° W. on Bald Mountain and north of the eastern peak of Mount Eielson, nearly east north of the central peak, and about N. 50° E. on the northern slopes of Copper Mountain. In most places the dip is steep toward the north. A normal fault of large displacement abruptly terminates the granitic area on the south.

Rocks

The oldest rocks in the vicinity of the ore deposits are limestones, phyllites, and quartzites, of Paleozoic, probably Devonian, age. These rocks have been recrystallized and part of them have been intensely sheared. In many places the original material has been replaced in part or wholly by hydrothermally introduced material.

Part of the walls of the lower end of the canyon of Grant Creek (see fig. 3) consists of thin-bedded white limestone, containing siliceous bands spaced one-half inch apart. The limestone has been completely recrystallized. At least 250 feet of limestone are exposed. The limestone has been replaced along some dike walls and shear zones by hornfels. This hornfels consists of clinozoisite and garnet, with quartz and calcite. Along the footwall of the southern of the two shear zones on the west side of Grant Creek on the Lillian (Denver) 1/ claim, the hornfels consists of quartz and clinozoisite.

In the vicinity of the ore deposits on the Zelma (Jiles) and Ruth (Tennessee) claims the metamorphosed sedimentary rocks are phyllites, impure quartzite, and hornfels (see figs. 4 and 5). In some places beds of phyllites 6 inches thick alternate with beds of impure quartzite and graywacke 2 feet thick. In other places the phyllite is interbedded with hornfels.

Elsewhere sediments consisting entirely of phyllite 20 to 30 feet thick crop out.

The hornfels consists of clinozoisite and augite, with minor amounts of garnet, calcite, and quartz. The hornfels is commonly very fine grained, the average grain size of the specimens studied in thin section ranging from 0.05 millimeter to 1 millimeter in diameter.

A large stock of granodiorite and granodiorite porphyry underlies most of Mount Eielson, and dikes and apophyses from this stock have intruded the sediments

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1/ The names of claims used in this report are names of claims covering the deposits in 1943. Names in parentheses are names of claims shown in U. S. Geol. Survey Bull. 849-D, fig. 37, p. 277.

in the vicinity of the ore deposits. The dikes in the vicinity of the ore-deposits consist of quartz-diorite porphyry and granodiorite porphyry with fine-grained groundmass. The average mineral composition of the dikes is 8 percent quartz, 30 percent andesine or oligoclase, and 5 percent hornblende, as phenocrysts, and 55 percent groundmass consisting chiefly of quartz and plagioclase, with or without orthoclase, and chlorite.

Some of the porphyry dikes are seamed with veinlets of epidote. At one place, dark porphyry with a fine-grained groundmass was observed to cut lighter-colored porphyry with a coarser groundmass, which was seamed with epidote. Most of the hornblende phenocrysts are altered to chlorite and epidote.

In addition to the porphyry, fine-grained dikes which are upper Cretaceous or Tertiary in age have been intruded into the region. These dikes cut the ore deposits, as well as the earlier porphyry. Two rock types have been observed in the dikes in the vicinity of the ore deposits. The commonest is a dense, fine-grained, dark brown andesite composed chiefly of andesine and pyroxene (?), with subordinate quartz and calcite. The other type is creamy white rhyolite composed of quartz, orthoclase, and sericite.

Glacial deposits are found on the broad terrace south of the Thoroughfare River, at the north base of Mount Eielson, and on its lower slopes. These are overlain in places by alluvium deposited by streams draining the north slopes of Mount Eielson. Talus, some of it containing numerous sulfide-bearing boulders, mantles most of the lower slopes of Mount Eielson.

Structure

The general dip of the sediments on the north slope of Mount Eielson, in the vicinity of the ore deposits, is to the north. However, in the lower part of the canyon of Grant Creek the limestone beds are nearly flat lying, and locally dip to the south (see fig. 3). To the east of Grant Creek Canyon the sediments have been sheared and contorted, and drag folds are common in the phyllite. The dip of the beds is 30 degrees to 60 degrees to the north, and the strike averages east-west.

The general direction of strike of the dikes in the canyon of Grant Creek is east. The dip of the dikes is steep or vertical (see figs. 3 and 6). The irregularity of the contact suggests that part, at least, of the emplacement of the dikes was accomplished by magmatic stoping. The intrusive bodies on the north side of Mount Eielson between Grant Creek and Granite Creek strike in general south of east, and dip steeply north or are vertical (see fig. 2). On the Zelma (Jiles), Dee (Carrie), Ruth (Tennessee), and Venora (Georgia) claims the dikes, where examined, appear to have been intruded by forcing apart their walls. However magmatic stoping has played a small part in their intrusion. A dike is exposed in the tunnel on the Zelma (Jiles) claim, and in the gulch to the east of the tunnel. This dike terminates below the surface directly above the tunnel (See figs. 4 and 6).

Shear zones have been observed in a few places in the vicinity of the Mount Eielson zinc deposits. They appear to be earlier than or contemporaneous with the intrusion of the granodiorite porphyry and quartz-diorite porphyry, and locally have afforded channels for the ore-forming fluids. Shear zones in the canyon of Grant Creek strike east to northeast, and dip from 50 degrees north to vertical. Movement along these shear zones apparently has taken place both before and after the deposition of the ore minerals.

Mineralization

During and after the intrusion of the porphyry dikes considerable quantities of material were introduced into the sediments by hydrothermal solutions, and new minerals were formed. Quartz, epidote, and calcite were introduced into the phyllite. The limestone was replaced selectively and along contacts and shear zones by hornfels. In the vicinity of the deposits on the Zelma (Jiles) and Venora (Georgia) claims rock that was probably originally impure limestone is now hornfels consisting of a fine-grained aggregate of augite and clinozoisite, with quartz, garnet, and calcite.

After the major part of the silicate minerals had been formed, quartz and clinozoisite, and calcite, were deposited in veins along cracks in the hornfels. Sulfides replaced some of the hornfels and were deposited along fractures and grain boundaries in the rock. The introduction of the sulfides appears, in part, to have accompanied the latest stages in the formation of the quartz-clinozoisite and calcite veins. The sulfides in the metamorphosed sedimentary rocks are sphalerite, galena, and chalcopyrite, and pyrite and chalcopyrite in the granodiorite porphyry. The channels along which the silicate- and sulfide-forming solutions rose were, in part, probably the contacts of the dikes with the sediments, as shown by the close association of the mineralization in both rocks with the contacts. Similarly, but to a lesser extent, the shear zones acted as channels for the solutions.

Supergene alteration has resulted in the formation of thin crusts and stains of limonite, smithsonite, and an orange-yellow mineral on rock containing sphalerite and galena, and secondary copper minerals where chalcopyrite is abundant.

ORE DEPOSITS

The zinc deposits of the Mount Eielson district are imperfectly banded deposits consisting of fine to medium-grained sphalerite and galena in irregularly shaped bodies ranging in diameter from .04 inch to 3 inches and as fine anastomosing veinlets in hornfels. The sulfide minerals comprise only a small percentage of the rock. The zinc-bearing bodies are localized along contacts between porphyry dikes and sediments and along shear zones. The largest and richest bodies are localized in inclusions in the porphyry, and along the crest of a dike that in places, terminates beneath the surface.

The largest deposits examined by the members of the Geological Survey in 1943 are those on the Zelma (Jiles) claim. On the basis of exposures at the surface and inferred structural relations a zone of zinc-bearing rock is indicated as extending from near the vein of the cuts in the gulch above the two lower adits on the Zelma (Jiles) claim for about 600 feet southwest to near the large outcrop of ore on the west side of the gulch west of the adits (see fig. 4). This zone splits to the east near the upper adit, and the two branches are separated by a porphyry dike.

The zone is thought to range from 20 feet to 65 feet in thickness, measured horizontally. A second ore zone is indicated by an exposure on the east side of the gulch west of the adits, at an altitude of 3,670 feet. It is possible that this zone, which borders a large porphyry dike north of the zone described above, may extend to the southeast and join that zone near the upper adit. However, there are no outcrops to test this interpretation. These ore zones are considered to have been formed in a band of hornfels formed by replacement of impure limestone that had been intruded by a complex porphyry dike. Parts of this dike terminate near the present surface (see fig. 7). The ore zone is thought to form a capping over the terminated part of the dike. This cap extends for some distance down the sides of the dike.

Two deposits of zinc- and copper-bearing rock, on the west wall of the canyon of Grant Creek near the middle of the Lillian (Denver) claim, lie on the hanging walls of two prominent shear zones. These deposits are irregular, and the concentration of sulfides varies from bed to bed, and also decreases away from the shear zones. The shear zones strike N. 60° E. and dip 60° north. The bedding in the outcrops in which these two ore bodies are exposed strikes from N. 40° E. to east, and dips from 15° to 45° south. Locally near the shear zones the limestone has been completely brecciated, and has been replaced by hornfels. This brecciation took place before or during the intrusion of the igneous rocks. The ore minerals are sphalerite and chalcopyrite, with pyrite and galena. The south ore zone is discontinuous, and is as much as 25 feet thick, and was traced for 100 feet along the slope. The northern ore zone is as much as 5 feet thick, and was traced for 60 feet along the slope. Individual beds of limestone, up to two feet thick, have been replaced for greater distances from the shear zones.

On the east side of Grant Creek, in the center of the Eva (Virginia) claim, large inclusions in the porphyry dike have been replaced along their borders by hornfels, which in places contains large amounts of sulfide minerals. The most heavily mineralized of these inclusions is near the middle of the claim, and extends from the creek up the east wall of the canyon to an elevation 80 feet higher. This inclusion is about 40 feet thick. It consists of limestone in which the bedding is nearly flat-lying. It has been replaced by hornfels and sulfides along four ore "beds" or zones. The uppermost is along the flat upper contact, and the two next lower, which do not extend completely across the inclusion, are 20 feet and 40 feet vertically below the top of the inclusion. These bands are each about two feet thick. A short adit has been driven along the north side of the lower of these bands, but had caved before the time of the investigation. A fourth ore zone extends a short distance along the bedding at the south side of the inclusion near the creek bed. According to Reed 1/ this body is exposed for a distance of 30 feet along the bedding and is 12 feet thick.

Immediately north of this inclusion, near the top of the bluff bordering the creek, the base of another inclusion is exposed. Sulfide-bearing hornfels is exposed for a distance of 20 feet along the contact at the base of this inclusion.

1/ Reed, J. C., op. cit., p. 279

On the west side of the mouth of the canyon of Grant Creek an ore zone in and bordering an east-striking vertical shear zone in flat-lying beds has been developed by a small open cut. This ore-body is about 4 feet wide, and is exposed for a distance of 20 feet along the slope.

An ore zone three feet wide is exposed in one of two trenches at an elevation of 4,500 feet on the crest of the ridge east of Grant Creek (see fig. 5). The ore bed strikes N. 75° E. and dips 38° north. This ore zone is part of a band of hornfels fifteen feet wide that dips 40 degrees north, approximately parallel to the slope of the hill.

Small areas of sulfide mineralization are scattered throughout the metamorphosed sediments along the north base of Mount Eielson. These are the results of the replacement of favorable beds by silicates and sulfides, and nearly all are closely associated with shear zones and dike contacts. Most of these are shown on figs. 2 and 3.

In addition to the ore in place, some areas of talus are rich enough in sulfide-bearing boulders to constitute reserves of zinc and lead ore. The source of these boulders could not be determined in many cases, but it is possible that some of them were derived from beds lying close to the present surface, which have completely disintegrated, and now form the talus. Several hundred thousand square feet of surface are overlain by the material. These areas are shown on figs. 2 and 4.

RESERVES

Available data are inadequate to estimate closely the size and average tenor of the reserves of zinc and lead in the Mount Eielson district. The variable composition of the ore, and the complicated structure of the deposits make predictions uncertain as to conditions that may prevail at some distance underground.

On the assumption that the ore-bearing zone on the Zelma (Jiles) claim pinches out at a depth of 100 feet below the lowest point of outcrop, 194,000 tons of sulfide-bearing hornfels are inferred. In addition 1,000 tons of sulfide-bearing hornfels were inferred from the exposure at the mouth of the gulch west of the adits. (see figs. 4 and 6). Surface exposures indicate that at least one-half of the hornfels in these two zones is barren of sulfides. Consequently only 100,000 tons of this rock should be considered as ore. On the basis of assay returns on U. S. Bureau of Mines samples the ore in these zones averages 5 percent zinc, 3 percent lead, 0.2 percent copper, and between 1 and 2 ounces of silver per ton. The samples taken by the Bureau of Mines from the Zelma claim range in zinc content from 2.42 percent to 7.5 percent, and in lead content from 1.14 percent to 5.82 percent. In those samples analyzed for copper, silver, and gold, the copper content ranges from 0.10 percent to 0.40 percent, and the samples contain from 0.22 to 2.14 ounces of silver per ton. No gold was reported.

The reserves in four bodies of sulfide-bearing rock exposed in the banks of Grant Creek were calculated. These include the two bodies associated with shear zones on the west side of Grant Creek near the middle of the Lillian (Denver) claim, the partly replaced inclusion near the middle of the Eva (Virginia) claim, and the ore body alongside the shear zone near the mouth of Grant Creek canyon. The total reserves calculated for these areas amount to 6,500 tons, of which 5,500 tons is in the large ore body at the southern of the two shear zones. On the basis of assay returns on U. S. Bureau of Mines samples the average grade for the ore bodies in Grant Creek is 8 percent zinc, 6 percent lead, and 1 percent copper. The samples taken by the Bureau of Mines from ore bodies along Grant Creek range in zinc content from 3.0 percent to 8.70 percent, and in lead content from 2.6 to 7.35 percent. Those tested for copper, silver, and gold range in copper content from 0.45 percent to 1.40 percent, and contains from 1.26 to 9.80 ounces of silver per ton. Only sample No. E-18 contained gold, 0.015 ounces per ton.

Talus slopes in this vicinity contain significant amounts of ore. Three areas aggregating 42,700 square feet of slope area are underlain by sulfide-bearing talus on the Zelma (Jiles) claim and three aggregating 389,200 square feet are underlain by similar material on the Ruth (Tennessee) and Venora (Georgia) claims. It was not possible in the time available to determine accurately the thickness of the talus material. However, the two lower adits on the Zelma (Jiles) claim penetrated several feet of talus. Assuming an average thickness of 3 feet of the talus material, and that the volume of the talus is equivalent to 75% of the same volume of solid rock, 8,500 tons of ore are on the Zelma (Jiles) claim, and 85,500 tons of ore in the talus on the Venora (Georgia) and Ruth (Tennessee) claims. Part of the talus on the Zelma (Jiles) claim was sampled by the Bureau of Mines (Sample No. E-26) and found to assay 5.20 percent zinc, 5.09 percent lead, 0.35 percent copper, and 1.50 ounces silver per ton. Assays of a sample collected by the Geological Survey 1/ from the talus on the Zelma (Jiles) claim gave 10.82 percent zinc, 8.89 percent lead, and 3.80 ounces of silver per ton. An assay of a sample collected by Reed from part of the rich talus on the Venora (Georgia) claim showed 12.28 percent zinc, 6.66 percent lead, 0.52 percent copper, and 1.30 ounces of silver to the ton 2/.

1/ Reed, J. C., op. cit., p. 282.

2/ op. cit., p. 281.

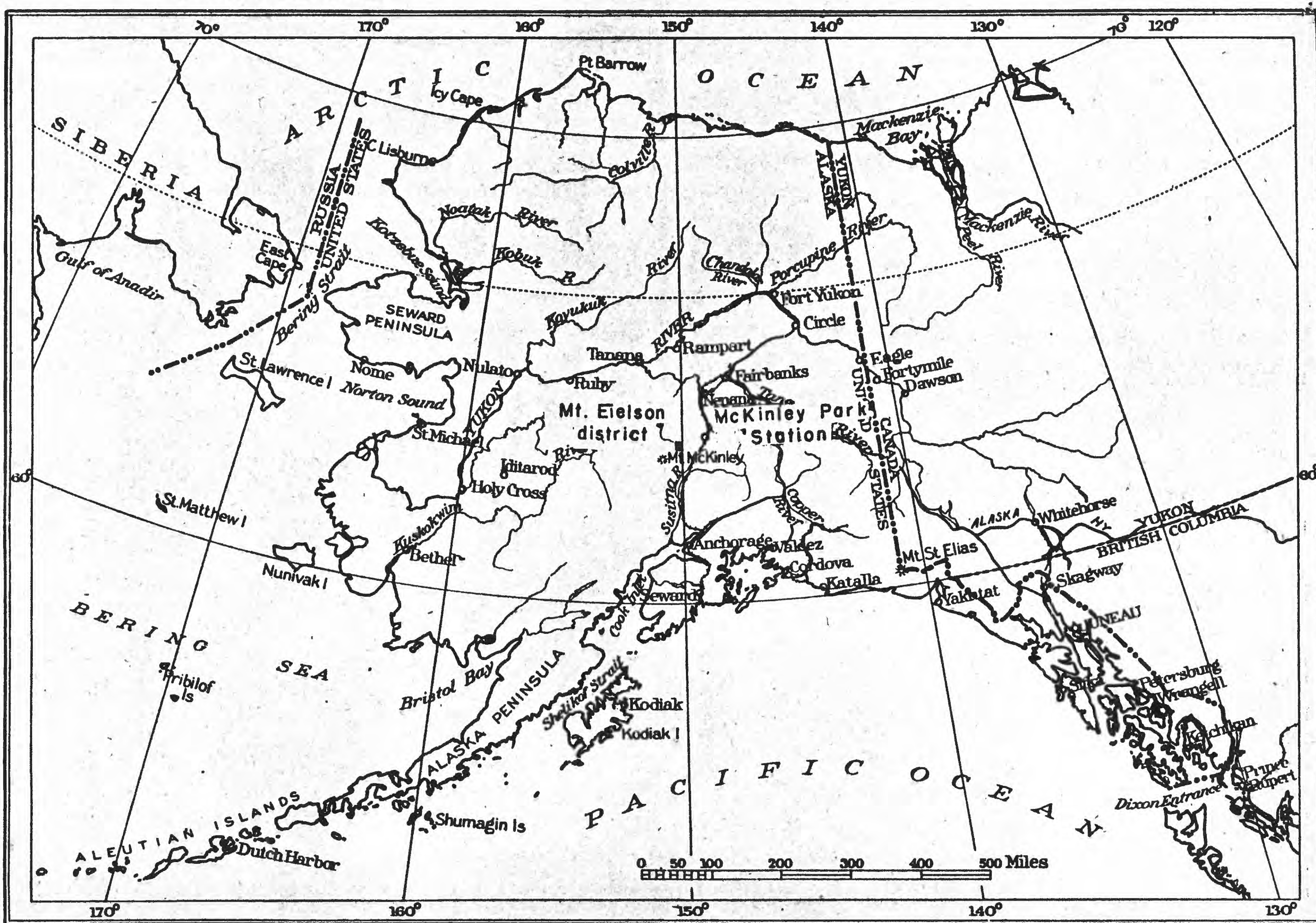

FIG. I: MAP SHOWING LOCATION OF MOUNT EIELSON DISTRICT, ALASKA

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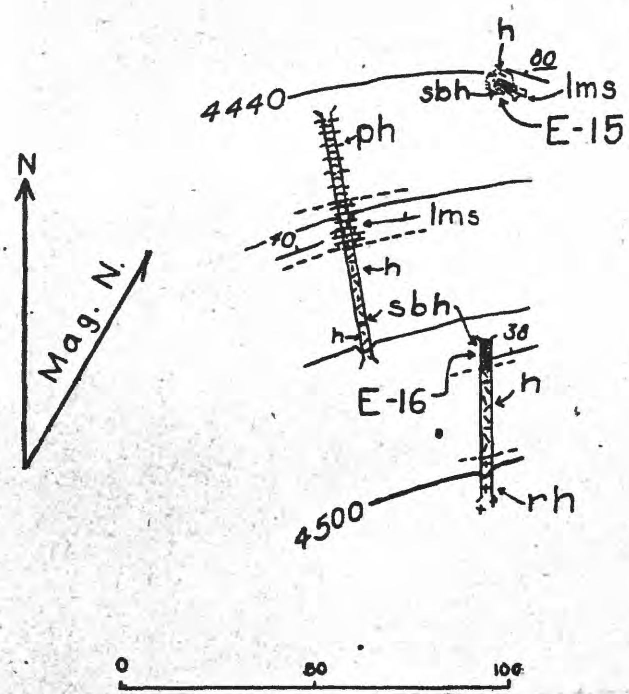
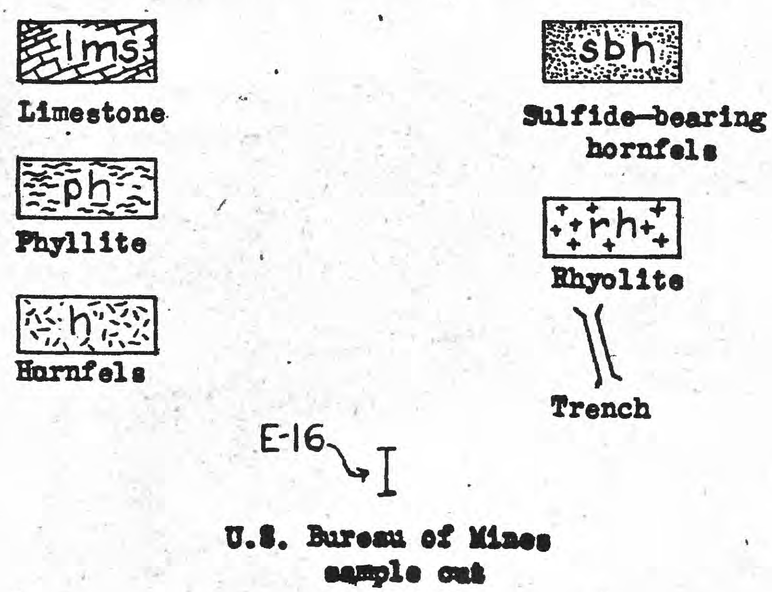
WAR MINERALS INVESTIGATION
PRELIMINARY MAP



Scale in feet
Contour interval 20 feet
Datum is assumed sea level

FIG. 5: SKETCH MAP OF TRENCHES ON VENORA CLAIM
MOUNT EIELSON DISTRICT, ALASKA

EXPLANATION



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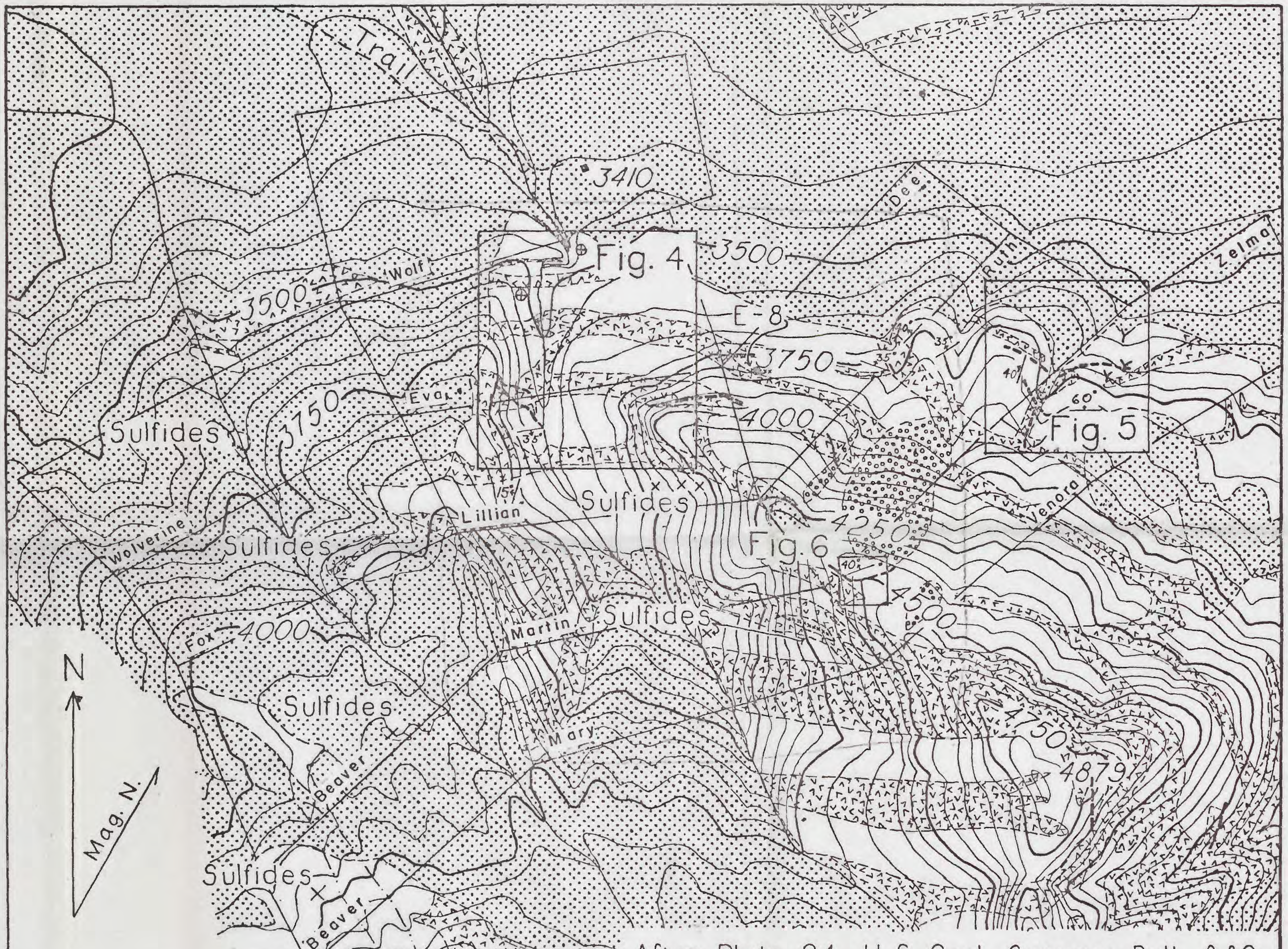
WAR MINERALS INVESTIGATIONS
PRELIMINARY MAP



After Plate 24, U. S. Geol. Survey Bull. 880

EXPLANATION

Alluvium and glacial deposits

Sulfide-bearing talus

Metamorphosed sedimentary rocks

Sulfide-bearing hornfels

IGNEOUS ROCKS

Andesite and rhyolite dikes

Granodiorite porphyry and quartz-diorite porphyry

Strike and dip of bedding and foliation

Horizontal bedding

E-30
U. S. Bureau of Mines sample cut

FIG. 2: GEOLOGIC MAP OF PART OF MOUNT EIELSON DISTRICT, ALASKA

500 0 1000 2000

SCALE IN FEET
CONTOUR INTERVAL 50 FEET
DATUM IS MEAN SEA LEVEL

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WAR MINERALS INVESTIGATIONS
PRELIMINARY MAP

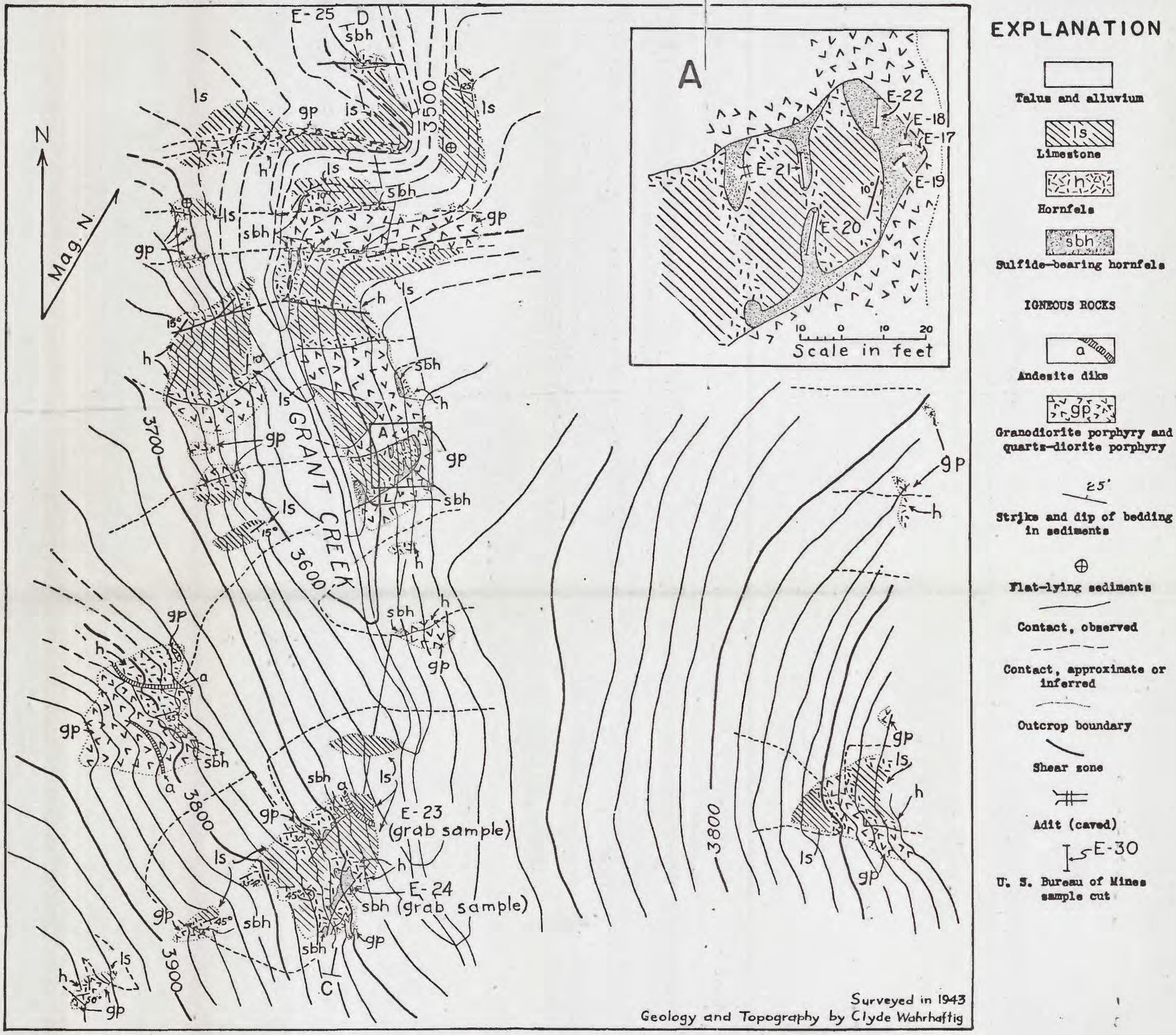

FIG. 3: MAP OF ZINC DEPOSITS IN LOWER PART OF GRANT CREEK CANYON, MOUNT EIELSON DISTRICT ALASKA

100 0 100 200 300 400

SCALE IN FEET

CONTOUR INTERVAL 20 FEET

DATUM IS APPROXIMATE SEA LEVEL

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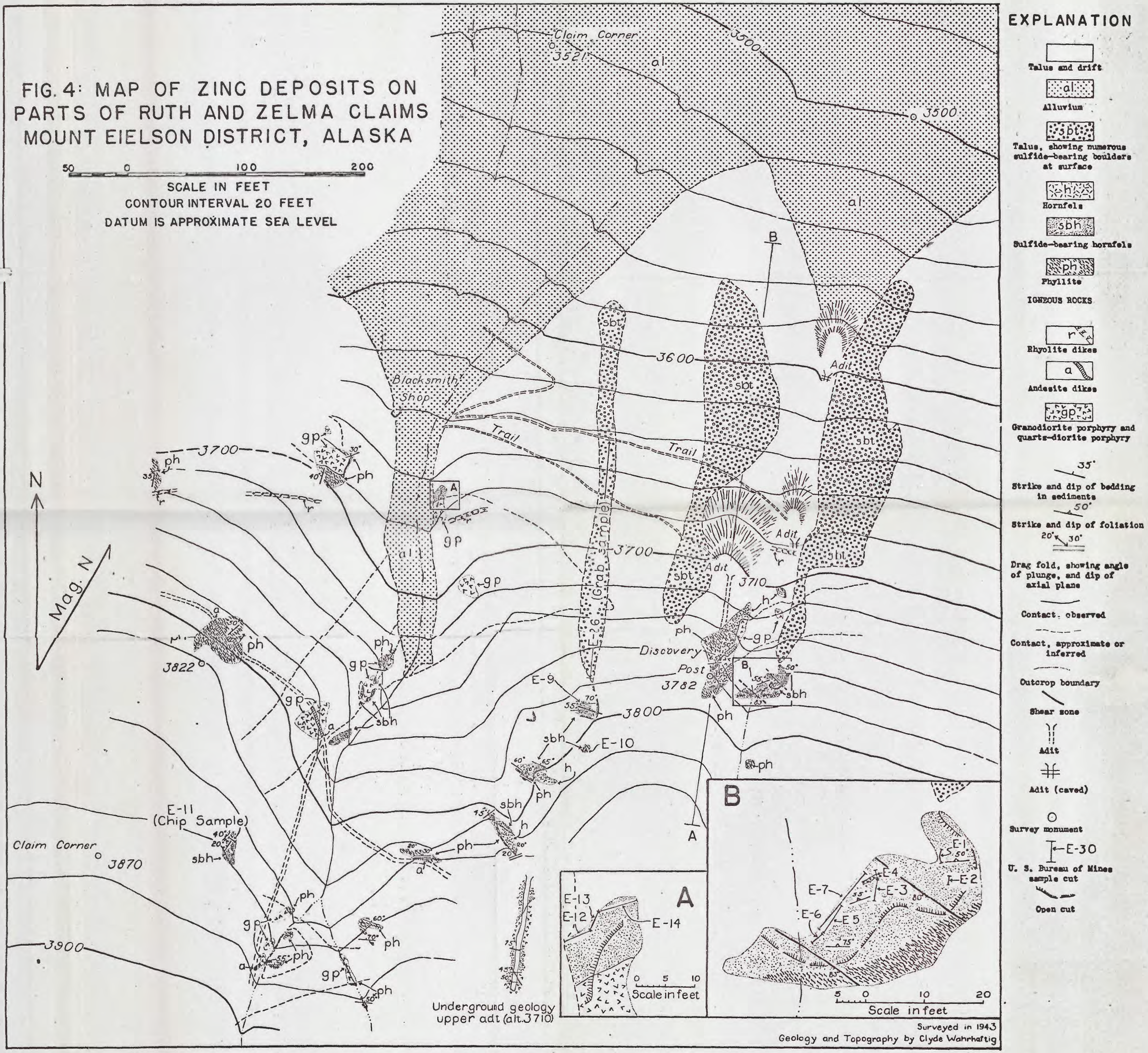
WAR MINERALS INVESTIGATIONS
PRELIMINARY MAP



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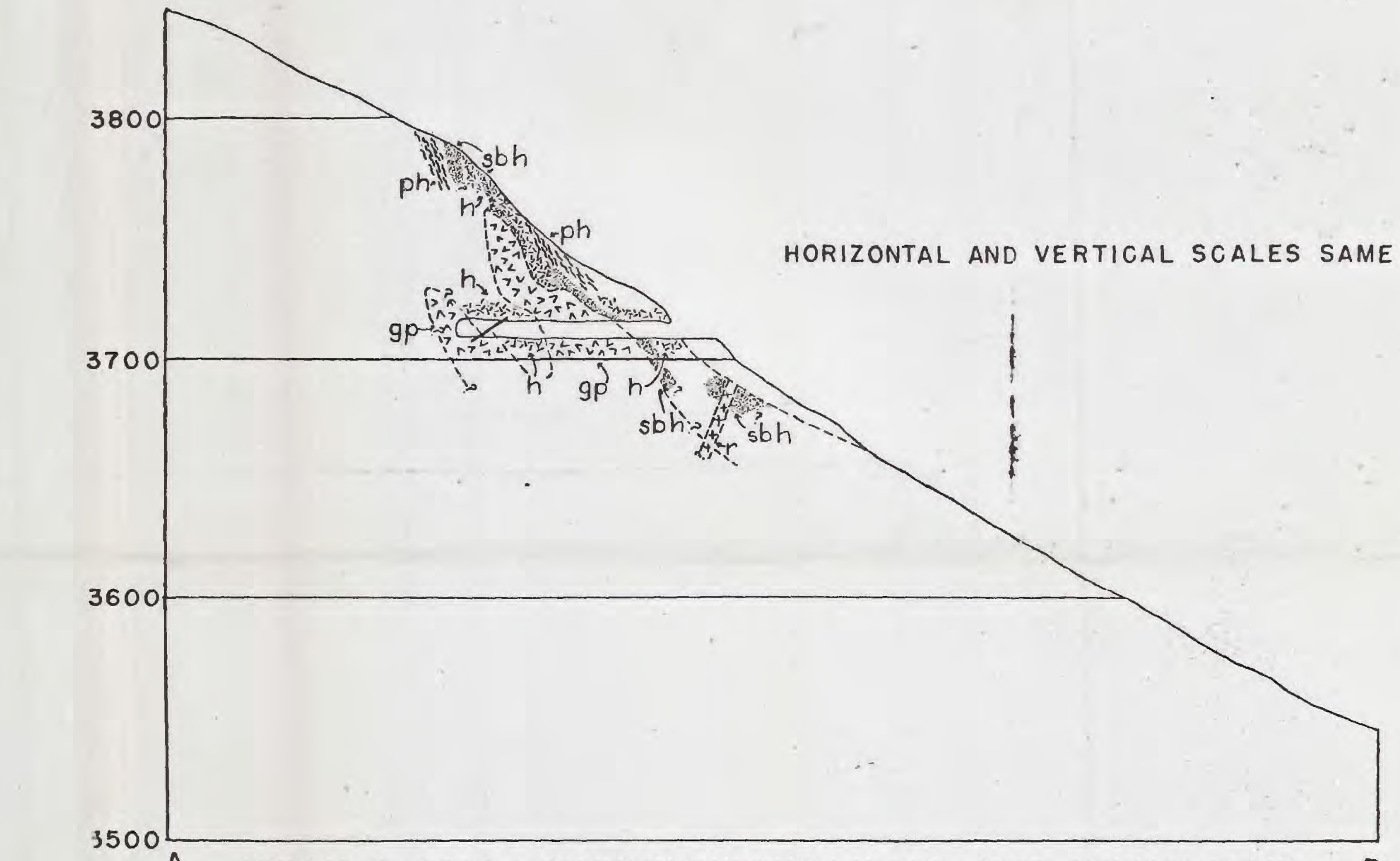
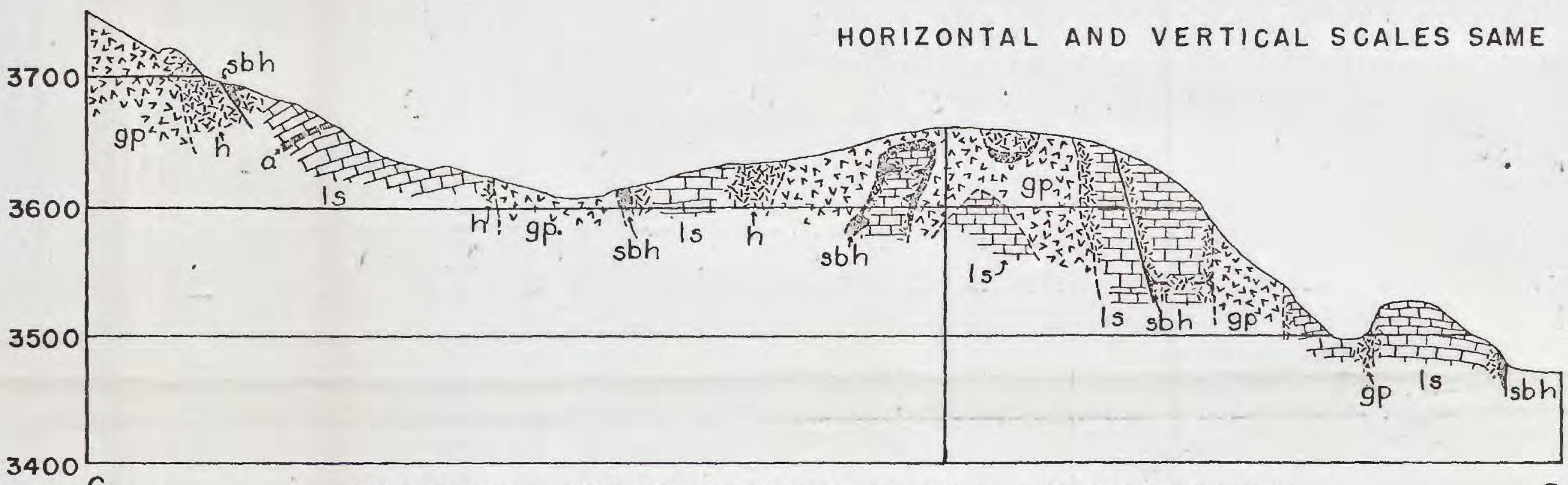
WAR MINERALS INVESTIGATIONS
PRELIMINARY MAP



VERTICAL CROSS SECTION THROUGH UPPER ADIT, ZELMA CLAIM



VERTICAL CROSS SECTION ALONG GRANT CREEK

FIG. 6: VERTICAL CROSS SECTIONS THROUGH ZINC DEPOSITS MOUNT EIELSON DISTRICT, ALASKA

EXPLANATION