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A GEOLOGICAL RECONNAISSANCE BETWEEN THE SNAKE AND SALMON RIVERS NORTH OF RIGGINS, IDAHO

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A Geological Reconnaissance Between the Snake and Salmon Rivers North of Riggins, Idaho

by

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INTRODUCTION

PURPOSE AND SCOPE

The study of the region between the Snake and Salmon Rivers north of Riggins, Idaho, was undertaken by the Idaho Bureau of Mines and Geology to meet the requests that have come to the office of the Director for information dealing particularly with the mineralization. Because of the lack of time and the inaccessibility of much of the region, detailed studies had to be confined to mineral deposits and reconnaissance studies to the region as a whole.

The field work covered about nine weeks from June 6 to August 15, 1944, and two days during July and three days during August of 1945. Travel was by car, horse, boat and on foot. On August 27, 1944, a three-hour reconnaissance trip was made into the area by plane, and some of the more inaccessible parts were photographed.

THE MAP

The work was considerably handicapped by the lack of a suitable base map. The only map available was the U. S. Forest Service map showing forest boundaries, streams, roads, and trails. The base for the geological map, which accompanies this report (inside back cover), was compiled from the U. S. Forest Service map, General Land Office township plats, and U. S. Geological Survey maps of parts of the Snake and Salmon Rivers. These sources were augmented by field sketching and aerial photographs. As some of the map has sketch value only, all geological boundaries are shown with broken lines.

ACKNOWLEDGEMENTS

The field work during the 1944 season was carried on with the assistance of Mr. Carlton Spalding, a senior student in the University of Idaho School of Mines. Mr. Spalding also aided in the preparation and examination of thin sections and polished sections.

The writer wishes to thank the personnel of the U. S. Forest Service; Mr. G. H. Smith and Mr. James J. Flynn of Riggins, Idaho, and Mr. E. W. Butcher of Lucile, Idaho, for information on the area as well as for kindness extended; also Mr. E. O. Thompson of Canfield, Idaho, and the Smith Brothers of Joseph Plains for providing living quarters and information of value while working in those vicinities. Mr. Kyle McGrady of Lewiston, Idaho, aided by supplying information on the prospects in the district and by providing boat transportation along the Snake River.

Thanks are also due Dr. Alfred L. Anderson of the Department of Geology of Cornell University for reading the manuscript and offering valuable suggestions while visiting the writer in the field for a few days in 1945.

GEOGRAPHY AND PHYSIOGRAPHY

LOCATION

The area lies in the western part of Idaho County, Idaho, between the Snake and Salmon Rivers and extends northward from Riggins, Idaho, to the confluence of the two rivers (Fig. 1). The area covers approximately 530 square miles about half of which lies within the Nez Perce National Forest.

SURFACE FEATURES

The region is conspicuous because it is isolated from adjoining parts of Idaho and Oregon by the Snake and Salmon Rivers, which have cut deep, narrow canyons. These canyons are essentially parallel from Riggins to a point 6 miles north of Whitebird, a total distance of 41 miles, but at this point the Salmon River changes its course from north to northwest and for 45 miles follows a sinuous course to its junction with the Snake. Both canyons are deeply entrenched in the Columbia plateau. The segment between the two rivers rises abruptly from the canyon floors, which have altitudes of 900 to 1,700 feet to levels 3,000 to 5,500 feet higher. The segment contains several contrasting types of topography. Much of it is a partly dissected plateau surface, but a part of it is a rugged, glaciated mountain mass; while another part is rugged canyon walls, known locally as the "Breaks" of the Salmon and Snake Rivers.

The mountains are a part of the Seven Devils which terminate just within the south border of the district. These have a local relief of 4,000 to 5,500 feet. The highest points from south to north are Bald Mountain (7,000 feet) and Cold Springs Lookout (6,500 feet). On these high points, as well as on the

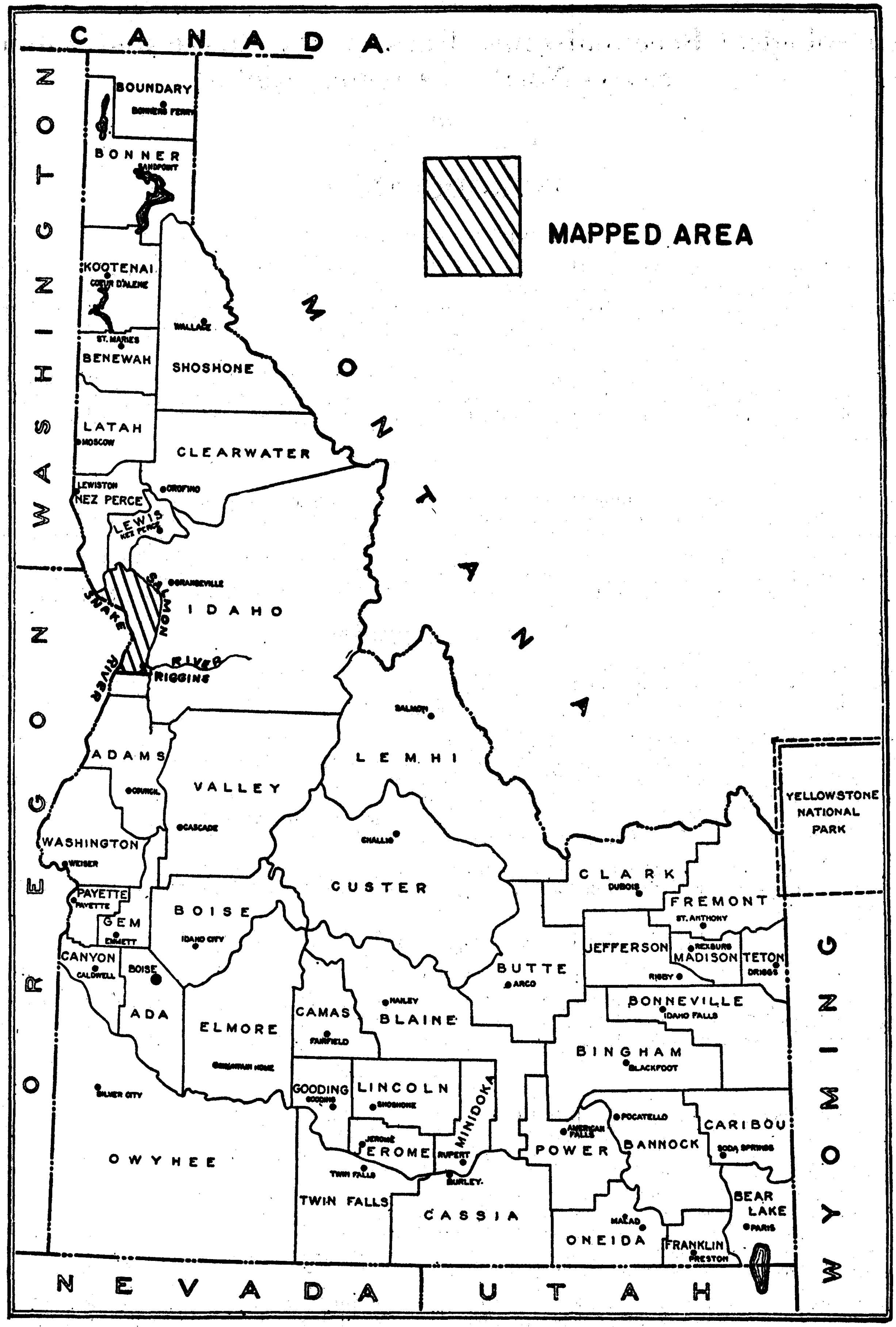

Fig. 1. Map of Idaho showing location of area.

somewhat lower area between, appear remnants of an old erosion surface which rises to the south. This surface is gently rolling. In places it reaches a width of about a mile, but in other places, where it is incised by glacial cirques, its width may be measured in feet.

Small streams flow from one or more lakes, which occupy rock basins in the cirques and tumble down into the Salmon River on the east and the Snake River on the west. The gradient of these streams is steep; several of the streams have a difference in elevation between the head and mouth of 3,000 to 4,000 feet within a horizontal distance of 5 to 6 miles.

Above 2,500 feet the mountains are heavily forested, except where glacial scour has denuded the slopes of soil. Open parks are numerous on the old erosion surface. These support a luxuriant growth of wild flowers and bunch grass which adds greatly to the value of the country as a summer stock range.

The partially dissected plateau, which extends north of the mountains, covers approximately two-thirds of the area. From Cold Springs Lookout to Deer Creek Saddle, the plateau has been so thoroughly dissected that only a long, narrow, occasionally interrupted remnant remains along the main drainage divide. North of Deer Creek Saddle, however, the plateau surface widens and has the appearance of a broad, gently rolling plain, the surface of which has been cut into a number of isolated segments by streams which have carved deep, V-shaped canyons. On the east side of Rice Creek Canyon one large segment is known as Dumacque Plain; on the west side of Rice Creek Canyon the remaining segments are collectively called Joseph Plains. The plateau has an excellent cover of grass and here and there an open stand of yellow pine.

The canyon walls or "Breaks" of the Salmon and Snake Rivers are rough and almost barren of vegetation other than scattered drought resistant plants and coarse grass. The lower slopes are steep, in places almost vertical, but the higher slopes are more gentle and are made up in part of long narrow spurs extending out between steep-walled, V-shaped canyons carved by tributary streams. The streams are mostly perennial; they head on the basalt-covered plateau, which has 25-30 inches annual precipitation. The broken and jointed basalt forms a good underground reservoir and feeds a plentiful supply of water to the streams below.

CLIMATE

Although the larger part of the district lies above 3,000 feet, it has a climate that may be classed as only moderately severe. In the higher parts the winters are long and snow may fall anytime between September 1 and June. From November until April the temperature rarely exceeds 35° F. and for brief periods may drop below zero. The summers are short but pleasant with temperatures seldom above 75° F.

Along the bottoms of the Snake and Salmon River canyons, winters are mild and summer temperatures may reach 110° to 115° F. Frost and snow are of rare occurrence. Such crops as soft fruits, melons, and English walnuts are grown on irrigated plots.

Rainfall records for the higher parts of the district are not available, but a 22 year average for Riggins, Idaho, in the Salmon River Canyon is 14.63 inches with the maximum in the early spring and fall. The higher slopes support an abundant stand of coniferous forests and grasses; therefore, the precipitation must be considerably more than in the canyon bottoms.

ACCESSIBILITY

Much of the district is difficultly accessible. Although U. S. Highway 95 follows the bottom of the Salmon River Canyon from Whitebird to Riggins, the river and canyon walls form a barrier to other parts of the region. Secondary roads leave the main highway at Whitebird, Lucile, and Riggins but do not extend far from the river. These roads are access roads only; travel within much of the area must be on foot or horseback. The northern end of the district may be reached from Cottonwood, Idaho, by a graded but poor road which crosses the Salmon River at Rice Creek Station and then winds upward to the Joseph Plains.

The Snake River side may be most easily reached by Kyle McGrady's river boat from Lewiston, Idaho. The boat runs once a week from Lewiston to Johnson's Bar at the north end of the Grand Canyon of the Snake River. The boat carries mail, freight and passengers to the scattered stock ranches of the region. This boat trip is one of the most scenic in the United States.

GEOLOGY

FOREWARD

The geology of the district is exceedingly complex. To divide the rocks into their natural units and to unravel their complicated structural relations would require many months of detailed field and laboratory work. The rocks include many sedimentary and igneous varieties belonging to several different epochs of sedimentation and volcanism, dating back as far as the late Paleozoic. The oldest group of rocks includes a thick succession of flows and pyroclastics which have been named the Seven Devils volcanics and which in the adjacent areas carries a Permian fauna of Phosphoria age. The Pittsburg formation rests unconformably on the older rocks and is composed largely of sandstone and conglomerate which has been derived by erosion of the Seven Devils volcanics. As these rocks are nonfossiliferous their age is uncertain, but they may be correlated with formations nearby which have been assigned to the Carboniferous (?). Younger than the sandstones and conglomerates is another group of rocks called the Lucile series, which consists of crystalline limestone, phyllites, schists and slates and which are believed to be of Triassic age. Except for some Quaternary sands and gravels, the youngest rocks are flows of Columbia River basalt along with intercalated, poorly indurated shales and sandstones of the Latah formation, all of Tertiary age. Both the Paleozoic and Mesozoic rocks have been intruded by stocks and dikes of granitic and porphyritic rock, probably during Mesozoic or early Tertiary time.

Structural relations are obscure, but the older rocks have been folded and faulted, perhaps during more than one period of diastrophism.

SEDIMENTARY AND EXTRUSIVE ROCKS

SEVEN DEVILS VOLCANICS

Distribution: The Seven Devils volcanics form the lower walls of the Snake River Canyon and also of the Salmon River Canyon near Slate Creek and Whitebird, and from Rice Creek Station to the Snake River.

Character: These rocks compose a metamorphosed complex of flows and pyroclastics with some minor intercalated sedimentary materials and many intruded stocks and dikes. The entire group is so metamorphosed that in many places it resembles greenstone.

Along the Snake River Canyon the volcanics are mainly porphyritic in texture and range in color from gray-green to red and purple, the red and purple colors predominating. Most of the flows are thick, but some are thin, and all are dense and more or less massive in structure. Because of alteration it is impossible to distinguish surface flows from intrusive masses, except for textural differences apparent in thin sections. Examination of thin sections indicates that the rocks are mostly porphyritic andesites. However, the number of specimens collected and examined microscopically is insufficient to permit recognition of all existing rock types. Because of the extreme alteration it may not be possible always to make positive identification.

In the Salmon River Canyon from Rice Creek Station to within a mile of the Snake River the flows are grayish to greenish in color and are highly schistose. Some tuffaceous as well as light tan quartzite beds are intercalated with the flows. Thin sections show all rocks to be so altered that positive identification is not possible. A few plagioclase phenocrysts, from one to two millimeters long and of intermediate composition, suggest that the flows, at least in part, are altered andesites.

In the Salmon River Canyon, below Whitebird, the flows are nearly all red to purple flow breccias, a few of which are porphyritic. One gray-green andesite porphyry dike was noted but was not mapped.

Near the junction of the Salmon and Snake Rivers the flows are dense, dark green or black and highly altered. With the flows are several gray to black, banded beds which resemble quartzites in the hand-specimen, but which under the microscope have the texture of a devitrified siliceous rhyolite or fine-grained, originally glassy tuff.

This complex series of volcanic flows, sedimentary rocks and intrusives have been so folded, faulted and altered that no sequence is readily apparent. No sections have been measured, but if the structure has been correctly interpreted, and no isoclinal folding exists, the series must have a thickness of about 10,000 feet.

Age: Nothing has been found within the district which would indicate the age of the rocks, but F. B. Laney[1] has found fossiliferous tuffs in the series in the lower Snake River Canyon near Homestead, Oregon, which according to Girty, have a Permian fauna of the same character as the Phosphoria in southeastern Idaho. The rocks are also similar to those that make up the Clover Creek greenstones in northeast Oregon in which Gilluly[2] has found Permian fossils in a limestone member. Thus the rocks along the Snake and Salmon are dated as Permian.

PITTSBURG FORMATION

Distribution: The Pittsburg formation, a sequence of sedimentary rocks lying above the Permian volcanics, is exposed near Pittsburg Landing on the Snake River. These rocks cover an area of approximately one and one-half square miles on the Idaho side of the river; they cover a much larger but undetermined area on the Oregon side. So far as known, these rocks do not occur elsewhere within the district.

[1]Personal Communication, reported to A. L. Anderson, Pamphlet No. 34, p. 13, 1930, Idaho Bureau of Mines and Geology.
[2]Gilluly, James, Geology and Mineral Resources of the Baker Quadrangle, Oregon, U.S.G.S. Bull. No. 879, p. 21, 1937.

Character: The rocks of this group are mainly conglomerates and sandstones (Fig. 2) with some argillaceous beds and here and there a dense tuffaceous bed. The conglomerates are made up of subangular to rounded pebbles and boulders from one to four inches in diameter in a coarse, grey-green sandy matrix. The sandstones are coarse. The whole formation is gray-green to dark green in color and seems to have been formed mostly of debris eroded from the Permian volcanics. The thickness has not been measured but is estimated to be between 200 and 300 feet.

Age: As these rocks are nonfossiliferous their age cannot be precisely determined. They apparently overlie the Permian volcanics unconformably. To the east they appear to have been intruded by Cretaceous (?) granite (Idaho batholith). Thus they must be younger than the known Permian rocks but can be no younger than Cretaceous. Lithologically similar rocks have been described by Ross[3] on Blue Creek in northeast Oregon. He calls them Carboniferous sedimentary rocks and states that they appear to overlie conformably the Permian volcanics at that locality. As the beds at Pittsburg Landing seem to have been deposited after the Permian volcanics had been folded and considerably metamorphosed, it is possible that they may have been deposited after late Paleozoic deformation. However, until more direct evidence is found for a later age the rocks, in accordance with Ross, will be tentatively assigned to the Carboniferous.

LUCILE SERIES

Distribution: The Lucile series, named for its occurrence at Lucile, Idaho, is exposed in the canyon walls of the Salmon River from Lucile to Riggins and in the canyon of the Salmon and Little Salmon east and south of Riggins beyond the borders of the map area.

Character: The series is divisible into a lower graphitic schist and calcareous shale member, a middle limestone member which has some intercalated tuffaceous lenses, and an upper phyllitic and schistose member in which are some volcanic flows.

Where exposed at Lucile, the graphitic schist is a gray to black, fine-grained rock with well developed schistosity. It contains so much pyrite in the form of small cubes that it may be aptly described as a pyritic-graphite schist. The schist is more than 400 feet thick locally, but apparently it is very lenticular, for not more than a mile northwest of Lucile it disappears and the limestone rests directly on the Seven Devils volcanics. As the contact is concealed by deep overburden and a dense growth of timber, the relation of the schist to the volcanics is obscure, but it seems to rest unconformably upon the volcanics.

The shale is white to light gray and pink in color. It is thin bedded, limy and shows signs of flowage. Schistose planes, having minute scales of white mica along them, have developed in some of the beds. Stratigraphically the shale may be equivalent to the graphite schist. Where it is exposed one-half mile south of Cold Springs Lookout, the shale is about 100 feet thick and lies unconformably upon the Permian volcanics but is conformable with the overlying limestone.

The limestone member is cliff-forming. The limestone itself is gray to bluish gray, except for some thin white to light gray beds. It is more or less metamorphosed and in places has been changed to white marble with complete loss of bedding planes; in other places, the beds have become schistose or have remained unchanged except for minor flowage. At Lucile the limestone is 500 feet thick; elsewhere it ranges from 50 feet to more than 500 feet thick. Intercalated with the limestone at several points are lenticular beds of tuffaceous materials ranging from a few feet to over 50 feet thick and from 50 feet to over a mile long.

The phyllites and phyllitic schists are fine to medium-grained, light to dark brownish gray micaceous rocks, which owe their color to abundant brownish colored mica. Some of the rocks may be classed either as phyllites or as fine-grained schists. Most of the rocks contain scattered grains or cubes of pyrite; a little of the rock is rich in carbonanesous matter. The rocks show progressive increase in grain size on approach to the Idaho batholith, which lies a few miles east of the mapped area. Typical fine-grained phyllites thus become coarse grained and change gradually to mica schist which in turn merges with gneiss close to the batholith. The rocks appear to be mostly of sedimentary origin, but some apparently have been derived from volcanic flows for they show traces of vesicular structure, now represented by stretched and misshapen vesicles and amygdules. This group of phyllites and phyllitic schist has a considerable thickness. Although no sections were measured, a thickness of more than 2,000 feet is exposed at Riggins.

Age: Fossil fragments found in the limestone at Lucile and along Papoose Creek road suggest that the beds are Upper Triassic. The fossil fragments were identified by J. B. Reeside, Jr., of the U. S. Geological Survey, who describes them as follows:

> The two specimens have been examined by a number of paleontologists, and the consensus is that they represent fragments of echinoderms and that at least the one specimen that shows tubular bodies is part of a stout echinoid spine (radiole). I have compared the structure of this specimen with that of spines of cidaroid echinoids from the Upper Triassic at a locality on the Lapwai Indian Reservation, Idaho, and they seem to me quite similar in size and make-up. So far as I am informed, no spines of this thick, heavy type occur in the Paleozoic, and their presence would imply a Triassic age for the containing beds.

[3]Ross, C. P., Geology of Part of the Wallowa Mountains, Oreg. Dept. of Geol. and Mineral Ind., Bull. 3, pp. 26-31, 1938.

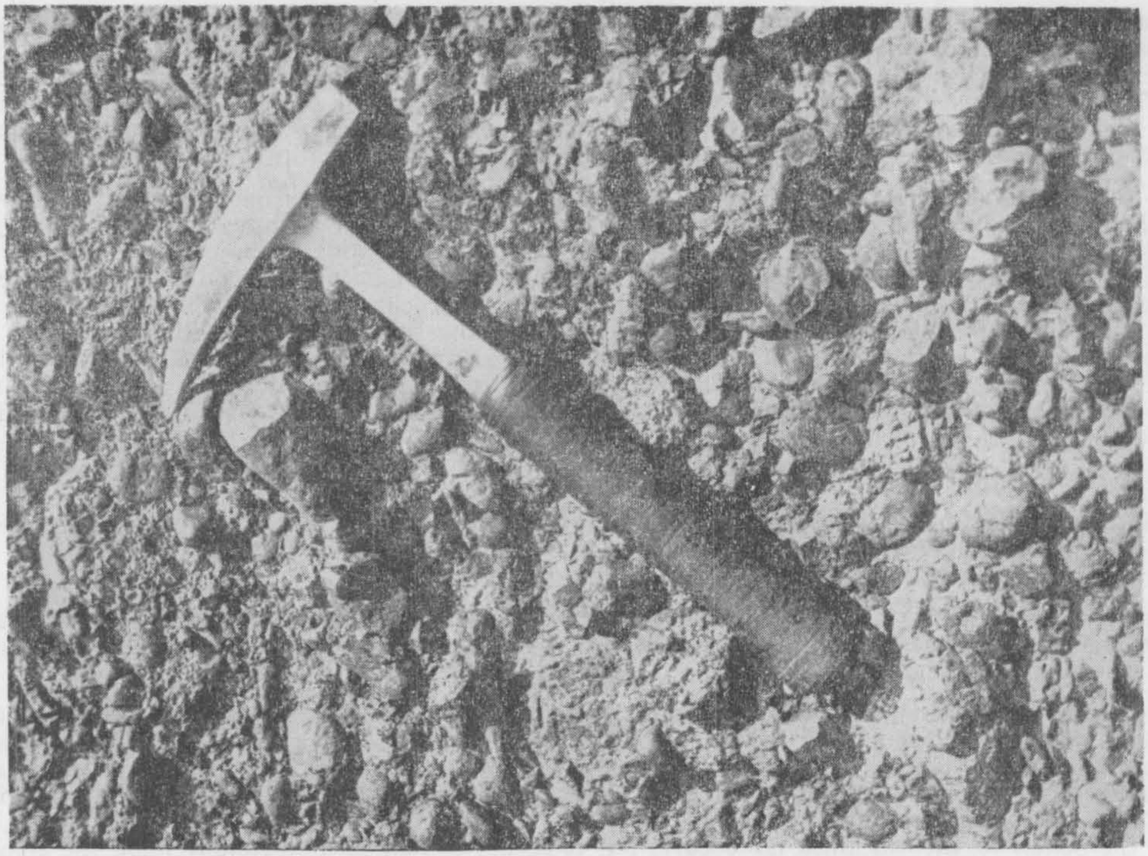

Fig. 2. Conglomerate of the Pittsburg formation along Kurry Creek.

Fig. 3. Syncline in the Pittsburg formation. View looking east from Pittsburg Landing on the Snake River.

The beds may also be correlated with similar beds (Martin Bridge formation) in northeast Oregon in which Ross[4] has found Upper Triassic fossils.

COLUMBIA RIVER BASALT

Distribution: The Columbia River basalt is by far the most widespread of all rocks. At one time it formed a continuous blanket across the area, but now it is confined to upper canyon walls and the upland areas between canyons. One of the larger caps extends northward from Cow Creek Saddle just west of Lucile to the "Breaks" of the Salmon River Canyon and then continues across on the opposite side of the canyon far beyond the north boundary of the map. The basalt also caps the Triassic rocks on the west side of the Salmon River from Lucile to Old Pollock. From Slate Creek to Whitebird the entire canyon is in basalt.

Character: The Columbia River basalt forms a series of flows which has, except against mountain slopes, an aggregate thickness of more than 2,200 feet. While descending the west wall of Rice Canyon, the writer collected specimens from 21 different flows which ranged in thickness from 6 to over 100 feet. There the basalt is about 2,200 feet thick and the bottom is not exposed. Some of the flows are thin, composed of either dense or vesicular rock; other flows are thick, composed of either dense, massive or columnar rock. The columns in some flows are small (measuring from four to five inches in diameter) whereas in others the columns may be three to four feet in diameter. Many of the flows are separated from those above by a layer of soil or weathered basalt.

The fresh basalt is dark gray-green to black. Much of it is even grained but some, particularly on the lower canyon slopes, is porphyritic and has lath shaped labradorite phenocrysts embedded in a dense, black fine-grained groundmass.

The bottom flow along Cow Creek Saddle and along Race Creek near Riggins is extensively weathered. This flow, when fresh, was highly vesicular but is now a soft gray-green mass which holds agate in former vesicles.

Age: As shown by other workers, the Columbia River basalt is Miocene in age. Kirkham and Johnson[5] found Miocene flora in intercalated Latah beds at Whitebird.

LATAH FORMATION

Distribution: Beds of the Latah formation are exposed along the highway about two miles north of Whitebird (outside the map boundary) and along the Deer Creek road about a mile south of the bridge that crosses the Salmon River not far above the mouth of Whitebird Creek. The beds along Deer Creek are exposed over an area of three square miles.

Character: In both localities the formation is typical of the Latah described in the literature. It consists mostly of soft, light brown to cream colored, poorly compacted, fossiliferous shale with some interbedded volcanic ash and locally a bed or two of conglomerate and sandstone. Along Deer Creek the beds have a total thickness of about 150 feet.

Age: The flora in the Latah north of Whitebird has been figured as Miocene by Kirkham and Johnson[6].

QUATERNARY DEPOSITS

Deposits of Quaternary age are confined to valley slopes and bottoms and include glacial till, outwash gravels (valley train), terrace gravels, landslide debris, and stream alluvium. All of these deposits, except the glacial till and outwash, have been mapped as a unit. The till and outwash are found in the upper valleys of several of the streams flowing into the Snake and Salmon Rivers. The deposits in Deer Creek Valley cover a considerable area. The terrace gravels are found at different levels along both the Snake and Salmon Rivers and in the lower valleys of the larger tributaries. Landslide deposits appear at several places along the canyons. The glacial deposits and terrace gravels are Pleistocene in age. The landslide deposits may range from Pleistocene to Recent; the stream alluvium is Recent.

INTRUSIVE ROCKS

GRANITIC ROCKS

Distribution: Bodies of intrusive granitic rocks are rather abundantly distributed through the area of pre-Miocene rocks, but only the larger masses have been mapped. The many dikes in the Permian volcanics are too small to be shown. As stated earlier, they, as well as the intruded volcanics, are so altered that it is virtually impossible to distinguish between them in the field. The intrusive that were mapped

[4]Ross, C. P., Opt. Cit., pp. 34-36.
[5]Kirkham, V. R. D., and Johnson, M. M., The Latah Formation in Idaho, Jour. of Geol. Vol. 37, 1929, pp. 483-504.
[6]Ibid., pp. 483-504.

include two large stocks and several smaller ones. The largest stock is on the west side of the Salmon River across from Slate Creek and underlies about 35 square miles in the drainage of Sherwin, Christie, and Rhett Creeks, tributaries of the Salmon River, and in the headwaters of Kurry and Klopton Creeks, tributaries of the Snake River. The second stock is exposed on the Snake River slope west of Cold Springs Lookout and underlies 10-15 square miles.

Character: The composition of the two stocks is somewhat variable, but differences within each of the stocks were not worked out in detail. The larger stock appears to be a porphyritic granite, pinkish in color along Sherwin Creek and light gray along Kurry Creek. The phenocrysts include quartz and orthoclase which measure 5 to 6 millimeters long. These are in a matrix of smaller quartz and feldspar grains along with some scattered grains of biotite, partially altered to chlorite, and epidote. There is much sericite and kaolin from the alteration of the feldspar.

The stock west of Cold Springs Lookout shows a range in composition from granite to granodiorite, with the granite predominating. It is a non-porphyritic, medium-grained, light gray rock made up largely of orthoclase, quartz, and plagioclase with minor amounts of hornblende and biotite. The feldspars are almost entirely altered to sericite and kaolin; and the biotite, to magnetite and chlorite. The hornblende is relatively unaltered. The granite contains many inclusions of the host rock; locally there are many dike offshoots.

Age: The ages of the intrusive rocks are not known and no evidence was found in the district from which to date them. The larger stock contains rock that resembles that described by Ross[7] along the middle Fork of the Salmon River; whereas, the smaller stock has much the same character as the Idaho batholith along the Salmon River 10 miles east of Riggins. The stocks may have been intruded over a considerable period of time; they cut the Permian volcanics and the Triassic sediments but do not intrude the Miocene volcanic flows. Thus they are younger than the Triassic rock but older than the Miocene basalt; they may have been intruded in Cretaceous (?) or early Tertiary time.

STRUCTURE

FOREWORD

The structural features of the area are extremely complcated and are the result of folding and faulting during several epochs. The faulting is complex; the recognition of faults in many places is impossible because of the similar lithologic character of the rocks.

FOLDING AND CLEAVAGE

The Seven Devils volcanics are folded, and metamorphism has obliterated the flow contacts and bedding planes so that it is impossible to obtain a clear picture of the true structure. In general the flows and intercalated strata trend N. 30° to 50° E. and dip 30° to 45° S. E. A regional schistosity is conspicuous in the tuffaceous beds but is not so noticeable in the more massive flows and breccias. These volcanics were first deformed at the end of the Paleozoic era, and later periods of deformation have further complicated the structure.

The beds of the Pittsburg formation strike N. 70° to 80° E. and are folded into a number of gentle anticlines and synclines (Fig. 3).

The Triassic sedimentary rocks and volcanics, which lie unconformably upon the Seven Devils volcanics, are folded and thrown into long, narrow anticlines and synclines, upon which are minor drag folds. Those folds trend northeast, but the broad cover of Columbia River basalt and destruction of bedding planes by metamorphism obscure the relations. Schistosity is well developed in most of the beds; it strikes N. 30° E. and dips 40° to 45° S.E., except for about a mile north of Riggins where the dip abruptly changes from southeast to northwest, producing a "Z" structure. The cause of this has not been determined.

Flows of Columbia River basalt are generally not horizontal but over most of the area have a gentle inclination (less than 5°) to the north. However, some warping has taken place as near Riggins the flows form part of the flanks of a broad shallow syncline which has a north-south axis. Faulting also has interrupted the more or less regional dip of the flows, particularly east of the Salmon River, between Slate Creek and Whitebird, where the tilted surface of the plateau is inclined about 15° W.

FAULTING AND JOINTING

Faults and joint fractures are very conspicuous in the older rocks, the joints perhaps being the most widespread structural feature. Most of the faults are confined to the older rocks but a few cut even the younger flows of Columbia River basalt. Very few of the faults were mapped, but, among those that were, are the Cow Creek fault and the Salmon River fault, the two largest faults in the district.

Cow Creek fault: The Cow Creek fault controls the course of Cow Creek from its source to its mouth and also extends into the Snake River Canyon where it has no surface expression. It is exposed under-

[7]Ross, C. P., Mesozoic and Tertiary Granitic Rocks in Idaho, Jour. of Geol. Vol. 36, 1928, pp. 682-684.

ground at the Bateman property near the headwaters of Cow Creek where its strike is N. 50° E. and its dip 78° S.E. Elsewhere it strikes about N. 70° E. The fault displaces Cretaceous (?) granitic rock, but flows of Columbia River basalt above it are undisturbed. It is a fault of pre-Miocene but post Cretaceous age.

Salmon River fault: The Salmon River fault is a north-south fault that controls the course of the Salmon River from Lucile to Whitebird. It is a fault that is younger than the Cow Creek fault for not only does it cut the Cow Creek fault but it also offsets the flows of Columbia River basalt, making a tilted block of a part of the plateau surface. The fault plane itself is visible at several points along the Salmon River near Slate Creek. Downthrow is to the east and the basalt flows on that side dip toward the fault at angles of 15° to 20°. West of the fault the flows are nearly horizontal or dip gently northwest. The fault appears to have a maximum displacement of 1,500 feet near the mouth of Whitebird Creek. North of the creek, the fault gradually dies out or passes into a downwarp of the plateau surface; south of Slate Creek, the fault passes into the north-south synclinal warp.

Other faults: Faults and joints are particularly numerous in the Snake River canyon between Kirkwood and Sheep Creeks where they form a closely spaced, nearly vertical set, which has a trend of N. 50° E. and cuts obliquely across the regional schistosity. The faults are very conspicuous because they are marked by light-colored granitic dikes which were intruded along them. These stand out in conspicuous contrast with the dark colored volcanics and give the rocks a striking banded appearance. These faults have little displacement, may even be considered as joints. They have, however, controlled the direction of flow of the Snake River for some 15 or 20 miles.

ORE DEPOSITS

INTRODUCTION

There are placer deposits along both the Snake and Salmon Rivers and copper lodes at several widely spaced localities. As the placer deposits are described elsewhere in detail, only a summary is given here. The copper deposits have not been described previously, therefore they are taken up in detail below.

PLACER DEPOSITS

HISTORY AND PRODUCTION

Gold was discovered along the Salmon River at a point where Lucile, Idaho, now stands in 1862 or 1863. Since then, the placers have been worked intermittently either by hydraulic methods or by drifting operations. During the depression years from 1930 to 1937 several small outfits and some lone workmen are reported to have made wages sluicing and panning. Several attempts to work some of the deposits on a large scale have ended in failure.

Little is known of the early production as the records are not complete. Much of the early mined gold may have been carried out of the state, and, therefore, does not show in the records. However, Mr. Walter Hovey Hill[8], a mining engineer who has worked in the area for fifty years, estimates that the placers along the Salmon from Riggins to Whitebird have produced $10,000,000 in gold since their discovery. The U. S. Geological Survey reports and the U. S. Bureau of Mines reports give a total gold production of $267,463 for the period from 1881 to 1943.

OCCURRENCE AND DISTRIBUTION

Gold-bearing gravel occurs along both the Snake and Salmon Rivers as well as in an old exhumed river channel on the old erosion surface at the head of Corral Creek; however, the most productive deposits are along the Salmon River between Riggins and Whitebird where they form an almost uninterrupted belt on both sides of the river. This stretch of the river is included within the following mining districts: the Riggins district, from French Creek (east of the map) to Lucile, the Lucile-Sampson district, from Lucile to Slate Creek, and the Camp Howard district, from Slate Creek to the Snake River.

The gravels along the river occur at several levels. As the river carved its valley there were temporary interruptions in the down cutting when limited flood planes were formed on which gravels accumulated. When downcutting resumed, these gold-bearing gravels were left behind as terraces or benches on the valley sides. Some of the bench deposits are as much as 400 feet above the present river level.

The gravel terraces have been mapped as a unit and are shown on the accompanying geologic map as alluvium. S. H. Lorain and O. E. Metzger[9], of the U. S. Bureau of Mines, have mapped these deposits in some detail and also give considerable data on some of the individual mines.

[8]Personal Communication, dated Feb. 21, 1945, Grangeville, Idaho.

[9]Information Circular 7023, U. S. Bureau of Mines. Govt. Printing office.

The ancient stream deposit is high on the Snake River side of the divide at the head of Corral Creek in the Crooks Corral mining district in sec. 24, T. 26, N., R. 1 W. Boise Meridian. The deposit is on the old erosion surface which was covered by Columbia River basalt during Miocene time and has since been exhumed as Corral Creek cut through and removed the lava capping.

VALUE OF THE DEPOSITS

No attempt was made by the writer to sample any of the deposits, but prospectors in the area report that gold values range from $0.35 to $10.00 per yard. Mr. Walter Hovey Hill[10] has the following to say concerning his experience with the gravel along the Salmon River:

> The drifting operations above and below Lucile on both sides of the river have, in my opinion, produced more gold per acre of ground actually worked than any other part of the river. I believe actual measured bed rock yardage with from one to two feet of gravel above bed rock also mined and washed can be proved to have produced more than $50,000 per acre not taking into account the original discoveries in 1862-63 when pay diggings were better than $20.00 per cubic yard. Personally I have taken out from tests and actual operations more than $10.00 per yard and some rich crevices produced $100.00 per pan.

A few nuggets worth up to $5.00 are reported to have been found near Lucile, but for the most part the gold particles are small and the miners must be careful in their recovery operations. It is reported that the gold ranges in fineness from 825 to 865.

FUTURE OUTLOOK

The Salmon River placers from Riggins to Whitebird offer the best opportunity for future placer mining in the district. Some of the deposits, particularly the higher bench gravels, have had very little work done on them.

COPPER DEPOSITS

HISTORY AND PRODUCTION

The copper deposits were discovered in the late eighties, but little or no work was done on them until the early part of the present century, when attention was directed mainly to the Blue Jacket and Great Eastern and Great Western properties. Aside from test shipments there has been no production from either property. When development was begun at these properties, a railroad was planned to follow down the Snake River Canyon from Council, Idaho, but when the railroad failed to materialize, work at the properties ceased. At that time transportation to the mines was difficult.

About 1915 the Blue Jacket property passed to the ownership of Consolidated Mines Syndicate of Boise, Idaho. This company carried on further development work, but finally operations were suspended and the property is now held for sale.

The Great Eastern and Great Western properties are now known as the Duncan property and are held by Mr. Asa Duncan, River Route, Lewiston, Idaho, who is carrying on development work alone.

DISTRIBUTION AND CHARACTER OF THE DEPOSITS

The copper deposits are few and widely separated. The Blue Jacket and Duncan properties, located on the same zone of shearing, are on the Snake River Slope west of Cow Creek Saddle. The Bateman property is near the headwaters of Cow Creek three miles east of the Blue Jacket, and the Pullman prospect, at the mouth of Salmon River, is 28 miles northwest of the Blue Jacket.

The deposits are much alike and may be classed as lodes developed along complex zones of fracturing or shearing in the Seven Devils volcanics. They have been formed both by filling and replacement and have very irregular, ill-defined outlines. Except at the Bateman and Pullman properties, the rock along the lodes has been extensively bleached and impregnated by minute grains of pyrite. Some of the lodes are chiefly pyritic but locally contain ore shoots of copper, lead and zinc sulphides in addition to gold and silver. The Bateman and Pullman lodes are less complex in mineralogy than the others.

[10]Personal Communication.

MINERALOGY

The minerals may be divided into two groups: (1) the primary minerals, deposited by the ascending mineral-bearing solutions of magmatic origin, and (2) the secondary minerals, derived from the first group by processes of alteration. Both the primary and secondary groups will be described in alphabetical order.

PRIMARY MINERALS

The primary minerals are many and include barite, bornite, calcite, chalcopyrite, galena, gold, pyrite, quartz, sphalerite and tetrahedrite.

Barite: Barite ($BaSO_4$) has been found only in the ore from the Blue Jacket. There it forms irregular, crushed grains, less commonly lath shaped crystals. Many of its grains have been irregularly penetrated by veinlets of sulphides and some have been engulfed in the sulphides, appearing as rounded inclusions.

Bornite: Bornite (Cu_3FeS_4), an ore of copper, is scattered as minute microscopic grains in the ore at the Blue Jacket, generally as small rounded islands in galena, sphalerite and chalcopyrite.

Calcite: Calcite ($CaCO_3$) is present in the ore from all properties as megascopic and microscopic veinlets cutting the other materials.

Chalcopyrite: Chalcopyrite ($CuFeS_2$), a copper iron sulphide, is the most abundant ore mineral. It is present in the ore at all properties and is the chief sulphide in the ore at the Pullman prospect. It tends to fill fractures in older sulphides and in gangue minerals and to hold older minerals as rounded and embayed inclusions. Some, however, is in the form of minute microscopic blebs along crystallographic partings in sphalerite.

Galena: Galena (PbS), lead sulphide, occurs in the ore at the Blue Jacket as irregularly shaped, microscopic grains and as fracture fillings in gangue minerals and sphalerite. It also forms embayments in grains of chalcopyrite.

Gold: Gold (Au) is not visible in any of the ore; however, assays of samples from all properties show the presence of minor amounts.

Pyrite: Pyrite (FeS_2) is everywhere the most abundant sulphide. It occurs as small disseminated, cubic crystals and crystal groups, particularly along the shear zone in which the Blue Jacket and Duncan ore bodies are located. Where accompanied by other sulphides it generally appears within them as rounded and embayed inclusions.

Quartz: Two varieties of quartz are present. The first, a very fine-grained, reddish, jasperoid quartz, was found scattered over the dumps. As none of it was observed in place, little could be learned of its occurrence. However, much of that observed appears as breccia fragments cemented by other minerals.

The second variety, a fine-grained, white quartz occurs as bunches and stringers in fractures in the earlier jasperoid quartz and pyritized material. It also is fractured and the fractures are generally filled with later sulphides and gangue minerals.

Sphalerite: Sphalerite (ZnS), zinc sulphide, is next to chalcopyrite in abundance among ore minerals, showing in the polished sections as rounded and embayed remnants in galena and chalcopyrite. It also fills fractures in and replaces quartz, barite and pyrite.

Tetrahedrite: Tetrahedrite ($Cu_8Sb_2S_7$), gray copper, is not visible in the hand specimen but does appear as small, rounded grains in the galena and chalcopyrite when viewed in polished sections under the microscope. No silver minerals were recognized, but assays of specimens containing abundant grains of tetrahedrite showed higher silver values than those which contained little or no tetrahedrite; the tetrahedrite is probably the source of the silver.

SECONDARY MINERALS

In the oxidized zone the characteristic secondary minerals are azurite, chrysocolla, copper pitch, cuprite, and malachite, whereas in the enriched zone the secondary minerals are covellite, chalcocite, and possibly bornite.

Azurite: Azurite ($2CuCO_3.Cu(OH)_2$), the bright blue copper carbonate, is present in small quantities in the surface croppings and the oxidized zone just below at all the prospects. It is most abundant at the Duncan property, but nowhere does it occur as an essential ore mineral.

Chalcocite: Chalcocite (Cu_2S), an important ore of copper, may be detected only in polished sections as veinlets in the primary sulfides at all properties, except the Duncan, where it occurs as a soft, sooty material in small fractures in the pyritized rock.

Chrysocolla: Chrysocolla ($CuSiO_3.2H_2O$), the copper silicate, is present in small quantities as a thin blue coating on some of the rock in the outcrop.

Copper Pitch: Copper pitch, a mixture of secondary copper minerals, forms brownish black bunches in the leached outcrops. It is most abundant at the Duncan but does not occur in sufficient quantities to be mined as ore.

Covellite: Covellite (CuS), copper sulphide, occurs in the ore from the Blue Jacket as microscopic plates embedded in and replacing bornite, chalcopyrite, sphalerite and galena. It is particularly noticeable along small fractures and in the primary sulphides adjacent to the fractures. Some of it is intimately associated with chalcocite. Where the covellite has almost completely replaced a grain of chalcopyrite the unreplaced portion of the chalcopyrite has a pinkish color resembling bornite.

Cuprite: Some small bunches of reddish cuprite (Cu_2O), copper oxide, are present in the oxidized ore at the Duncan property.

Malachite: Malachite ($CuCO_3$), the green copper carbonate, is the most abundant secondary mineral of copper. It forms a green stain on the outcrop and patches through the oxidized zone below.

PARAGENESIS

Structural and mineralogical relationships suggest that mineral deposition was not continuous but was interrupted by structural adjustments and actually took place in successive stages. The first stage was marked by the deposition of jasperoid quartz in openings along the zones of shearing, then after extensive brecciation, resurgent solutions caused widespread sericitization, silicification and pyritization, features of the second stage of mineralization. Structural adjustments then reopened parts of the shear zones which permitted renewed movement of mineral-bearing solutions and the deposition of the third stage minerals, quartz, barite, sphalerite, tetrahedrite, chalcopyrite, galena and calcite in the order listed.

At the Bateman prospect only sphalerite and chalcopyrite were deposited as channels were evidently not opened to solutions carrying the other minerals. For the same reason, only quartz, chalcopyrite and calcite were deposited at the Pullman prospect.

The paragenesis of the secondary minerals has not been completely learned. In the oxidized zone, the order seems to be cuprite, copper pitch, malachite, azurite; and in the enriched zone the succession seems to be bornite (?), covellite, chalcocite. As the covellite and chalcocite are intimately intergrown, it is difficult to distinguish between them.

TENOR OF THE ORE

Only one or two test shipments of ore have been made. Samples collected by the writer on the dump of the Blue Jacket assayed 14 per cent copper, 8.6 per cent zinc, 0.06 ounces of gold and 15 ounces of silver per ton. According to records loaned by Mrs. Johnesse, the owner, a 34-ton car of ore shipped by boat to Lewiston, Idaho, and then to the smelter at Tacoma, Washington, contained 24.3 per cent copper and 36.9 ounces of silver and 0.12 ounces of gold per ton.

WALL ROCK ALTERATION

The porphyritic andesites and associated dike rocks impregnated by ore in the deposits have lost their originally dark color and are now almost white, closely resmbling granite. The bleaching or change in color is most pronounced near the center of the deposits and gradually decreases in intensity toward the edges of the zone. In the most intensely bleached part, the original minerals and texture of the rocks have been completely obliterated. The feldspars have been changed into sericite and epidote and the dark minerals to magnetite and chlorite. Locally the rock has been thoroughly silicified with the loss of these minerals.

OXIDATION AND ENRICHMENT

The deposits were uncovered by erosion in pre-Miocene time, when buried beneath flows of Columbia River basalt and later exhumed by erosion of the overlying basalt. As erosion has been rapid since Miocene time the oxidized zone is less than 100 feet thick, in places no more than a few feet thick, and because the water table has been lowered so rapidly by deep canyon cutting, there has been neither time nor opportunity for downward enrichment except in almost negligible quantities. At the Blue Jacket, the chalcopyrite has been replaced to some extent by bornite (?), covellite and chalcocite (?).

GENESIS OF THE DEPOSITS

All prospects in the district are closely associated with granitic intrusives which have been assigned a Cretaceous (?) or early Tertiary (?) age. This would imply that the mineralizing solutions had their origin in a deep magma to which the granitic masses are genetically related.

The compositional, textural and structural features of the deposits indicate deposition in a number of different stages under changing physical and chemical conditions. The mineralizing solutions first emitted were rich in silica, potash, iron, and sulphur and caused extensive silicification, sericitization and pyritization accompanied by widespread bleaching, apparently when temperatures were well within the mesothermal range. When recurring structural movements formed channels for renewed circulation, the composition of the solutions had changed; they now carried, in addition to silica, potash, iron and sulphur, some barium, copper, zinc, lead, silver and gold. When deposition took place, the temperature must have been considerably lower than in the previous stage, for barite is considered to be a low temperature mineral. The extremely fine grain of the minerals suggest rapid cooling under near surface conditions.

FUTURE OUTLOOK

Much of the underground work is inaccessible, therefore, little could be learned about the size and value of the deposits, which are known to be low grade, perhaps too low grade to be worked with the price of copper at normal level. Any prospecting should be carried on in the vicinity of the known lodes; additional work could be done in delineating the limits of the ore bodies.

PROPERTIES

BLUE JACKET

The Blue Jacket property, owned by Consolidated Mines Syndicate of Boise, Idaho, consists of seven patented claims located in sec. 27 and 34, T. 26 N., R. 1 W. Boise Meridian (Fig. 4). The property is reported to have 4600 feet of development including a 300 foot, inclined shaft, a crosscut driven to cut the deposit 500 feet below the outcrop, raises from the crosscut to the shaft, and numerous crosscuts and drifts driven on various levels to prospect the deposit. Except for the upper 50 feet of the shaft, this work is now inaccessible.

As far as the writer was able to learn, only one shipment of ore was made. This ore was sent by boat from the mine to Lewiston, Idaho, and by rail from there to the smelter at Tacoma, Washington. Some ore remains on the dump at the collar of the shaft and on the dump at the portal of the crosscut. The property has been idle since 1918.

The deposit is contained in the Seven Devils volcanics. The rocks are metamorphosed andesite flows and dikes, both of which have been so folded and faulted that the structural relations cannot be worked out with any degree of certainty. In general, however, the rocks strike N. 30° to 50° E. and dip 45° S.E. The ore body is in a broad fracture zone which strikes N. 50° E. and is vertical or nearly so.

The crosscut, which was driven to cut the deposit at depth, seems to be near the contact between bleached rock of the highly altered zone and the overlying less altered country rock. The ore on the dump at the portal of the crosscut contains pyrite and chalcopyrite (?), but apparently little or no sphalerite, tetrahedrite or galena. However, the ore on the dump at the collar of the shaft contains considerable barite, sphalerite, tetrahedrite, chalcopyrite and galena besides secondary bornite (?), covellite, and chalcocite. The copper-zinc ore body seems to lie in a fracture zone in the country rock above the bleached zone. This fact is substantiated by the sample map[11] (Fig. 5). The samples were taken and the map was made by the late Mr. Frank Johnesse. Samples numbered 24 through 26 and 50 through 65, all on the crosscut level, average 1.2 per cent copper, whereas samples 1 through 23 and 27 through 49, all above the crosscut level, average 3.9 per cent copper. A single sample taken by the writer from the bleached zone well below the crosscut level assayed 0.4 per cent copper. Apparently, therefore, the copper-zinc ore body must bottom at or near the crosscut level.

Chalcopyrite is the main ore mineral, but there is some sphalerite, tetrahedrite, galena, bornite, covellite, and chalcocite along with barite and quartz. Small amounts of gold and silver show in all assays.

DUNCAN

The Duncan property, formerly known as the Great Eastern and Great Western Mines, is located in sec. 1 and 12, T. 25 N., R. 2 W. Boise Meridian. It is within ½ mile of the Snake River and approximately 800 feet above water level. The development consists of numerous open cuts and three adits totaling 1200 feet (Fig. 6).

This property was located about 1900 and development has been carried on intermittently from that time to the present. In 1913, several shipments of ore with 10 to 20 per cent copper are reported to have been made by boat to Lewiston, Idaho, and by rail from there to the smelter. Apparently there have been no shipments since.

The rocks in the vicinity of the Duncan property are highly altered, schistose, andesitic flows and volcanic tuffs intruded here and there in a complicated manner by dikes and appear to strike N. 30°-50° E. and dip 38°-45° S.E.

All the rocks along the mineralized zone have been thoroughly bleached, and pyrite and minor amounts of chalcopyrite (?) have been added as more or less uniformly disseminated grains. Besides the disseminated pyrite and chalcopyrite (?) there are also minor amounts of azurite, malachite, and chalcocite in small fractures and along the planes of schistosity.

[11]Loaned to the writer by Mrs. F. E. Johnesse, Pres. Consolidated Mine Syndicate.

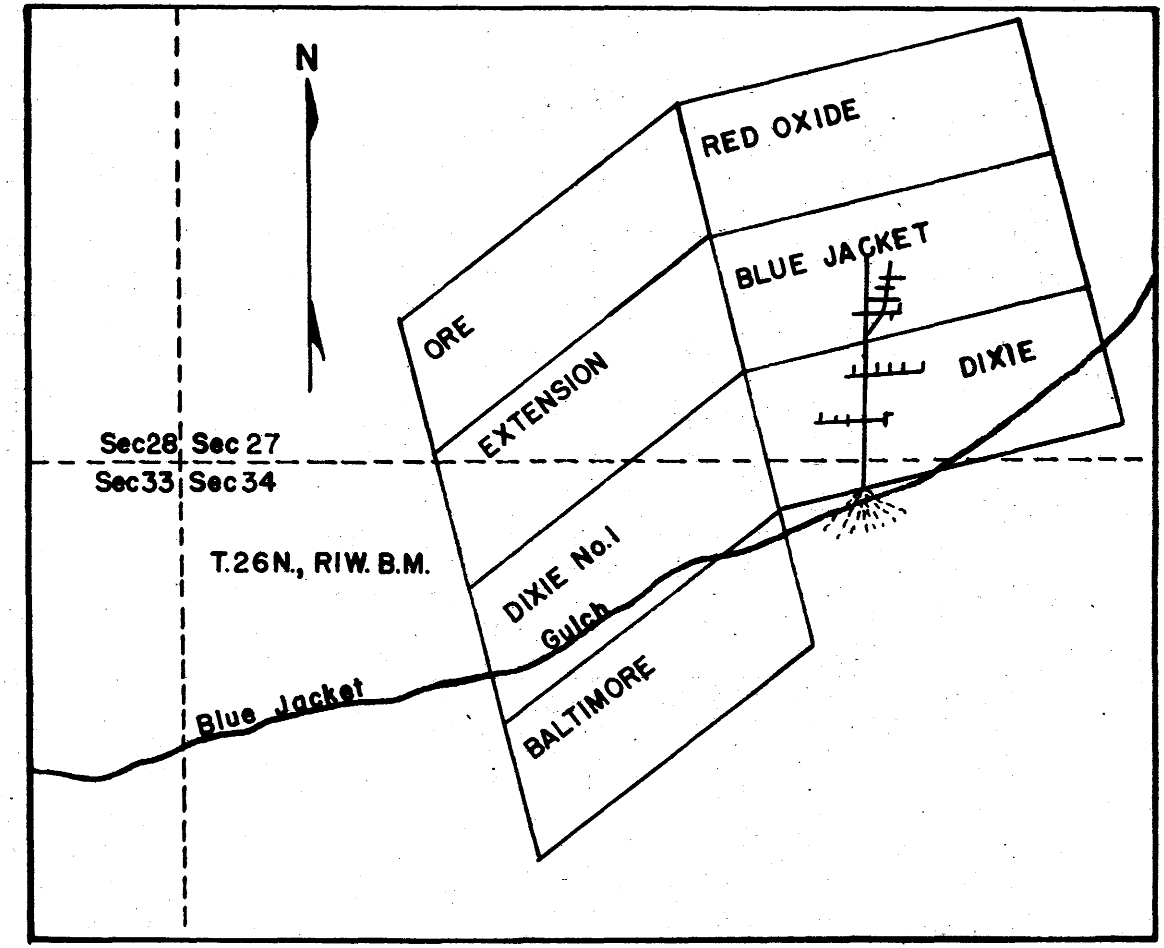

Fig. 4. CLAIM MAP BLUE JACKET CROUP

Scale 1" = 1000'

modified from map by F. E. Johnesse

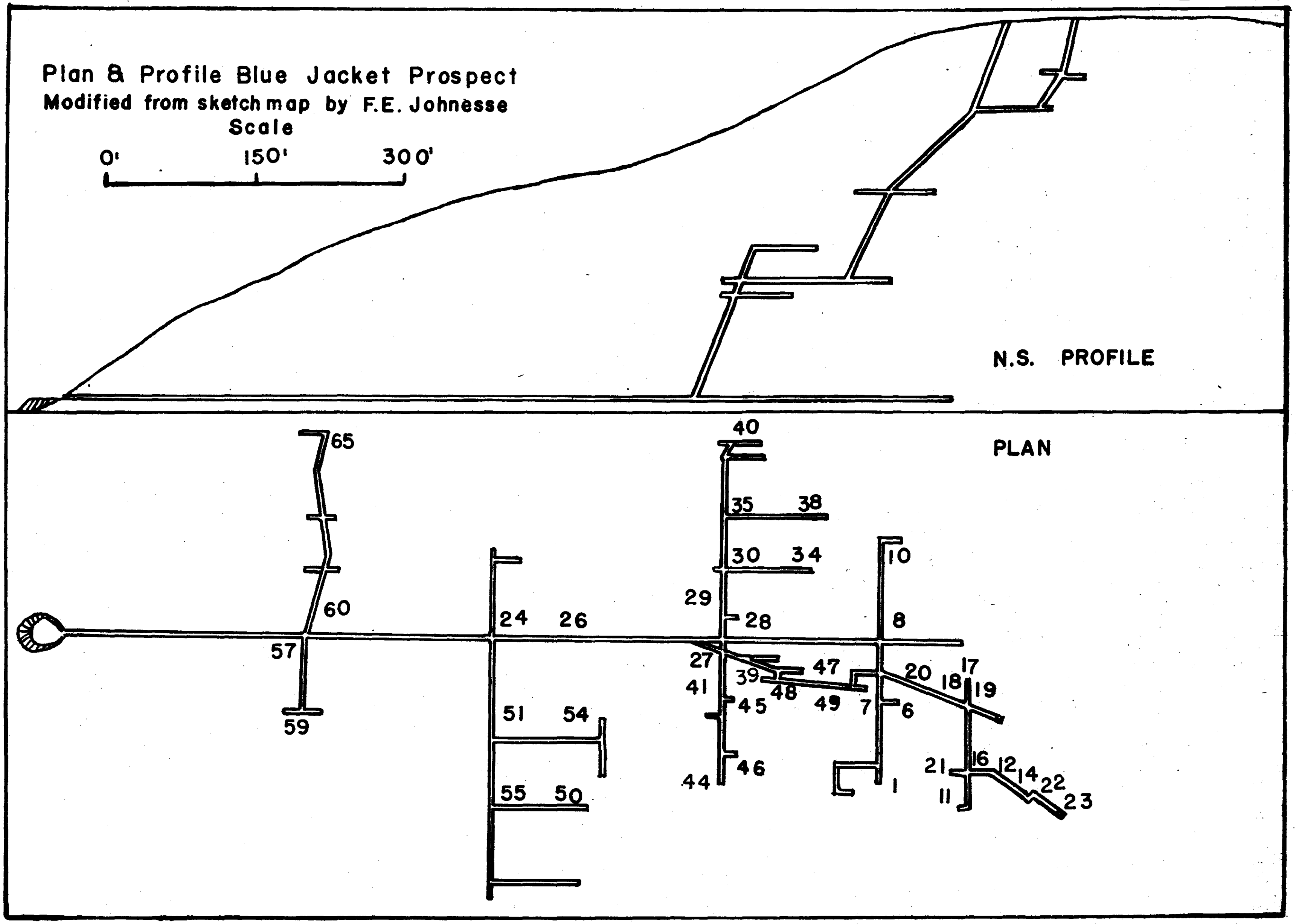

Fig. 5. Profile, plan and sample map of the Blue Jacket.

BATEMAN

The Bateman or May Day property is located near the headwater of Cow Creek in sec. 6, T. 25 N., R. 1 E. Boise Meridian. The development consists of two caved tunnels, which from the size of the waste dump must have been several hundred feet in length, and three recent short tunnels which are accessible. Nothing could be learned of its early history.

The property is in the Seven Devils volcanics. A regional fault (Cow Creek fault) cuts off the ore body in one of the short, open tunnels (Fig. 7).

Chalcopyrite, which is the most abundant mineral, is accompanied by minor amounts of sphalerite and pyrite. These minerals fill fissures in the fractured country rock.

PULLMAN

The Pullman property is located in sec. 14, T. 29 N., R. 4 W. Boise Meridian, at the junction of the Snake and Salmon Rivers. The development work, in addition to a number of open cuts and pits, consists of two adits. The lower tunnel (Fig. 8) is about 50 feet vertically above water level of the Salmon River and the upper tunnel (Fig. 9) is about 125 feet vertically above the lower. The property is now idle and little or no work has been done since the early thirties.

The country rock (Fig. 10) is mostly dense, fine-grained, silicified volcanic tuffs and flows intruded by porphyritic masses; they are so metamorphosed and faulted that the trend cannot be determined with any degree of assurance.

Chalcopyrite is the most abundant ore mineral, while pyrite is visible at places, and assays show minor amounts of gold. Calcite is the only abuntdant gangue mineral. All of the minerals fill small fractures which form a reticulated pattern. The development work has not explored enough of the deposit to give much information as to its size.

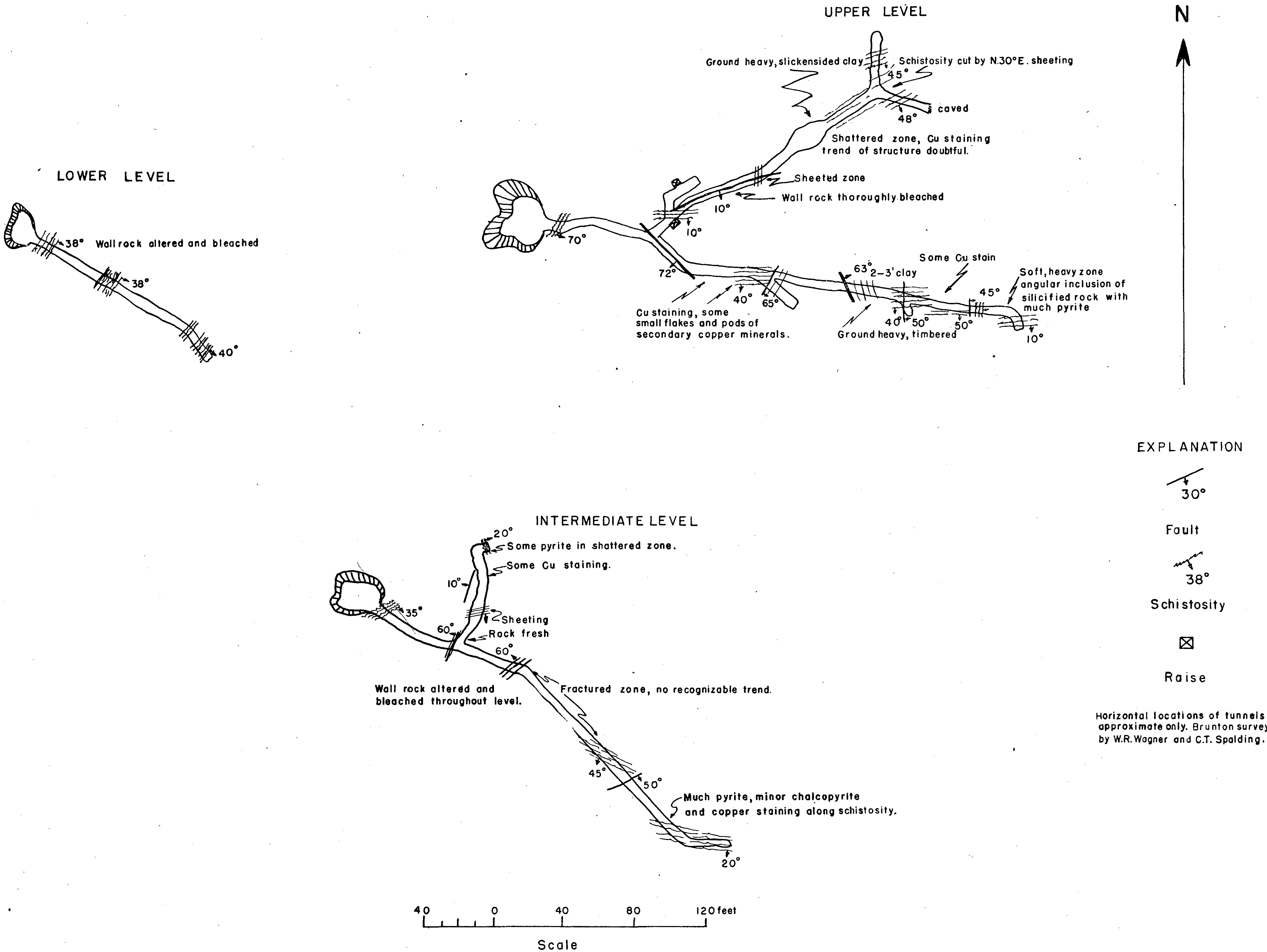

Fig. No. 6. Geologic map of underground work at the Duncan Property

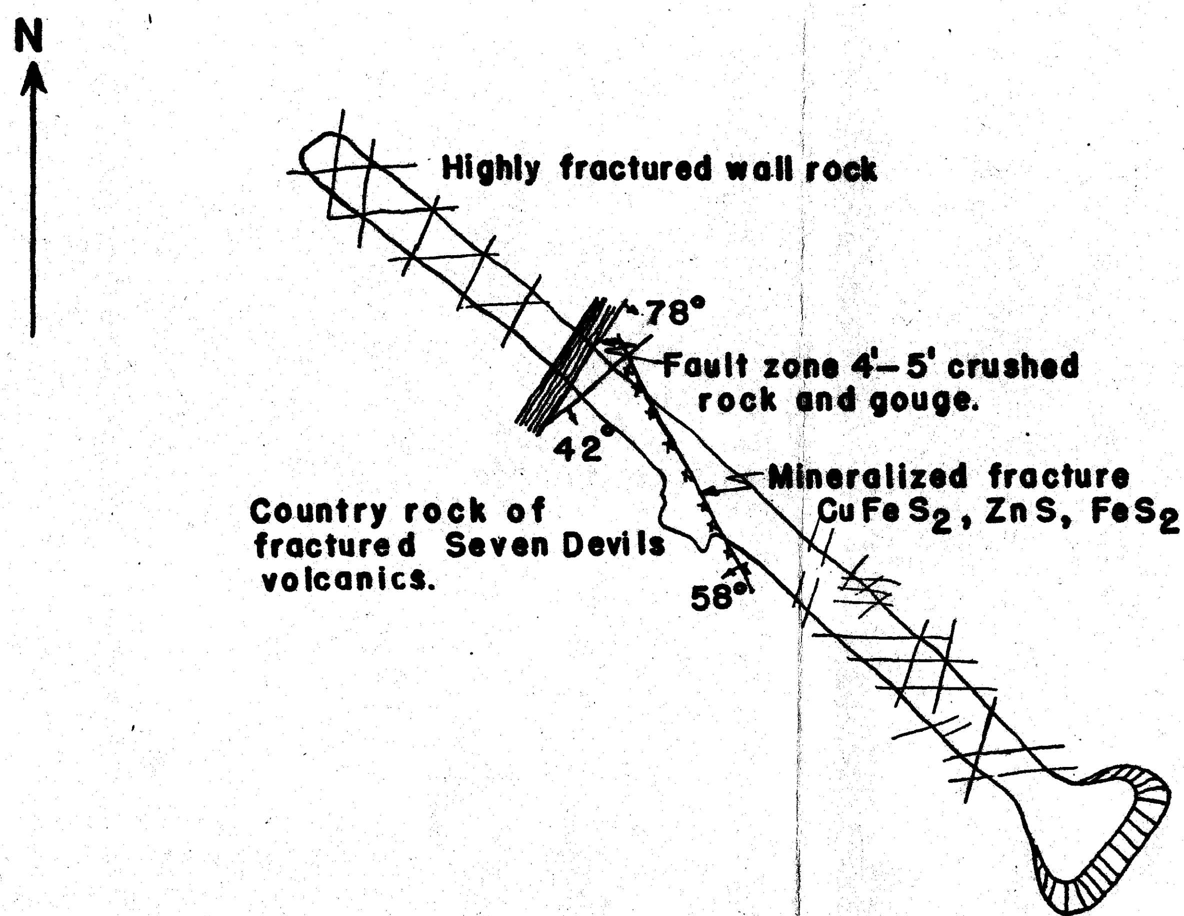

Fig. 7. Geologic Map Bateman Prospect

1 0 20 40 feet

Scale

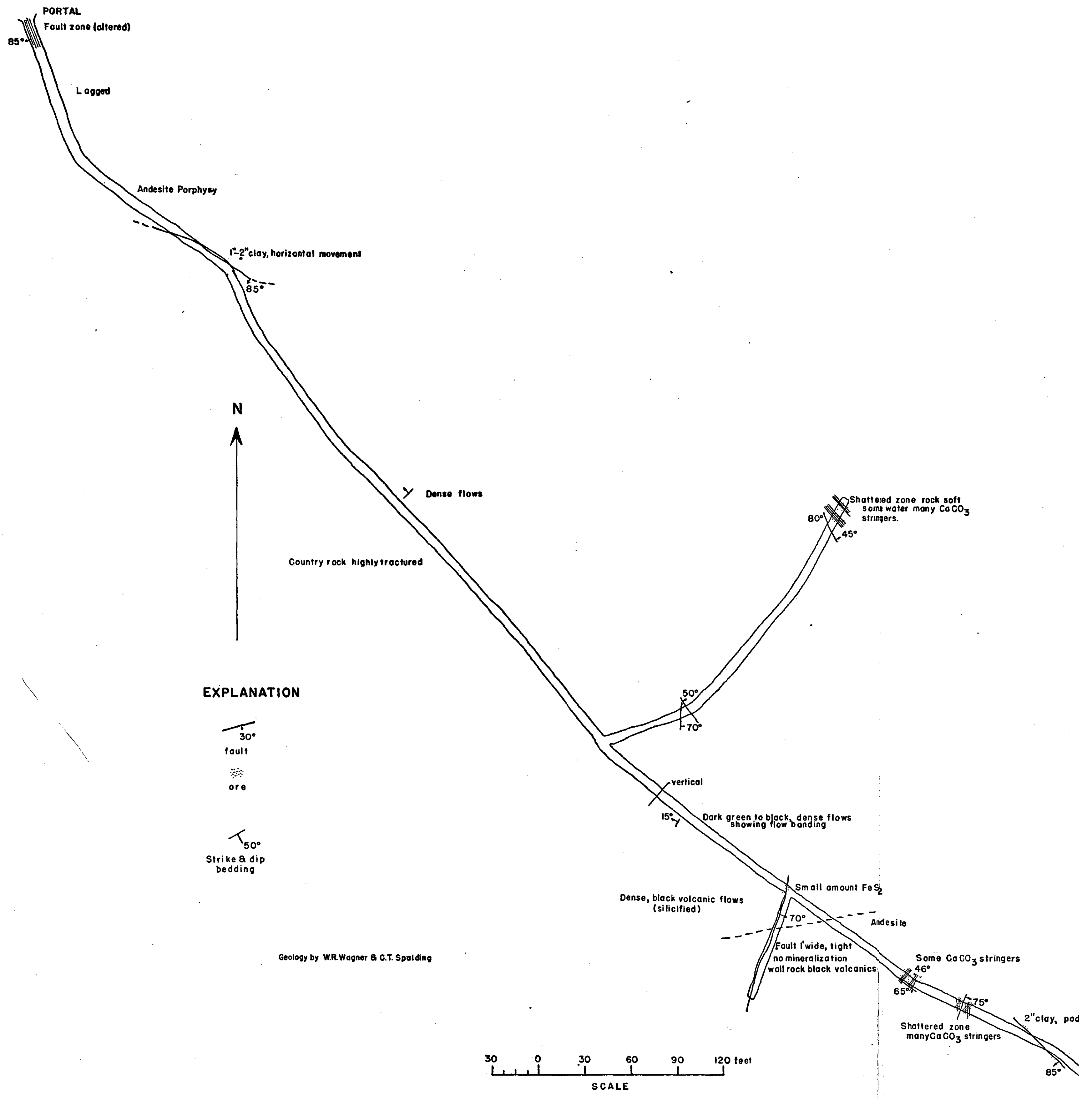

Fig. 8. Geologic map underground workings at the Pullman mine. lower level

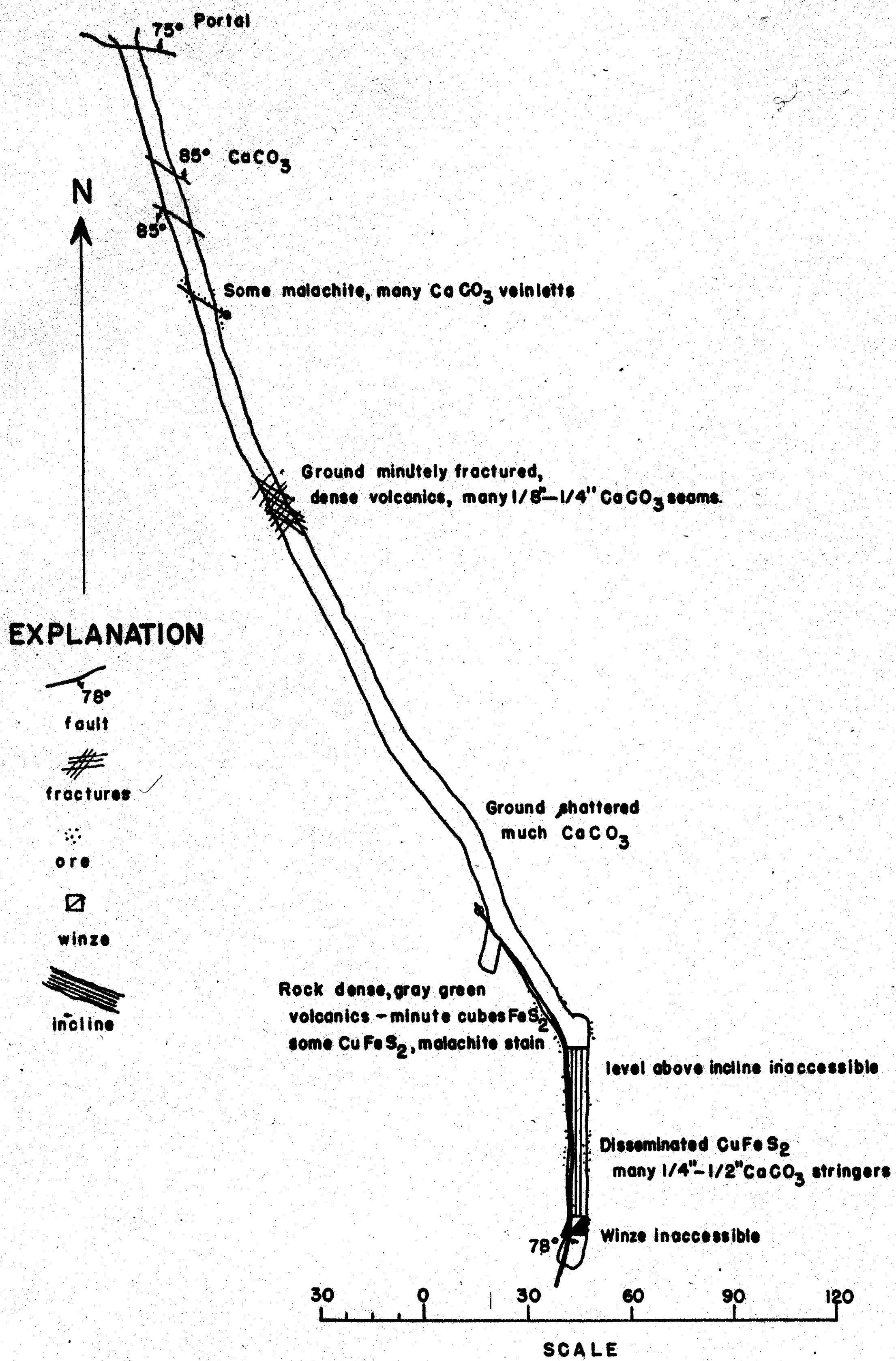

Fig. 9. Geologic map underground workings of the Pullman mine, upper level

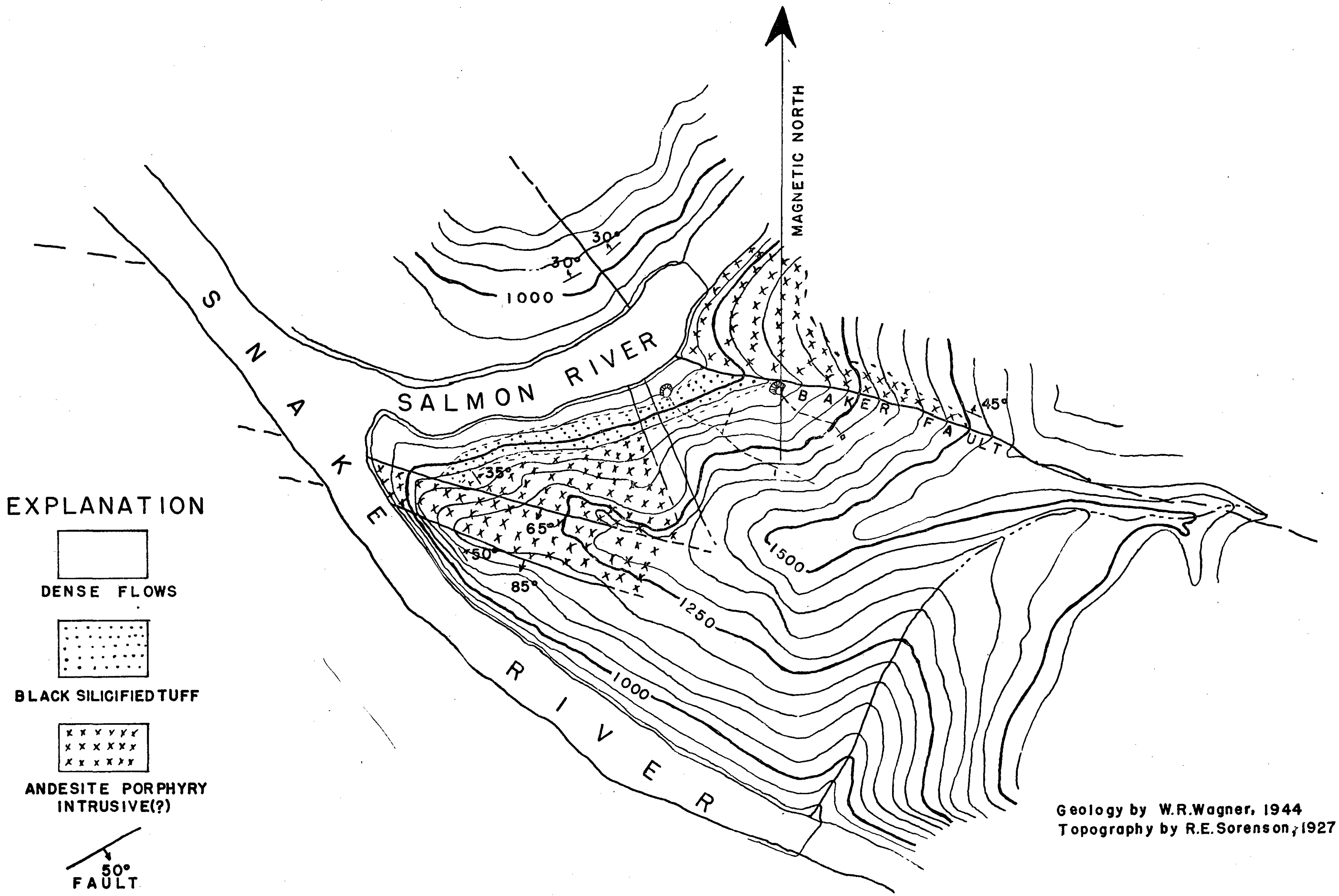

Fig.10. GEOLOGIC MAP PULLMAN MINE SURFACE

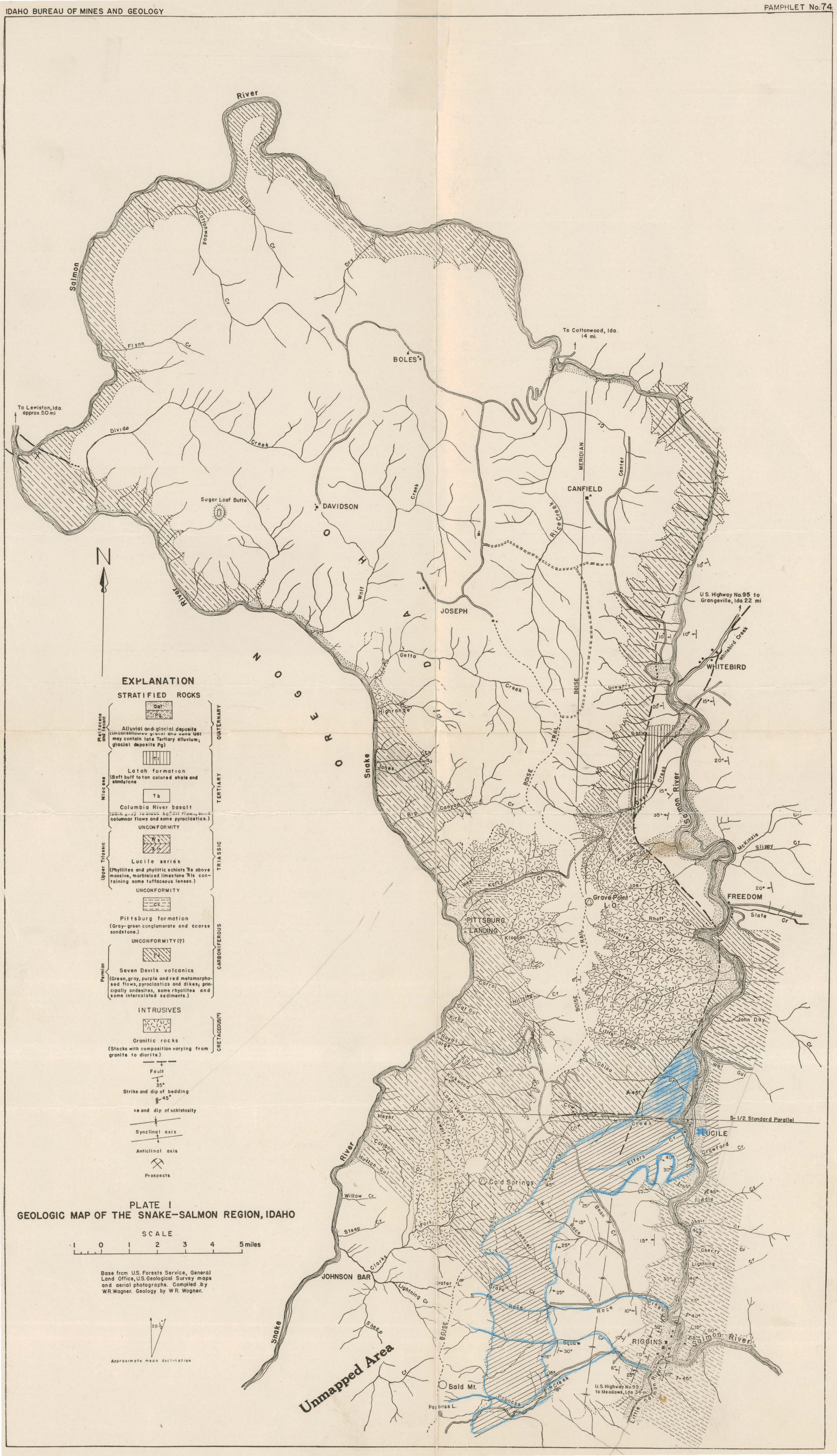

PLATE I
GEOLOGIC MAP OF THE SNAKE-SALMON REGION, IDAHO

SCALE 1 0 1 2 3 4 5 miles

Base from U.S. Forests Service, General Land Office, U.S. Geological Survey maps and aerial photographs. Compiled by W.R. Wagner. Geology by W.R. Wagner.