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GEOLOGY AND ORE DEPOSITS OF THE WARREN MINING DISTRICT
IDAHO COUNTY, IDAHO

By
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Prepared in cooperation with
the United States Geological Survey

University of Idaho
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ABSTRACT

The Warren mining district lies in the Salmon River Mountains of north-central Idaho, in southern Idaho and northern Valley counties. The part of the district mapped for this report includes most of the productive mines, both placer and lode, and covers about 22 square miles, all in Idaho County.

The oldest bedrocks in the mapped area have a limited distribution in the northwest part of the area. They are chiefly quartzite with gneiss and schist, and are believed to belong to the Belt series of pre-Cambrian rocks. The deformed Belt rocks were intruded, probably in Cretaceous time, by quartz monzonite and related rocks belonging to the Idaho batholith. The Idaho batholith is widespread in central Idaho and the predominant bedrocks of the Warren district are a part of it. Lamprophyre dikes are sparingly present in the mapped area. They are probably of Middle Miocene age.

Unconsolidated sediments occupy large parts of the mapped area. These are of several ages and were deposited under different conditions. The unconsolidated sediments include older gravel, younger gravel, glacial moraine, and alluvium. In age these are believed to be, respectively, post-Middle Miocene and pre-Wisconsin, post older gravel and pre-Wisconsin, Wisconsin, and post-Wisconsin.

The interstream areas in central Idaho are, for the most part, broad and relatively flat, and appear to be remnants of a widespread erosion surface beneath which the present streams are incised deeply. This surface was cut probably late in Lower Miocene or early in Lower Middle Miocene time for the Lower Miocene Challis volcanics are cut by the surface and flows of Lower Middle Miocene Columbia River lava rest on it. After the surface was cut it was elevated approximately to its present altitude and tilted toward the northwest. The Warren basin includes a part of the old surface that lagged behind the surrounding parts during the uplift (the Warren basin was relatively depressed). Locally the basin is bounded by normal faults, but at other places the surface appears to rise gradually from the interior to the surrounding divide.

Sediments were deposited in this structural basin during its formation. At times the stream flowing from the basin was able to cut more rapidly than the basin sank, and removal of earlier deposited material took place. At other times the basin sank too rapidly for the outflowing stream to maintain an effective outlet, and deposition was the rule. At the present time the youthful canyon of Warren Creek has progressed headward from the mouth of the creek at Salmon River and is at the threshold of the flat meadow in the central part of the basin. Unless the basin is depressed further, the canyon will migrate farther headward and the creek will eventually remove much or all of the unconsolidated sediments in the basin.

The Warren district was discovered in 1862. It has produced about \$17,000,000 worth of precious metals, most of it gold. All but about \$2,000,000 worth of the metal has come from placers. Most of the production was before 1870. The production of gold from the district began to increase rapidly in 1931. In 1930,

the district's output was about \$8,500 and by 1934 it was more than \$500,000. Production was maintained at about \$500,000 per year in 1935 and 1936, and most of this came from dredges.

The older gravel of the district has been worked locally for gold. The younger gravel and alluvium has been placered extensively. Further prospecting of the older gravel may be warranted.

There are, in the younger gravel, bench, hillside, and high-meadow deposits. The bench and hillside deposits, with one notable exception, a broad low terrace that lies just west of the large meadow in the central part of the basin, have been largely worked out. The high-meadow deposits have not been placered and yet they appear to be worthy of prospecting.

In the alluvium there are both meadow and gulch deposits. The meadow deposits are particularly well suited to placer mining by dredges, and a large part of the available ground has been worked. A considerable area of such ground still remains, however, near the lower end of the centrally-located meadow. The gulch deposits were very productive and were largely worked out many years ago.

Some forty fissure veins are known in the Warren district. Most of them are in the southern part of the mapped area. Almost all of the veins trend easterly and dip steeply to the south, and belong to a group that constitutes the Warren vein system. They fill a well developed set of joints that cut the quartz monzonite bedrock. Locally the veins are offset along joints that trend northwest. These latter joints were favored channels for the material that on consolidation became lamprophyre. The veins are lenticular and the quartz lenses range up to three feet thick. Some veins that were not seen are reported to be thicker. Much of the gold is free. The associated sulphides, including galena, sphalerite, tetrahedrite, stibnite, and pyrite, are not abundant.

All of the active, and many of the old, placers and lodes are described briefly in this report.

INTRODUCTION

The constantly increasing interest in placer gold mining first manifest early in the present decade resulted in the inauguration in 1933 of a cooperative project between the U. S. Geological Survey and the Idaho Bureau of Mines and Geology, the major purpose of which was the investigation of the gravel deposits of north-central Idaho with the idea of evaluating them as sources of placer gold.

It soon became apparent that the individual placer districts were but details of a broad geologic picture, and that for an adequate understanding of how the auriferous gravel deposits accumulated and of their probable value as gold producers, an intensive study of the physiographic history of a large area was imperative. Field work on the project has progressed through the seasons of 1934 and 1935, but is still far from completed. The plan of procedure adopted was that of mapping and studying in detail small areas that contained important placer deposits, or that were thought to be important in working out the geologic history of the region. Eventually the events as recorded in these small areas can be brought together to form the composite picture that was set up as the object of the project. Meanwhile preliminary reports on the small areas already covered are being prepared in order to make the results of the work available as soon as possible.

To make the final report as inclusive and as useful as possible, it would be very desirable to have considerable sampling done in certain areas of gravel that, for geologic reasons, seem favorable for the accumulation of placer gold but the gold content of which is now unknown. Another related and important line of investigation that so far has not been undertaken is the comprehensive study of the heavy sands of the placer districts to determine what other minerals of economic importance may be present. Pitchblende, the first reported from Idaho, was discovered in the heavy sands at Warren during this investigation, and monazite is known to be present there and elsewhere. Sulphides are undoubtedly present in some or all of the placer districts, and, in some places, assays of the heavy sand tailings indicate a considerable amount of gold which was not recovered by the method used.

This report is of the preliminary type mentioned above. The Warren district was studied and mapped in the summer of 1935. The field work occupied two and one-half months. Although it was constantly borne in mind that the primary objects of the work were the study of the placers and the physiographic processes that caused their formation, the lode deposits at Warren were studied also because of their importance as sources of the placer gold, and in order to get as much information as possible on the district as a whole.

The writer was assisted in the field for the full period of the work by Vernon E. Scheid and Veral F. Hammerand, and G. D. Emigh was with the party for a short time. John D. Crosby assisted with the underground mapping of the Unity mine. All of these men rendered uniformly able and energetic service, and the writer is greatly indebted to each of them.

The party was met by the operators and others in the district in a spirit of cordial and enthusiastic cooperation. To name all those to whom acknowledgment is due is impossible. The following, however, were particularly helpful: Granville T. Eyman of the Unity Gold Production Company; E. T. Fisher of the Idaho Gold Dredging Company; A. E. Briggs of the U. S. Forest Service; Clarence Pickell; Theodore Mauersberger; W. R. McDowell; and Otis Morris, Warren postmaster.

Previous to this investigation, very little geological work had been done in

the Warren district. The area was studied briefly in 1897 by Lindgren ^{1/}, and his report is still the classic foundation of geologic investigations there. C. P. Ross ^{2/} visited the Warren district briefly in 1930 and his manuscript report has been consulted freely. His report will be summarized in a U. S. Geological Survey professional paper on south-central Idaho now being prepared by Mr. Ross.

In addition to the above, scattered references to the district appear in various historical works and technical publications. Most of these are either of an historical nature or record publication from, or mining activity in, the vicinity. Most of them do not contain much geologic information. The following contain references such as those mentioned above: Annual Reports of the Mining Industry of Idaho by the State Inspector of Mines, annual volumes of Mineral Resources of the United States published by the U. S. Geological Survey until 1925 and by the U. S. Bureau of Mines from 1925 to 1932, Minerals Yearbook published by the U. S. Bureau of Mines since 1932, Engineering and Mining Journal, and Bancroft's History of Washington, Idaho, and Montana (vol. 31).

An article containing a great deal of interest about the Warren district is that by B. S. Pointon in the August 19, 1921, issue of Northwest Mining Truth.

GEOGRAPHY

The part of the Warren mining district (Fig. 1) that was mapped for this report comprises about 22 square miles in southern Idaho County, Idaho, and entirely within the Idaho National Forest. Most of the district lies in Townships 22 and 23 N., R. 6 E., and a small fraction in T. 22 N., R. 7 E. Township 22 N., R. 7 E. and T. 23 N., R. 6 E., are entirely unsurveyed, but the following sections in T. 22 N., R. 6 E., have been surveyed by the General Land Office and the section corners are marked on the ground: 1, 2, 11, 12, 13, 14, 15, 22, 23, 24, 25, 26, 27, 34, 35, 36, and all but the north line of 10. All or parts of the following surveyed sections lie within the mapped area: 1, 2, 10, 11, 12, 13, 14, 15, 22, 23, 24, 26, and 27. The point having the latitude 45° 15' N. and the longitude 115° 40' W. lies within the area. The boundaries of the mapped area are purely arbitrary and are not to be considered the limits of the district. According to Ross ^{3/}, the Warren district as a whole is enclosed by the following boundaries: The Salmon River on the north, the South Fork of the Salmon on the east and southeast, the Secesh River on the southwest, the west line of R. 6 E., from where it crosses Secesh River northward to the north line of T. 23 N., where it meets the south line of the Marshall Lake mining district, the north line of T. 23 N. eastward to the northwestern corner of T. 23 N., R. 7 E., and the west line of R. 7 E., northward to the Salmon. The Marshall Lake district joins the Warren district along the last two mentioned lines.

The district centers around Warren, a mining town of a few hundred inhabitants. A few isolated cabins are scattered over the district and about a dozen of them house the area's only other residents.

Lindgren ^{4/}, writing of the Warren district in 1897, says that it "is one of the least accessible mining camps in the West, being about 130 miles by wagon road from the nearest railroad". Warren is still difficult to reach, but transportation facilities have improved greatly under the administration of the region

^{1/}Lindgren, Waldemar, The gold and silver veins of Silver City, De Lamar, and other mining districts in Idaho: U.S. Geol. Survey 20th Ann. Rept., pt. 3, pp. 237-249, 1900.

^{2/}Ross, C. P., The Marshall Lake and Warren mining districts, Idaho County, Idaho: manuscript report.

^{3/}Ross, C. P., personal communication.

^{4/}Lindgren, Waldemar, Ibid, p. 237.

by the U. S. Forest Service. Since 1933, many miles of roads have been built by the Civilian Conservation Corps under the direction of the Forest Service. The main road toward Warren was built by the U. S. Bureau of Public Roads.

Warren is a little more than 50 miles by road from the present railroad terminus at McCall, a summer resort and lumber town, at the southern end of Payette Lake. The road from McCall to Warren has been widened and improved to well within the district, but still falls a few miles short of the town, which is reached by an improvised road mostly over placer tailings. Warren may be reached from the north by the new C.C.C. road that leaves the Idaho North-South Highway at Riggins in the Salmon River Canyon, follows up the river to French Creek, and thence climbs out of the canyon, passes through the hot springs resort at Burgdorf, and joins the McCall-Warren road about 15 miles from Warren.

The district can be reached from the east by a Forest Service road from Edwardsburg. Edwardsburg was formerly accessible only from McCall via Warren, but in 1933 a road was completed over Profile Gap thus connecting Yellow Pine and Edwardsburg. Yellow Pine in turn is linked to Cascade. It seems likely that the Edwardsburg-Warren road will be very little used in the future.

Between McCall and Warren the road crosses three summits - Secesh at an elevation of about 6,450 feet, and Long Gulch and Steamboat summits, 6,664 and 6,696 feet high respectively. These summits are blocked by snow and thus render Warren inaccessible by automobile from about the middle of November to the middle of June. Except under unusual conditions, mail, freight, and passengers pass in and out of Warren twice weekly during the winter months by caterpillar tractor or team.

A large amount of the freight and passenger traffic into Warren is by plane. This is particularly true during the winter months. The airplane field is on an open meadow about 2-1/2 miles north of the town.

The district is served by a number of Forest Service and privately cut trails. Some of these have been improved and widened so that they are traversable by car.

TOPOGRAPHY AND DRAINAGE

Central and north-central Idaho is a vast elevated area. The monotonously rugged surface is formed chiefly by the steep sides of narrow valleys and ridges, and at many places the local relief exceeds 5,000 feet. The profound canyon of the Salmon River (in places more than 6,000 feet deep) crosses the area from east to west. The mountain mass north of the river constitutes the Clearwater Mountains and that south of the river the Salmon River Mountains. The two mountain groups are of similar origin and have had the same geologic history; they are, in fact, parts of the same mass and are separate only because of the erosion of the Salmon River Canyon in late geologic time.

The main ridges in the Clearwater and Salmon River Mountains have gentle longitudinal profiles and most of them trend northward. Some of the ridges are narrow and serrate, others are broad and flat.

In strong contrast to the deep, steep, and narrow valleys are several broad, shallow, flaring basins, commonly several miles long and half as wide, cradled, as it were, here and there within the mountains. As a rule, their longer axes, like the ridges, trend northward.

In a general view from any elevated point the principal ridges are seen to rise to an accordant height and to thus suggest a surface of comparatively little

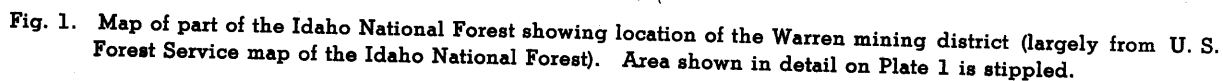
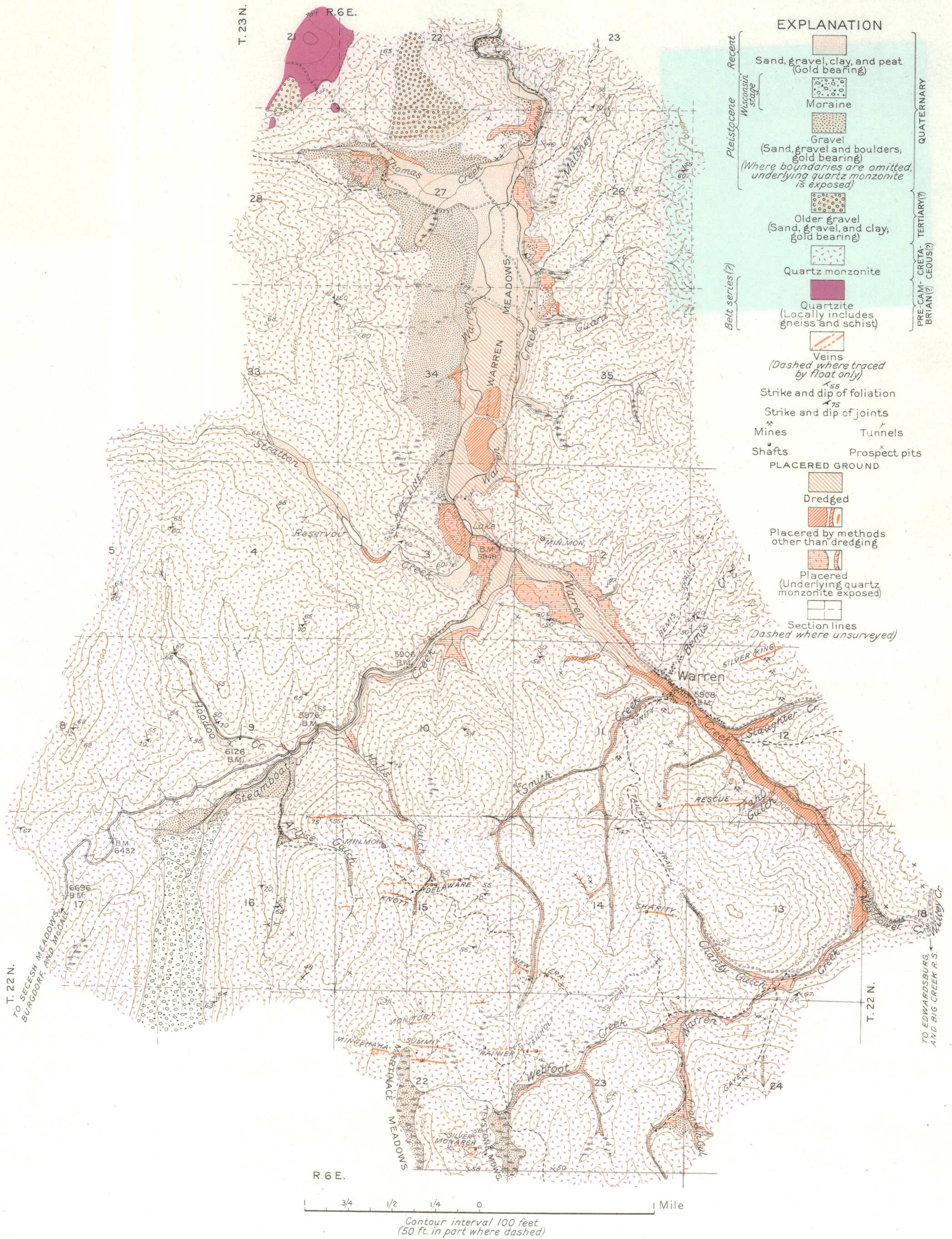




Fig. 3. Warren Meadows. View downstream, northward, from point above and about one-half mile west of Warren, showing dredge, placer tailings, and ground not yet placered.
(Photograph by Washington National Guard.)



relief that extends to the horizon in all directions. A few peaks rise above this surface, but, except in the immediate foreground, the deep valleys, including that of the Salmon, are hidden. The slope of the surface shows local variations, but in general rises toward the southeast. In the Clearwater Mountains its altitude is about 7,000 feet. In the western part of the Salmon River Mountains it lies at about 8,000 feet. Farther east, however, it attains altitudes of 9,000 feet or more.

Many of the valleys that head against the higher ridges and peaks show along their upper courses the U-shape, typical of glaciated valleys. Such valleys commonly have this shape down to an altitude of about 5,500 feet and exceptionally as low as 4,000 feet. Rock-walled lakes lie at the heads of many of these valleys.

The Warren district in the Salmon River Mountains includes one of the broad, flaring basins, the Warren Basin. Except for the trench of Warren Creek, the drainage outlet, the basin is surrounded by a broad divide that coincides in height with the general summit level of about 8,000 feet. Steamboat Mountain and a peak 3 miles south of it rise about 500 feet higher. Two passes, one through the western part and the other through the southeastern part of the basin's rim, are about 1,000 feet lower. Through these passes run the roads into the basin.

The lowest part of the basin is a broad, flat area (Warren Meadows) near the center at an altitude of about 5,800 feet. From all parts of the encircling divide the general surface descends inward to the flat.

Considered in detail, the surface of the basin is moderately dissected by local streams. Some of the larger streams, such as Steamboat and Stratton creeks, have cut their valleys below the general surface from their mouths to their heads on the divide around the basin. These show throughout the normal stream profile that is concave upward (pl. 1). Others, such as Warren Creek, have not yet cut their upper stretches below the general surface. These streams show, for their upper courses, an abnormal flattening of their gradients and they head in swampy meadows such as Martinace and Keystone meadows.

Within the basin the stream valleys are cut 500 feet or more below the general surface as represented by the intervening ridges. Nearer the floor of the basin (Warren Meadows) these valleys are wider and their gradients are very gentle, as is evidenced by the presence of extensive peat bogs (fig. 2).

Warren Creek, in passing across the floor of the basin, descends 150 feet in about 4 miles (pl. 1 and fig. 3). After leaving the basin, the creek plunges 3,650 feet down to the Salmon River through a gorge 10 miles long.

In general, the streams from all sides of the basin flow toward the center as if consequent on the sloping surface. Parts of some of the stream courses, such as the northward-trending parts of the courses of Stratton and Steamboat creeks, may be developed at nearly right angles to the general slope of the surface because of structural control or control by the foliation of the underlying bedrocks.

Many of the tributaries of the South Fork of the Salmon River, notably Secesh River and Bear Creek (fig. 1), join the trunk stream at acute angles pointing upstream (southward). This feature indicates a reversal in the direction of flow of the South Fork of the Salmon.

Most of the smaller tributaries of the Salmon River are short streams with very steep gradients. Fall Creek, for example, descends 4,500 feet in 5 miles. That stream and a branch of Lake Creek, itself a tributary of Secesh River, head



Fig. 2. Peat bog along lower course of tributary of Warren Creek.

at the same divide and the two illustrate a most unusual drainage condition; water falling on one side of the divide reaches the Salmon through Fall Creek by flowing 5 miles, whereas water falling on the other side takes a circuitous route by way of Lake Creek, Secesh River, South Fork of the Salmon River, and the Salmon River, and finally reaches the mouth of Fall Creek after a journey of nearly 100 miles.

CLIMATE

The climate of the Warren district is severe. The mean annual temperature is probably about 42 degrees, and mean monthly temperatures range from about 20 degrees in January to about 60 degrees in July and August. Winter temperatures as low as 30 degrees below zero are not uncommon. The mean annual precipitation is probably not less than 30 inches, and much of this falls as snow which ordinarily accumulates to depths up to 10 feet.^{1/}

The very low temperatures and deep snow prohibit placer mining, except dredging operations, and handicap surface work around quartz mines, during the winter season. Occasionally when the ground freezes to an unusual depth even the dredges must shut down temporarily. Hydraulic placer mining is retarded or stopped during the dry months of late summer and early fall because of lack of water.

VEGETATION

Most of the mapped area is covered by a moderately dense stand of lodgepole pine. Some hillsides support only a scattered growth, whereas at other places the small trees grow so densely that progress through them is nearly impossible. Douglas fir is a common tree in the area, and some individuals are nearly 4 feet in diameter. Engelmann spruce is sparingly represented, and the lower slopes of Warren Basin opposite the mouth of Steamboat Creek has a scattering of large specimens of ponderosa pine.

Most of the floor of the basin, because of placer mining operations, is practically devoid of vegetation. The unplacer swampy meadows and peat bogs are ordinarily not timbered, but at many places are covered with thickets of a variety of shrubs that make foot travel difficult.

Lodgepole pine is a satisfactory wood for mine timbers, and appears to stand up particularly well in the wetter parts of the mines. An abundant supply of suitable size for this and other purposes, such as fuel and buildings, is available almost everywhere in the district.

GEOLOGY

DISTRIBUTION, DESCRIPTION, AND AGE OF THE ROCKS

The rocks of the Warren district are divided into two groups - bedrocks and superjacent rocks. The rocks of the former group are by far the more widespread in the district, are older, and are generally hard, consolidated rocks. The rocks of the latter group are generally unconsolidated sediments. An unconformity representing a long span of geologic time separates most of the bedrocks from the

^{1/}Most figures are estimated from the Annual Climatic Summary of the United States published by the U. S. Weather Bureau, for points not far from the district, particularly McCall.

See also Shenon, P. J., and Reed, J. C., Geology and ore deposits of the Elk City, Orogrande, Buffalo Hump, and Termile districts, Idaho County, Idaho: U. S. Geol. Survey Circular 9, p. 9, 1934.

superjacent rocks, but the time interval between the youngest bedrocks, lamprophyre dikes, and the oldest superjacent rocks, is not definitely known and they may not differ greatly in age.

Bedrocks

Quartzite, gneiss, and schist

Quartzite, with subordinate gneiss and schist, is limited within the mapped area to its northwest part in the country north of Thomas Creek and west of Warren Creek (see pl. 1). The boundaries between these rocks and a much younger group of unconsolidated sediments and rubble (older gravel) that is widespread in the same vicinity are placed with difficulty and uncertainty. The poorly sorted, at many places angular or subangular, fragments that constitute the younger formation are of the same material as the quartzite formation. The distinction between the two is more easily made on steep slopes than on the flat ridge tops.

Although only sparingly represented in the mapped area, these metamorphic rocks are widespread in central Idaho. They are present on War Eagle Mountain between Warren and the Marshall Lake district, and constitute a large proportion of the bedrock in the latter district. According to Ross and Shenon ^{1/}, similar rocks occupy considerable areas south and east of the Warren district, particularly in the Edwardsburg district. Large areas in which are exposed thicknesses of several thousands of feet of what appears to be the same series are found in the Nezperce National Forest north of the Salmon River. They have been mapped in the Gospel Mountain country and elsewhere in the Buffalo Hump quadrangle, but the maps have not yet been published. Their presence and characteristics in other parts of the Buffalo Hump quadrangle have been described by Shenon and Reed. ^{2/}

White, glassy quartzite is the most abundant representative of this formation in the Warren area. Ordinarily it contains a considerable amount of muscovite. A thin section of the typical white, glassy quartzite is made up of about 87 per cent quartz and 13 per cent muscovite. Very small amounts of zircon and apatite are present. The quartz grains have lace-like borders and are strained and locally crushed. Some of the quartz grains attain a length of 8 millimeters, but most are much smaller. The muscovite blades range in size up to 1.5 by 0.5 millimeters. The largest zircon noted was 0.15 millimeter long. Locally, near contacts with granitic rock, the quartzite is impregnated with much granitic material, and one rock grades into the other through a zone several hundred feet thick. In other places, the contacts are sharp. At a few places the rock contains a conspicuous amount of spessartite-almandite garnet.

At several horizons, gneiss and schist are interbedded with the quartzite. None of these horizons could be traced more than a few hundred feet. The gneiss and schist include such varieties as quartz-sillimanite schist, biotite-sillimanite-garnet gneiss, and diopside-clinozoisite gneiss.

The biotite-sillimanite-garnet gneiss is constituted principally of the named minerals. The garnet is present as large rounded crystals in a matrix of associated biotite blades and sillimanite needles. Minor constituents are quartz, oligoclase, muscovite, and zircon.

In the diopside-clinozoisite gneiss, bands, composed principally of calcic labradorite and diopside with some titanite and a very little quartz and zircon alternate with bands made up dominantly of clinozoisite with minor amounts of the other named minerals.

^{1/} Shenon, P. J., and Ross, O. P., personal communication.

^{2/} Shenon, P. J., and Reed, J. C., op. cit., pp. 10-15.

In many places it is impossible to distinguish between jointing and bedding in the massive glassy quartzite. Where the rock has been partially replaced by granitic material, garnet or other minerals, the replacement process was more active along the bedding, thus making the strike and dip apparent. Bedding is also defined by different amounts of muscovite in different layers of the glassy quartzite and by the foliation of the interbedded gneiss and schist. These foliated rocks commonly exhibit a marked linear, as well as a planar, foliation caused by a parallel arrangement of elongate minerals.

Age of the quartzite, gneiss, and schist.

The structural relations between the quartzite, gneiss, and schist, which show that the granitic rocks cut pre-existing folds in the sedimentary rocks, and the replacement phenomena, particularly around the contacts with the granitic rocks, show that the sedimentary rocks are older. The quartzite, gneiss, and schist are probably safely correlated with the lithologically similar rocks in the Marshall Lake district and the Nezperce Forest. Shenon and Reed¹ have referred the rocks from the latter area to the Belt series, which is widespread in northern Idaho. Enough evidence is not available in the Warren district to assign these pre-Cambrian rocks to any formation within the northern Idaho Belt series.

Quartz monzonite

Quartz monzonite and related rocks predominate in the Warren district (see pl. 1). They underlie the whole district and form its surface except for the restricted outcrops of the Belt rocks and the relatively small areas occupied by younger unconsolidated rocks. The granitic rocks are part of the extensive Idaho batholith. The Warren district is well within the main mass of the batholith.

The typical quartz monzonite is medium-grained and light gray. Quartz, feldspar, and biotite are readily recognizable. The rock is porphyritic and the moderately numerous feldspar phenocrysts are ordinarily about one-half centimeter across, although they have a considerable size range. Variants from this type include granodiorite, pegmatite, aplite, and a series of hydrothermally altered rocks the final representative of which is a fine-grained, dark olive green mass, cut by a myriad of greasy-appearing slickensided surfaces. This rock does not differ from the unaltered quartz monzonite as much as its field appearance indicates. Outcrops of the altered varieties of the quartz monzonite are scarce, probably because the rock weathers and crumbles very easily. The material for the study of these altered varieties came principally from underground in the Unity mine.

The normal quartz monzonite is coarse-grained, and the ordinary grain size is about 2 millimeters. Some phenocrysts attain diameters of about one centimeter. Plagioclase, most of which has a composition about An 30, ordinarily makes up about 40 per cent of the rock, but may range from as little as 20 to as much as 60 per cent. The content of quartz commonly lies between 20 and 40 per cent. Potash feldspar, mostly microcline, makes up about 20 per cent of the normal rock. Biotite and muscovite are present in about equal amounts, and together commonly do not exceed 10 per cent of the rock. Zircon, apatite, titanite, magnetite, and epidote are common accessories. At some localities the granitic rock, because of its relatively small content of microcline, is classed as granodiorite.

At many places the granitic rock is fresh. At other places, the minerals, particularly plagioclase and biotite, are partially or completely altered.

¹/ Shenon, P. J., and Reed, J. C., op. cit. p. 15.

Alteration is intense in the vicinity of some of the veins. The most conspicuous mineralogic result of the alteration is the destruction of biotite and the formation in its place of residual magnetite, chlorite, calcite, and muscovite. Accompanying these changes is the alteration of the plagioclase to sericite and calcite. Calcite forms a large proportion of some of the more intensely altered rock.

The granitic rock over most of the Warren district has been deeply weathered. In many places there are no outcrops and the surface is covered by a deep layer of granitic sand. In depth this sand passes into granite, but the grains are almost entirely uncemented. The new road cut at Long Gulch Summit less than a mile outside the mapped area exposes about 20 feet of this softened quartz monzonite.

At some places, where removal of material has kept pace with weathering, outcrops of hard, granitic rock are common. These ordinarily take the form of tall, thin, pointed spires or steep-sided domes. Some spires only 5 or 6 feet through at the base reach a height of 20 or 30 feet. Domes more than 100 feet high are not uncommon. Some of these forms, for example, those along the east side of Warren Creek, both above and below the mouth of Steamboat Creek, are made up of partly softened quartz monzonite.

The granitic rock has a distinct foliation that dips steeply. The foliation in many places affects erosional forms so that they are elongated parallel to the foliation. The rock is cut also by a number of joint sets. Many of the joints were channels for hydrothermal solutions that altered the rock along the joints and rendered it less susceptible to weathering than the unaltered rock. Thus, on many outcrops deep pits have developed due to the more rapid weathering of the rock between the joints (fig. 4).

Age of the quartz monzonite.

Ross ^{1/}, from evidence in other areas, believes the batholith to be older than the Eocene and younger than the Triassic.

A determination of the lead-uranium plus thorium ratio in a one-gram sample of uraninite from the Warren Meadows forms the basis for a calculation of the age of the uraninite. The calculation indicates that the mineral is of Upper Cretaceous age.^{2/} This result serves both to confirm the belief that the uraninite came from the rocks of the batholith and to substantiate Ross in his conclusion as to the age of the batholith.

Lamprophyre dikes

Lindgren ^{3/} mentions the sparse distribution of fine-grained, dark-colored dikes in the Warren district. They also have been observed by Ross ^{4/} in the Unity mine. The dikes are thin, the largest one observed having a thickness of 3-1/2 feet. They weather easily and therefore are seldom seen in natural exposures. Nine dikes were observed in the course of this investigation. Of these, only three were surface exposures; the others were all cut by mine workings.

^{1/} Ross, C. P., Mesozoic and Tertiary granitic rocks in Idaho: Jour. Geology, vol. 36, pp. 673-693, 1928; Some features of the Idaho batholith: Report of the 16th International Geological Congress, Reprint, Nov. 1935.

^{2/} Analysis and calculation of age by R. C. Wells.

^{3/} Lindgren, Waldemar, op. cit., p. 239.

^{4/} Ross, C. P., The Marshall Lake and Warren mining districts, Idaho County, Idaho: Manuscript report, p. 19.

All the dikes seen are in the area west of Warren Creek and southeast of Steamboat Creek. This is in the same general vicinity as the Warren vein system (see page). However, the dikes may have a much wider distribution in the district, but remain concealed because of the absence of mine workings that reveal them.

Of the nine dikes, six were observed to strike in the NW quadrant, the range being from N. 23° W. to N. 82° W. The dip of each of these was to the NE., between 33° and vertical. No dip or strike observations could be made on the other three dikes.

The dike rock is dense, fine-grained, and dark-colored, locally almost black. It weathers readily to a buff, brown, red, or light-olive-green. Locally, the rock carries quartz amygdules up to one-eighth inch across. In most places it is unsheared, but the numerous joint surfaces are locally coated with calcite crusts. At a few places in the Unity mine, where dikes have been sheared along their trend, a gummy, yellow, clay-like mass is developed in the shear.

The lamprophyre dikes are holocrystalline and porphyritic. The phenocrysts, which make up between about 5 per cent and about 25 per cent of the rock, are commonly smaller than 0.8 millimeter by 0.4 millimeter.

The shapes of the phenocrysts indicate that they were originally olivine. They are now made up of a fine-grained mass of serpentine and quartz in different proportions. Commonly, the serpentine is more abundant near the ends and around the borders of the phenocrysts. Serpentine networks also intricately vein the fine-grained mosaic of strained quartz that largely fills the interiors.

The groundmass is ordinarily about 75 per cent hornblende and 25 per cent quartz and oligoclase-andesine. Much of the quartz appears to be later than the other minerals and in some slides very little is present. Most of the hornblende crystals are acicular. The largest seen is about 0.4 millimeter by 0.1 millimeter. Most are much smaller. One thin section contained a little biotite in addition to the hornblende. Enough chlorite masses, having the shapes of biotite crystals, were present in that section to indicate the former predominance of biotite over hornblende in that rock.

All of the thin sections studied contain a considerable amount of tiny, angular, dust-like, magnetite grains. In most sections, the magnetite is present in groundmass and phenocrysts alike. In one slide the magnetite is largely excluded from the phenocrysts. Calcite is a common alteration product of the lamprophyre dikes.

One section cut across a thin dike and its contact with the quartz monzonite country rock showed a chilled, fine-grained border about 5 millimeters thick. In this border zone, many of the larger crystals are oriented with their axes parallel to the walls.

Age of the lamprophyre dikes.

From the evidence within the Warren district, the lamprophyre dikes are known to be younger than the mineralized quartz veins ¹, which are in turn

¹/Lindgren, Waldemar, op. cit., p. 247. Lindgren in this reference notes that "the (Rescue) vein cuts a dark dike (minette) ***** and faults it 4 feet". The place in the Rescue mine where this observation was made is now inaccessible. Possibly the dike observed by Lindgren is older than the lamprophyre dikes here considered. The relations between the veins and dikes in the Unity mine (see fig.13) appear to show incontrovertably that the dikes post-date the veins.

younger than the Idaho batholith, and older than the younger gravel that contains boulders of dike rock. Similar dikes in the Edwardsburg district, a few miles to the southeast, are younger than the Challis volcanics ^{1/}, which, from paleobotanical evidence, are believed to be Lower Miocene. ^{2/} No pebbles or boulders of the dike rock were found in the older gravel. However, it will be pointed out that much of this older gravel is so greatly weathered that everything in it has disintegrated except quartzite. Thus, any pebbles of lamprophyre would have been destroyed. Therefore, the relative ages of the dikes and the older gravel are not known.

In addition to occasional pebbles of dike rock in the younger gravel, an exposure in an old placer cut on the low point between Steamboat and Warren creeks shows younger gravel covering the eroded outcrop of a dike. Thus, the dikes are definitely older than the younger gravel, which is known to be pre-Wisconsin.

Assuming the correlation between the Warren dikes and the Edwardsburg black dikes to be correct, the dikes would be post-Lower Miocene and pre-Wisconsin. Basic dikes in the Thunder Mountain district, which lie southeast of the Edwardsburg district, have been observed by Shenon ^{3/} to pass upward into lava flows that lie on an erosion surface cut across the Challis volcanics. Columbia River lava flows lie on what appears to be the same erosion surface west of the Warren district around the edge of the Columbia Plateau. Along Slate Creek, a tributary to Salmon River in the Nezperce Forest, many large basic dikes appear to be related to the Columbia River lava flows. These flows are interbedded with sediments of Latah age and are believed to be Middle Miocene.

The above evidence is not conclusive, but seems to point to a Middle Miocene age for the Warren dikes, and they are tentatively so classified.

Superjacent rocks

Older gravel

Distribution.

Parts of the relatively flat ridge tops, and locally the side slopes, in the area in which the Belt rocks crop out, that is, north of Thomas Creek and west of Warren Creek, are covered with a thick blanket of gravel and other unconsolidated material. This material is widespread outside the mapped area and locally is several hundred feet thick on the broad flat divide between Shissler and Houston creeks (see fig. 1). This divide is a little higher than the Thomas-Shissler Creek divide, and dips gently southward. The same sort of material is reported to be present on Republican Flats that lies north of Houston Creek. Republican Flats is higher than the Shissler-Houston Creek divide, and, like it, dips southward. All of these flat areas are terminated abruptly on the west by the high War Eagle Mountain-Cottontail Lookout Ridge, but, because of the higher altitude of Republican Flats (relative to the Shissler Creek-Houston Creek divide and the lower altitude of Cottontail Lookout (relative to War Eagle Mountain), the scarp is not as high there as it is between the Thomas-Shissler Creek divide and War Eagle Mountain. Except for the sharp canyons of Houston and Shissler creeks, carved by those streams in the process of grading themselves to their master stream, Warren Creek, these gravel-blanketed, flat divides would form a continuous, gently southward-dipping bench above the Warren Creek canyon.

^{1/}Shenon, P. J., personal communication.

^{2/}Brown, R. W., personal communication.

^{3/}Shenon, P. J., personal communication.

The material of these unconsolidated sediments is very similar to extensive deposits that lie in a similar physiographic setting in the west-central part of the Buffalo Hump quadrangle north of the Salmon River in the Nezperce National Forest west of the Gospel Mountain-Marble Point ridge and east of Mill Creek. The latter deposits were studied by the author in 1934, but no report on that area has yet been written.

The placer work done in 1935 by McGovern and Hackney along the western edge of the Warren Meadows exposes sediments beneath younger gravel that should perhaps be correlated with the higher gravel in the Thomas and Shissler Creek vicinity. The area of outcrop in the placer pit is so small that it could not be shown on the map.

Description and origin.

The older gravel, as seen on the flat ridge tops and hill slopes, is composed almost entirely of fragments of quartzite and fine, white, quartz-muscovite sand. This is the same material that results from the breaking down of quartzite outcrops and leads to the difficulty encountered in attempting to distinguish between the two (see page 6). The distinction is relatively easy in places where the quartzite fragments in the gravel are well rounded pebbles, which is commonly the case near the downhill margins of gravel areas. At other places, the quartzite fragments are angular or subangular and range from sand-grain size to several feet across. Natural exposures showing sections of the gravel were not found. Some exposures, however, have been made by placering at the Buck placer on the south side of Houston Creek and at the Shissler Creek placer. Both of these placers are outside the mapped area, but are within the Warren district (see fig. 1).

An almost complete section is exposed at the Buck placer from Houston Creek to the flat ridge top about 450 feet above. Figure 5 shows the general relationships there. Houston Creek has cut about 100 feet into the quartz monzonite and Belt rocks that underlie unconsolidated sediments. On the bedrock lies a mass of unsorted material, presumably old landslide or talus, that is locally at least 50 feet thick. No stratification was observed in it. It is composed of angular and subangular blocks of quartz monzonite up to 10 feet in diameter in a matrix of granite sand, and pebbles and boulders of gneiss, schist, quartz monzonite, and quartzite. Above this, and probably also behind it in the hill, and continuing up to the divide, are nearly horizontal beds of poorly-sorted gravel, sand, and clay. The pebbles of most of the gravel beds are only partly rounded, but some beds are made up of well-rounded pebbles. Near the top a ditch exposes several feet of clay containing a few quartzite pebbles less than an inch in diameter. The whole face of the hill to a depth of 6 to 20 feet is of quartz-mica sand, and quartzite pebbles, boulders, and angular pieces. This layer shows a crude stratification parallel to the surface of the hill.

At the Shissler Creek placer the stream has cut through the gravels just about to bedrock, but not 100 feet into the bedrock as at the Buck placer. A large part of the valley floor, which is several hundred feet wide here, is composed of a heterogeneous mass similar to that just above bedrock at the Buck placer. It contains many partly-rounded quartz monzonite and quartzite boulders between 3 and 15 feet in diameter in a finer matrix. This appears to be largely landslide material from the steep scarp about one-half mile to the west that rises to War Eagle Mountain. A few hundred feet farther down Shissler Creek the landslide mass appears to rest not on bedrock, but on horizontal sediments similar to those in the higher parts of the Buck placer.

According to Mr. Baker, the pay is largely confined to these lower sediments and the main pay streak is a 300-foot channel running south transverse to eastward flowing Shissler Creek. The Shissler Creek operations are largely confined to the valley bottom and no section of the hillside is exposed; however, the trail

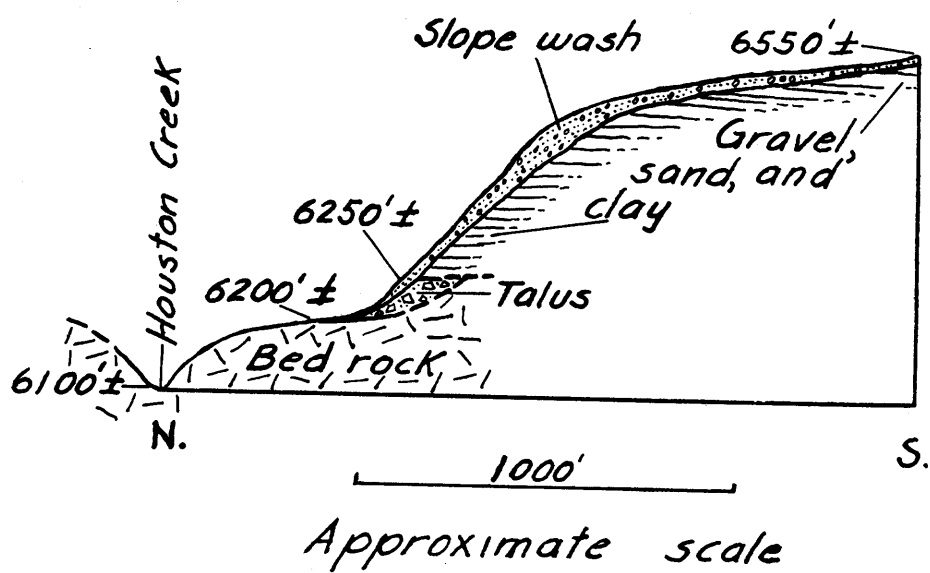


Fig. 5. Sketch showing section exposed in Buck placer on Houston Creek.

southward toward Warren is over quartz-mica sand containing quartzite fragments to and beyond the Shissler-Thomas Creek divide.

In later sections of this report, dealing with geologic structure and physiography, it will be pointed out that the long eastward-facing, northward-trending scarp east of the War Eagle Mountain-Cottontail Lookout ridge is believed to be the trace of a normal fault. This scarp has given rise to much landslide material over a considerable range of time. Some is found under several hundred feet of sediments, as at the Buck placer. Some has moved so recently as to destroy placer ditches. Such material can, therefore, be expected at any place in the nearly horizontal sediments not far from the scarp. The thick unconsolidated strata are believed to be lake and stream deposits laid down in a structural basin to which the fault just mentioned is related. The hillside and hilltop veneer of quartz-mica sand and quartzite fragments is due to the deep weathering of the sediments over a long period of time, and is partly controlled by the elevated position of the beds above the streams. This process quickly breaks down quartz monzonite boulders and pebbles into sand. The feldspar and biotite crystals of the sand thus formed and of sand originally in the beds are altered, comminuted, and thus destroyed or removed by hillside creep. Only the relatively resistant quartz grains, muscovite, and quartzite fragments remain.

Much of the material of the older gravel, particularly in the area mentioned in the Nezperce National Forest, has many of the characteristics of glacial moraine, and a large part of it may well be the result of widespread pre-Wisconsin glaciation.

McGovern's and Hackney's hydraulic pit is in the SE 1/4 of Sec. 34, T. 23, N., R. 6 E., at the end of the pipe line (see pl. 1). There is exposed about 12 feet of sediments beneath about 20 feet of younger, horizontally-stratified sand and gravel. The beds of the 12-foot section strike N. 10° E. and dip 23° N.W. They are not deeply weathered as they lie in the floor of the Warren Basin, but they are clearly older than the material that unconformably overlies them and, therefore, are tentatively correlated with the older gravel so far described. The base of the series is not exposed. Two feet of gray sand are overlain in turn by one foot of white, soapy clay, 1-1/2 feet of very fine white sand, 1/10 foot of soapy clay, 1-1/2 feet of thinly-bedded gray clay containing a small amount of gritty material, 5 to 6 feet of alternating layers of granite sand, 3/4 of a foot to one foot thick, and clay up to 1/2 foot in thickness, and 12 to 20 feet of unconformable, horizontally-bedded gravel and sand. If these tilted beds are, indeed, correlatives of the other earlier gravel, then the absence of anything but fine-grained material may be due to the position of the beds in the interior of the basin a considerable distance from the margins.

Age of the older gravel.

No fossil animal or plant remains have been found in any of the older gravel. If the Warren Basin were formed at the same time as the similar Meadow Creek Basin east of Grangeville in the Clearwater Mountains, and if the earlier gravel at Warren began to accumulate as a result of the start of the formation of the basin, then the older gravel of the Warren district is post-Middle Miocene, because Columbia River lava and intercalated sediments containing fossil leaves of Latah age were found faulted into the Meadow Creek Basin. 1/ The heads of certain valleys that have cut their way through the older gravel and into the underlying bedrock have been glaciated during the Wisconsin glacial stage. Thus, the age of the older gravel probably lies between the Middle Miocene and the Wisconsin. This gravel is older than other unconsolidated sediments in the Warren Basin.

1/ Reed, J. C., Gold-bearing gravel of the Nezperce National Forest, Idaho County, Idaho; Idaho Bur. Mines and Geology, Pamphlet 40, p. 15, 1934.

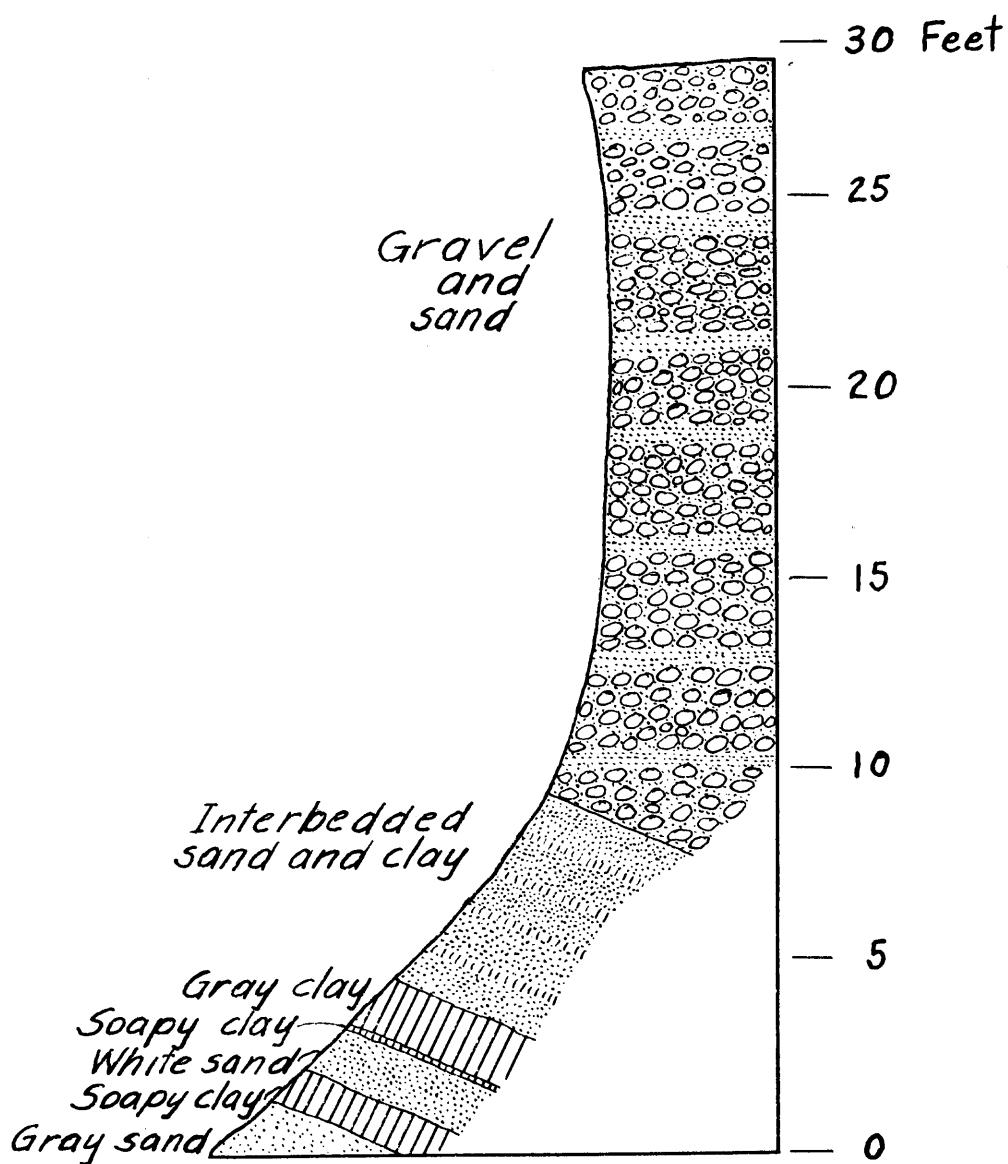


Fig. 6. Sketch of section exposed in McGovern's and Hackney's hydraulic pit.

Distribution.

Unconsolidated material younger than the gravel just described is widespread in the Warren district and elsewhere in central Idaho. For convenience in referring to this material, the term "younger gravel" is applied to it. (This material is the "gravel" of Plate 1.) Within the district the younger gravel accumulated in great amounts, and large areas and volumes of it still remain in the lower interior part of the basin around Warren Meadows. Small areas of it, some of them too small to map, are common along Warren Creek above the meadows and along all of the creek's major tributaries. An area, noteworthy for its large size, flanks, Steamboat Creek for about a mile upstream from where the road to McCall leaves the creek and starts upward toward Steamboat Summit. Gravel assigned to the younger gravel also fills extensive swampy meadows along the upper reaches of the streams tributary to the Warren Basin. Two of these meadows, Keystone and Martinace, are included in the mapped area near its southern border.

Description.

The younger gravel can be divided into two general types, based on physiographic position; bench or terrace gravel, and high-meadow gravel. The first type can ordinarily be recognized without difficulty. The second is distinguished with difficulty from both the older gravel and the recent alluvium.

Bench or terrace gravel.

The deposits of bench gravel are found at different altitudes up to about 150 feet above their adjacent streams. At some places as many as three successively higher bench deposits can be recognized.

The largest deposit of bench gravel in the district constitutes the low terrace along the western side of Warren Meadows. Its front in most places rises steeply about 20 feet above the adjacent meadows. Locally the rise is gradual. The terrace surface is nearly flat, locally swampy, and reaches an altitude of about 5,850 feet at the back. The terrace is covered locally with peat up to several feet and is unusually thick along the front edge of the terrace.

At McCovern's and Hackney's placer, at the front of the terrace, is exposed a section about 20 feet thick (see fig. 6). The younger gravel shows a crude horizontal stratification and overlies unconformably the older sediments already described (p. 12). The gravel is poorly sorted in general, but there are some well-sorted, sandy layers. The average pebble diameter may be about 5 inches. Two-inch pebbles are common, and boulders as much as one foot in diameter are rare. Most of the pebbles and cobbles are subangular, but some of the smaller ones are well rounded and smooth. About 97 per cent of the pebbles and boulders at this place are of quartz monzonite. Pebbles of andesite, pegmatite, gneiss, schist, and vein quartz make up the other 3 per cent.

The weathered quartz monzonite of the bedrock is exposed in an old placer in the younger gravel of the terrace south of Thomas Creek. Here quartz monzonite boulders and pebbles are common, but are subordinate to ones of quartzite. The gravel ranges in thickness from 2 to 8 feet.

A small part of the terrace just described is preserved on the north side of Thomas Creek not far above its mouth.

Benches carved from quartz monzonite are conspicuous along the east side of

Warren Meadows. They are found also on both sides of Warren Creek below the meadows to and beyond the north edge of the mapped area. Many of these benches are covered with deposits of bench gravel which attain a maximum altitude of a little more than 5,900 feet. Most of the material of these deposits was washed for gold many years ago. Here and there small unplaced areas remain. Study of the old pits and the tailings piles indicates that the gravel was generally only a few feet thick, attaining a maximum of 30 feet only in a few places. On some of the benches only a few scattered pebbles remain to indicate that the bench was once covered with gravel. The gravel has been completely removed from a few benches. The bedrock of the benches is deeply weathered, and much of it was moved during the placer operations.

Gravel on the point between the mouths of Stratton and Steamboat creeks reaches to an altitude of nearly 5,950 feet. Here are deposits of at least two ages. The higher gravel is composed predominantly of pebbles and boulders of quartzite, whereas a lower bench is made up principally of boulders and pebbles of quartz monzonite.

Unconsolidated sediments that cap the low hill just northwest of the mouth of Stratton Creek contain few pebbles more than 4 inches in diameter and they are almost exclusively of quartzite.

The gravel on a well-developed bench between Steamboat Creek and Warren Creek has been extensively washed for gold. It reaches to nearly 6,000 feet or a maximum of about 140 feet above Warren Creek. The deposit has a maximum width of about 800 feet. The tailings piles are constituted principally of quartz monzonite sand. Most of the pebbles in the piles are of quartzite and the next most abundant rock is quartz monzonite. In general the boulders and pebbles are not well rounded. Those less than 2 inches in diameter are ordinarily more rounded than larger ones. It is estimated that less than 20 per cent of the boulders and pebbles are more than 10 inches in diameter. Many of the quartz monzonite boulders and pebbles are soft and may be easily crumbled in the hand. This feature suggests a source for some of the large amounts of quartz monzonite sand in the sediments at many places, and for the high proportion of quartzite pebbles in some localities. The degree of weathering is probably controlled partly by the age of the gravel and partly by its position relative to the water table and possibly also to peat beds. Figure 7 is a section of undisturbed sediments at the edge of a placer cut. A pebble count of material from the 5-foot part of the section just above bedrock showed 56 per cent quartz monzonite, 37 per cent quartzite, 3 per cent vein quartz, 2 per cent gneiss, 1 per cent schist, and 1 per cent andesite.

In places around the area of alluvium that fills the valley of Stratton Creek near McGovern's and Hackney's reservoir are low gravel terraces of small extent that stand between 10 and 15 feet above the valley floor.

Deposits of bench gravel are present along Steamboat Creek for nearly a mile upstream from the mouth of Arlise Gulch. The highest gravel is that on the point between Arlise Gulch and Steamboat Creek. It reaches an altitude of about 100 feet above Steamboat Creek. The most extensive terrace lies about 50 feet above Steamboat Creek and is well developed on both sides of the creek. The material of this terrace is about two-thirds sand and one-third gravel. The pebbles are almost exclusively quartz monzonite and are well rounded for the most part. Below the 50-foot terrace are two others, one about 15 feet and the other about 10 feet above Steamboat Creek. The gravel of these two terraces appears to have come from the glacial moraine farther upstream.

Rock benches and remnants of gravel terraces are found at a number of places

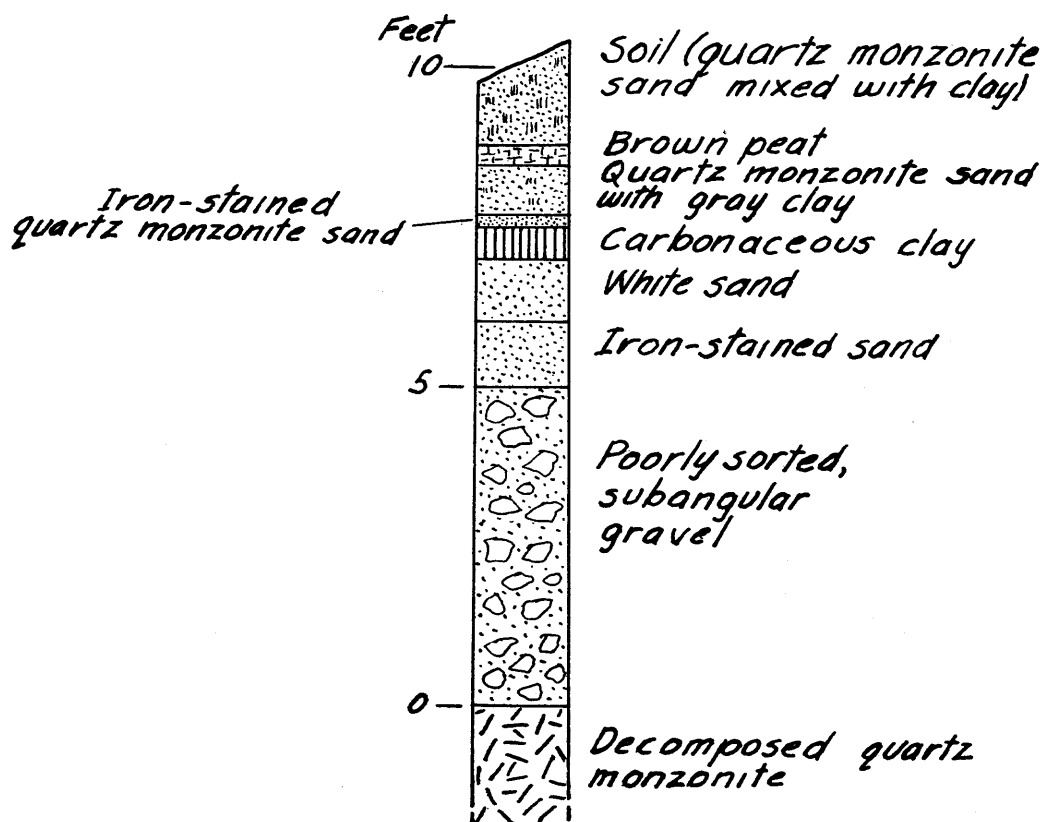


Fig. 7. Section of younger gravel on bench between Steamboat and Warren creeks.

along Warren Creek between the Mayflower and Steamboat creeks. The highest bench observed is about 60 feet above Warren Creek and covered with quartz monzonite sand and angular fragments and blocks of quartz monzonite up to several feet across. These apparently are detritus from the adjacent slopes. Some of the lower terraces are gravel-covered and have been locally placered.

A thin veneer of unconsolidated material borders Mayflower Creek upstream from its mouth. It lies on a rock bench between 10 and 20 feet above the creek and is composed of sand and boulders, about one-third of which are quartzite the rest being quartz monzonite. The terrace material is unsorted and the boulders but slightly rounded.

The point between Franklin Gulch and Warren Creek is covered with terrace material to a height of about 50 feet above the streams. The material is sand and quartz monzonite boulders. Some of the boulders, which are sub-angular, are as much as 3 feet in diameter.

High-meadow gravel.

The Keystone and Martinace meadows lie at altitudes of about 7,200 and 7,450 feet respectively. They are swampy and are covered with grassy vegetation and brush, and it was not possible to study in detail the material that fills them. The material thrown out of a prospect pit, which is now full of water, near the outlet of Martinace Meadows, is principally quartz monzonite sand containing a few fragments of sub-rounded vein quartz and quartz monzonite. The sand is overlain by 1-1/2 feet of peat.

Origin and age.

The foregoing descriptions show that the younger gravel differs widely from place to place in degree of weathering, degree of sorting, nature of component materials, grain size, and in other ways. All these features indicate that, whatever the origin of the basin, the formation of which resulted in the accumulation of the gravel deposits and the subsequent removal of large volumes of gravel from the basin and the re-distribution of other large volumes in the basin, the processes of deposition and removal were repetitive and covered a considerable time range.

Periodic structural deformation of the high, relatively flat, erosion surface caused the accumulation of unconsolidated materials at different times. Erosional activity between such disturbances removed and re-distributed much of the material. This complex origin gives rise to the difficulty of accurately differentiating gravel deposits of one age from those of another.

The deposits of bench gravel are clearly younger than the older gravel for they are found along streams of erosion cycles later than the formation of the basin. The older gravel bears no such relation to the streams and is typically found on divides between them.

The material in Martinace and Keystone meadows, on the other hand, may be as old, or even older, than the older gravel. It may have been deposited in broad erosional valleys on the high surface before the formation of the basin and carried down into the basin during the deformation. It seems more probable, however, that it was deposited during the formation of the basin. Some alluvium is even now being deposited in the meadows.

Glacial moraine

Contrary to a rather general belief in the Warren district, the gravel deposits are not largely due to glacial action. It is true that the older gravel

in the northern part of the district may be in part of glacial origin. Definitely recognizable glacial moraine is present within the mapped area, only along Steamboat Creek from about one-half mile above the mouth of Hoodoo Creek southward (upstream) to the south edge of the mapped area, a distance of a little more than a mile. The width of the moraine ranges from about 1,000 feet to about 2,100 feet. No evidence of glacial action was recognized elsewhere within the mapped area.

In general, the surface of the moraine is flat and poorly drained. In detail, however, as is typical of such glacial deposits, the surface is irregular and hummocky, and is pitted with numerous undrained depressions up to 100 feet in diameter, called kettle holes. A local relief of more than 30 feet is unusual. Some areas of the moraine were once covered with lakes, which have now been filled with sediment and are either swamps or meadows. Part of a rather extensive meadow of this type occupies a strip about 2,000 feet long and up to 600 feet wide along Steamboat Creek at the south edge of the mapped area.

The unconsolidated material of the moraine is predominantly quartz monzonite. No sorting is apparent; the size range is large - from fine sand to boulders many feet in diameter - and the fragments are ordinarily angular or sub-angular.

The part of Steamboat Creek's valley that is floored by glacial moraine exhibits also the characteristic U-shaped cross section of glacial valleys. The Steamboat Creek glacier headed in a number of cirques on the flanks of Steamboat Mountain and elsewhere in that vicinity. Some of the other streams in the Warren Basin, for example Warren Creek itself, rise on parts of the high plateau that for one or more reasons, such as a slightly lower altitude or a position relatively protected from snowfall, did not accumulate enough ice to sand glaciers down the valleys. Still others, such as Stratton Creek, are known to rise in glaciated valleys, but the glaciers never advanced far enough to leave their deposits within the mapped area.

The abundant evidence of glacial activity, only slightly modified by subsequent erosion, the presence of demonstrably older glacial deposits in neighboring parts of north-central Idaho ¹, and the widespread recognition of the Wisconsin stage of glaciation in the Rockies and the Pacific Northwest all point to a Wisconsin age for the moraines in the Warren Basin.

Alluvium
(Sand, gravel, clay, and peat of Plate 1)

Warren Meadows is an extensive alluvial plain. The alluvial flat extends in a broad belt for nearly a mile up Thomas Creek, and in narrower belts for several miles each up Warren Creek to above the mouth of Mayflower Creek, and up Steamboat Creek to the end of the moraine. An area of alluvium up to 500 feet wide flanks Stratton Creek from about one-half mile above its mouth for nearly a mile upstream. In addition to these considerable areas of alluvium, alluvial material is distributed along parts of all the streams in the higher and steeper parts of their courses above the Warren Meadows. In places, areas of this material are too narrow to be shown on a map of the scale used, but locally deposits of it are several hundred feet wide. Alluvium also extends in a narrow band down Warren Creek from the mouth of the Warren Basin to and beyond the mapped area.

¹/Between the Salmon and the South Fork of the Clearwater rivers in the area between Florence and the mouth of Mill Creek, and elsewhere, extensive moraines have been trenched by streams which have incised themselves in bedrock valleys several hundred feet below the bottoms of the moraines. The valley sides are sculptured and the bottoms filled with younger moraines, presumably of Wisconsin age.

Large areas of undisturbed alluvium remain in the Warren district. Much of it, however, has been washed for gold and its original stratification destroyed. Placer mining has also resulted in the re-distribution of much of the finer material downstream from the scenes of the operations. For example, the alluvium, at least the upper layers of it now visible in the stream banks, below the Warren Meadows is almost entirely placer debris.

The alluvial material differs widely from place to place in thickness, degree of rounding, degree of sorting, constitution, and in other ways.

Test-pitting and dredging operations show the alluvium in Warren Meadows to be at least 20 feet thick in places. Near the town of Warren and on Steamboat Creek, 12 feet may approach the average thickness. Small areas of alluvium higher up in the narrow gulches are, of course, very thin.

The following sections, none of which reached bedrock, measured in undisturbed material, will serve to indicate differences in the alluvium at different places:

From Warren Meadows north of dredged area

	<u>Feet</u>
Quartz monzonite Sand containing pebbles up to 0.1 foot in diameter	1.5 - 2
Fine sand with gray clay, containing much mica	0.5
Peat	0.1
Fine sand with carbonaceous clay	0.7
Gravel. Sub-angular, average size of pebbles less than 0.5 foot.	
Boulders larger than 0.8 foot uncommon. Most of the pebbles are of quartz monzonite, but some are of vein quartz, quartzite, gneiss, and andesite	2.0
Total (average)	<u>5.1</u>

From along the east side of Warren Meadows,
at the mouth of Guard Creek

	<u>Feet</u>
Peat	1.0
Coarse quartz monzonite sand	0.7
Peat	2.0
Dark carbonaceous clay	0.3
Quartz monzonite sand with much carbonaceous material	0.8
Clay with peaty material and fine micaceous sand. Carries a few lenses of quartz monzonite sand	1.5
Quartz monzonite sand	0.2
Black carbonaceous clay with a lens of sand	0.8
Quartz monzonite sand	0.3
Black clay	0.2
Fine-grained, brown, sandy clay	0.3
Quartz monzonite sand	4.0
Total	<u>12.1</u>

From Smith Creek, near S.W. cor. sec. 14, T. 22.N., R. 6 E.

	Feet
Muck	3.0
Gray, sandy clay with thin carbonaceous streaks	2.0
Poorly sorted gravel. Pebbles and boulders sub-rounded to angular. Boulders up to 1.5 feet, but most of them less than 0.7 foot in diameter. All pebbles and boulders of quartz monzonite except a few of vein quartz. Matrix is coarse quartz monzonite sand	4.0
Total	9.0

In general, the narrow strips of thin alluvium in narrow canyons along streams of considerable grade are less sorted and less rounded than farther downstream. Locally, only angular blocks many feet in diameter are present.

A 1.1 cubic foot sample of dredge tailings from about one-half mile below Warren along Warren Creek yielded 79 pebbles between 2 inches and 3 inches in diameter, 35 between 3 inches and 4 inches, 19 between 4 inches and 5 inches, 9 between 5 inches and 6 inches, and 9 over 6 inches. The remainder (about 2-1/4 buckets full) was all pebbles and particles less than 2 inches in diameter and was made up principally of quartz monzonite sand with small pebbles of quartz monzonite. Of the pebbles and boulders larger than 2 inches in diameter, 89 were quartz monzonite, 42 quartzite, 11 vein quartz, 3 schist, 2 gneiss, 2 andesite, and 2 pegmatite.

A sample of the same size of old tailings from Warren Creek below the mouth of Slaughter Creek contained 78 pebbles, 40 of which were between 2 inches and 3 inches in diameter, 22 between 3 inches and 4 inches, 9 between 4 inches and 5 inches, 3 between 5 inches and 6 inches, and 4 were over 6 inches in diameter. The three buckets of material smaller than 2 inches in diameter was made up of about 80 per cent quartz monzonite sand and 20 per cent clay. Sixty-one of the pebbles and boulders were quartz monzonite, 9 vein quartz, 6 quartzite, 1 schist, and 1 pegmatite.

A similar 1.1 cubic foot sample from dredge tailings from along Steamboat Creek about 600 feet above its mouth revealed 101 pebbles between 2 inches and 3 inches, 27 between 3 inches and 4 inches, 16 between 4 inches and 5 inches, 15 between 5 inches and 6 inches, and 14 over 6 inches. Less than 5 per cent of the 1-3/4 buckets of material less than 2 inches in diameter was smaller than one-fourth inch. The material less than one-fourth inch in diameter was sharply angular fragments of quartz monzonite. Of the 173 pebbles and boulders of greater diameters than 2 inches, 168 were quartz monzonite, 2 were quartzite, and there was one each of andesite, pegmatite, and vein quartz.

Finally, a sample of the same size from dredge tailings near the north edge of the dredged area in the Warren Meadows contained 100 pebbles between 2 inches and 3 inches in diameter, 62 between 3 inches and 4 inches, 17 between 4 inches and 5 inches, 17 between 5 inches and 6 inches, and 12 over 6 inches. The remaining 1-3/4 buckets full of material less than 2 inches in diameter was mostly quartz monzonite sand with a little clay. One hundred seventy-three of the pebbles and boulders were quartz monzonite, 25 quartzite, 5 vein quartz, 2 andesite, 2 pegmatite, and 1 schist.

The alluvium has probably been deposited throughout a considerable time range. Some of it may be older even than the Wisconsin moraine. It is, however, definitely younger than the younger gravel as it floors flat areas below terraces of the younger gravel. Some alluvium has been deposited on the moraine. A part of the

alluvium is probably outwash material from the glaciers, which in Wisconsin time occupied parts of Steamboat, Stratton, and perhaps other creek valleys tributary to the Warren Meadows. Peat is forming today on some of the alluvial flats, locally on the lower terraces, as, for example, the terrace west of the Warren Meadows and in the high meadows such as Martinace and Keystone. Deposition and transportation of alluvium is going on locally along all the streams in the district and placer operations are resulting in the redistribution of large quantities of material.

PRE-TERTIARY STRUCTURE

The pre-Tertiary rocks in north-central Idaho in general trend northerly and dip steeply. In some districts, for example, those near the South Fork of the Clearwater River and south from there to the Salmon River, the regional trend is northwest and the regional dip is steep to the west. ^{1/} In others, such as the Marshall Lake district south of the Salmon River, the general strike is northeast and the dip northwest. ^{2/} Throughout the Warren district, the structural trend approaches N. 20° W., although there are many local deviations from that direction. The dip at most places is greater than 50° and less than 70° toward the northeast. At some places, the rocks dip toward the southwest.

The attitude of the rocks of the Idaho batholith is defined in most places in north-central Idaho by a distinct foliation. In some places no foliation has been recognized. In the Warren district the foliation is well defined although not conspicuous.

At most places, the contacts between the batholith and the older rocks show that the intrusion was of the concordant type, in which the foliation of the intruded and the intruding rocks are mutually parallel. At some places, however, folds of metamorphic rocks are transgressed by bodies of igneous material showing that the folds existed prior to the final consolidation of the intrusive. ^{3/} With in the Warren district, as mapped, pre-batholith rocks are limited to a very small area in the northwest part and reveal little of the structural conditions prior to the intrusion of the quartz monzonite.

The quartz monzonite in the district is cut by several sets of joints of which one is particularly well developed and is a conspicuous feature of most outcrops. The general trend of joints of this major set is about N. 80° E. and most of the joints dip between 55° and 70° toward the south. Inspection of Plate 1 shows that the strike of the foliation is less uniform than the trend of the joints and that the two directions are about at right angles. These relationships can be expressed quantitatively: The median direction of 54 measured strikes of the foliation, well distributed over the area, is N. 22-1/2° W. Of the 54 strikes 26 per cent lie within 5° of the median direction or in 10° of the arc. Forty-four per cent lie within 10°, and 56 per cent within 15° of the median direction. The median direction of 26 measured trends of the joints, equally well distributed, is N. 80° E. Of the 26 trends 54 per cent lie within 5° of the median direction, 81 per cent within 10°, and 88 per cent within 15°. The angle between the median strike direction and the median joint direction is 102-1/2°.

The better developed joint set is of particular economic importance because it was in joints belonging to it that the metalliferous veins were deposited.

^{1/}Shenon, P. J., and Reed, J. C., op. cit., p. 19.

^{2/}Ross, C. P., The Marshall Lake and Warren mining districts, Idaho County, Idaho; Manuscript report.

^{3/}Shenon, P. J., and Reed, J. C., op. cit., p. 20.

Joints of a less conspicuous set trend in general about N. 10° W. and commonly dip about 50° toward the northeast. Exposures in the Unity mine (see fig. 13) indicate that these joints were favored channels for the material that consolidated to form the andesite dikes. Some dikes, however, came in along still less well developed joints. Observations in the Unity mine also show clearly that joints of the major set are older and are offset by joints of the less well developed set.

TERTIARY STRUCTURE AND DEVELOPMENT OF TOPOGRAPHIC FEATURES

Many of the Tertiary and younger structural movements in north-central Idaho, including the Warren district, were of such magnitude that they are responsible for some of the broader features of the topography. Therefore, Tertiary structural movements and the development of the topography are discussed under one heading.

One of the most outstanding topographic features of central and north-central Idaho is the extensive but dissected surface or plateau that constitutes the locally termed "high country" in this region (see pp. 3 and 4). This is an erosion surface and represents an old topography developed at a much lower altitude than that at which it stands today. It is the so-called "summit" or Idaho peneplain and its extent, age, and manner of development are controversial.^{1/}

Strictly speaking, this surface is not a peneplain at all, but rather a mature erosion surface of considerable relief, in many places as much as 500 feet within a mile.^{2/}

Although little is known of the drainage system over this old surface except that most of the streams probably flowed in broad, locally gravel-filled valleys, some evidence contributed by the streams now flowing over remnants of the surface and fragments of old gravel-filled channels indicate that the major drainage lines may have flowed either north or south roughly parallel to the trend of the rocks. Lake Creek and Secesh River, for example, flow southward away from the Salmon River Canyon for many miles (see p. 4). Old, gravel-filled channels high on War Eagle Mountain, and, according to local reports, others farther west along some of the eastern tributaries of the Little Salmon River, also indicate a southward trend of the drainage on the old surface.

Southwest of the Warren district near McCall and west and northwest of the western part of the Nezperce National Forest north of the Salmon River the Columbia River lava flows rest on the old erosion surface, thus indicating that it is older than Lower Middle Miocene. Toward the southeast, in the vicinity of Edwardsburg and Thunder Mountain, and beyond,^{3/} the surface truncates rocks of the Challis volcanics, which have been determined as Lower Miocene (see p. 10). Thus, the erosion surface must have developed in the latter part of the Lower Miocene or very early in the Lower Middle Miocene.

The large areas of the surface developed on the quartz monzonite of the Idaho batholith, which must have crystallized at depths of several thousand feet, indicate that a large amount of erosion was involved in the cutting of the surface.

- ^{1/} Mansfield, G. R., Geography, geology, and mineral resources of part of southeastern Idaho: U.S. Geol. Survey Prof. Paper 152, pp. 354-359, 1927. Ross, C. P., Mansfield, G. R., and Anderson, A. L., Erosion surfaces in Idaho - discussion: Jour. Geol., vol. 38, No. 7, pp. 643-651, 1930. Kirkham, V.R.D., Old erosion surfaces in southwestern Idaho: Idem, pp. 652-663.
- ^{2/} Reed, J. C., op. cit., p. 9.
- ^{3/} Shenon, P. J., and Ross, C. P., personal communications.

Following the formation of the erosion surface, a period of uplift resulted in raising it to its present altitude. One of the accompanying results of the uplift was the tilt of the surface toward the northwest. The tilting explains the generally higher altitudes of the mountain tops formed by the surface in the southeastern part of the Salmon River Mountains than in the western part of the Clearwater Mountains (see p. 4).

The elevation and tilting resulted in the development of major drainage systems (parts of the Salmon and Clearwater river systems) across the mountains in a westward direction in disregard of the rock structure. Because of the relatively great elevation of the surface these westward-flowing streams cut deeply and rapidly, and their valleys progressing headward (eastward) captured the southward, and perhaps locally northward, flowing streams of the old drainage system across the erosion surface. An example of such stream piracy is the capture of the Secesh River by the South Fork of the Salmon.

As might be expected, the uplift and tilt of such an extensive block of the earth's crust as that embraced by the Salmon and Clearwater mountains were not performed without many local structural movements. Block faulting along the western side of both mountain groups and the western part of the Sawtooth Mountains around Boise Basin ^{1/} is common.

Small areas, many of them less than 20 miles long in a northward direction and about half as wide, within the mountains were elevated less than the surrounding mountains (were relatively depressed) and now form structural basins ^{2/} from which has come most of central Idaho's placer gold. Many of the basins are bounded on one or more sides by normal faults, most of which trend northward. Where not bounded by faults, the old erosion surface appears to be carried down into the basins by warping.

Most, if not all, of the structural movements attending the elevation and tilting of the old erosion surface and the formation of the basins were completed before the Pleistocene. This is shown by the widespread distribution of undisturbed moraines in some of the structural basins and in canyons cut below the old erosion surface. The moraines, such as that along Secesh River near where it is joined by Lake Creek, in the basins belong to an older glacial stage. The younger moraines - those found in the canyons such as the one in the upper part of the valley of Slate Creek in the Nezperce National Forest, represent the Wisconsin stage of the Pleistocene epoch.

The Warren Basin is representative of the structural basins described above. Along its western side outside the mapped area it is bounded by a northward-trending normal fault, on which the east side is the downthrown side, that forms the scarp bounding on the west Republica Flats and the flat divides between Houston and Shissler creeks, and between Shissler and Thomas creeks (p. 10). The scarp is a conspicuous feature from the brink of the Salmon River Canyon near Cottontail Lookout southward to the valley of Thomas Creek. From there its projection would extend up the valley of Stratton Creek, but it apparently has died out before it reaches the higher altitude of the vicinity of Steamboat Mountain (fig. 1).

No faults are shown on the accompanying geologic and topographic map of the Warren district (pl. 1), although the presence of at least three of the type just described is postulated from physiographic evidence. The bedrock scarp rising steeply from the western edge of the broad but low gravel terrace just west of

^{1/} Anderson, A. L., A preliminary report on recent block faulting in Idaho: Northwest Science, vol. 8, pp. 17-28, June 1934.

^{2/} Anderson, A. L., op. cit. Shenon, P. J., and Reed, J. C., op. cit., pp. 21-23. Reed, J. C., op. cit., pp. 11-12.

Warren Meadows probably marks a fault. It trends west of north, and possibly joins the longer fault of greater displacement described above somewhere in the valley of Thomas Creek, where the topographic expression of the faults is absent. This fault was not recognized south of Steamboat Creek.

A smaller but otherwise similar fault, which probably has a displacement of less than 25 feet, may separate the low terrace mentioned in the preceding paragraph from the Warren Meadows. Test-pitting and drilling both on the Meadows and on the terrace, dredge operations, and placering at McGovern's and Hackney's pit all show that the bedrock floor beneath the gravels of the Meadows rises abruptly to the bedrock floor beneath the gravels of the terrace. The tilted sediments at McGovern's and Hackney's pit (p. 12) may reflect movement along this fault.

The surface formed by the local divides east of Warren Meadows projected westward across the Meadows would pass probably between 50 and 150 feet above the floor of the basin. A northward-trending fault, downthrown on the west, along the east side of the Meadows may account for this.

From the high surrounding divide on all sides of the basin the old erosion surface dips conspicuously inward except where the depression has been by faulting, as already described, and not by warping.

Evidence of relative movement between blocks bounded by joint planes is furnished by the striations observable on many joint surfaces. A large amount of the adjustment indicated by the evident movement along joints probably took place before the structural deformation of the high erosion surface. Thus, exposures in the Unity mine show that such displacements commonly do not cut the andesite dikes that are correlated with the Columbia River lava, which elsewhere in north-central Idaho is involved in the structural movements resulting in the basins. It is possible, however, that some of the depression of the Warren basin was accomplished by movements too small to be reflected in the present topography along joints.

In the deepest part of the basin in the vicinity of Warren Meadows, normal faulting and warping have together resulted in a subsidence of approximately 2000 feet below the general level of the surrounding divide.

As the high erosion surface was being elevated and tilted, and the basin was being relatively depressed, a drainage system was formed down the structural slopes into the basin.

The interior became an accumulating ground for material brought in through the system. The variety of unconsolidated sediments deposited in the basin, which includes unsorted material, presumably landslide and talus, beds of poorly-rounded boulders, well-rounded gravel, sand, clay, and peat, indicate that conditions were different at different times during the spasmodic settling of the basin.

At times, when the outlet was well established and had cut deeply below the level of its recent spillway, large volumes of sediments were removed from the basin. The streams of the interior drainage system correspondingly cut, particularly near their mouths, through the previously deposited sediments and into the rock floor of the basin as defined by the warped old erosion surface. Additional impetus to the canyon cutting along the lower parts of the interior-draining streams was given by the downfaulting, relative to the rest of the basin, of the central part that now constitutes Warren Meadows. Stream-cutting below the rock floor of the basin, resulting in the moderately steep valleys described on page 4, was thus caused both by downcutting of the outlet level and by local downfaulting in the interior of the basin.

During the times that downwarping and downfaulting more than kept pace with the lowering of the basin's outlet, accumulation of sediments in the interior was the dominant process, although the streams that brought in the material were, of course, eroding above the level of deposition in the interior. The sediments indicate that much of the deposition was on land, although some of the finer-grained material was probably laid down in a lake, or lakes, ponded behind the rising outlet.

These alternating conditions of removal and accumulation resulted in the formation of the gravel terraces around the Warren Meadows and along the lower parts of the interior streams and in the reworking of much of the material deposited in the basin early in its history.

At the present time, the deep canyons cut by the Salmon River and Warren Creek in the recent cycle as a result of the uplift and tilt of the old erosion surface have worked headward far enough to tap some of the interior of the basin through Houston, Shissler, and a few smaller creeks, and the Warren Creek Canyon that falls more than 3,600 feet in 10 miles (p. 4) is at the very threshold of the Warren Meadows and it will rapidly tap and dissect the remaining parts of the basin in a comparatively short span of geologic time.

ORE DEPOSITS

HISTORY AND PRODUCTION

In 1862 the wave of prospectors that had spread southward from the first Idaho gold camp at Pierce, which was founded in 1860, finally crossed the Salmon River Canyon and a group of miners under the leadership of James Warren discovered the rich placer ground in what now is the Warren district. Since that time through 1935 this small district has produced about \$17,000,000 worth of precious metals, mostly gold. Possibly another half million dollars should be added to the total for the 1936 production. Of the \$17,000,000, nearly \$15,000,000 has come from placers and the rest from lodes.

The bulk of the production came from the rich stream and hillside placers within half a dozen years of the district's discovery. Lindgren,^{1/} who visited the district in 1897, said that the production to then "certainly must exceed \$15,000,000". He cites the following figures, which he obtained from mint reports

Reported production of gold in the Warren mining district, Idaho

<u>Year</u>	<u>Placer</u>	<u>Quartz</u>	<u>Total</u>
1869	\$385,000	\$35,000	\$420,000
1871			160,000
1872			56,000
1875			120,000 *
1881	108,800	18,672	127,472
1882	115,280	11,170	126,450
1884	83,000	17,000	
1886			124,077 **
1887			145,000 ***

* Approximate

** \$121,881 gold, \$2,196 silver

***\$141,127 gold, \$3,873 silver

These figures indicate that the early boom had largely run its course before 1869.

^{1/} Lindgren, Waldemar, op. cit., p. 238.

Large numbers of Chinese miners who followed the white men into most of the Idaho placer camps reached the Warren district about 1870, and Lindgren says ^{1/}, "The placer production since 1870 has been largely by Chinese miners".

Lode mining started at Warren in 1866,^{2/} and has continued intermittently until the present day. In the early days mining and milling costs were very high, occasionally reaching \$50.00 a ton. But the veins, although thin, are rich. Lindgren ^{3/} gives a range of \$20 to \$100 and estimates the average as being "probably above \$50.00 per ton".

Of the many veins in the Warren district, the Little Giant and the Rescue have been by far the most productive. By 1897 the lode production, according to Lindgren ^{4/}, probably had not exceeded \$2,000,000. Since that year the veins have probably yielded about \$265,000 and most of this was from the Unity mine, which taps the Little Giant, Rescue, and several other veins. Other moderately productive veins include the Charity, Knott, Tramp, Delaware, Lucky Ben, and Silver Monarch (Keystone).

The production table already quoted from Lindgren indicates the slight activity in the district from 1869 through 1887. Of the period 1887 to 1897, Lindgren says ^{5/}, "No later (than 1887) data are available, but the production is known to have remained about stationary since 1887, and has possibly increased during the last few years".

Production from the district for the period 1902 through 1928 is shown in the following table, which is abstracted from a table given by Ross. ^{6/}

^{1/}Lindgren, Waldemar, op. cit., p. 238

^{2/}Lindgren, Waldemar, op. cit., p. 238

^{3/}Lindgren, Waldemar, op. cit., p. 245

^{4/}Lindgren, Waldemar, op. cit., p. 244

^{5/}Lindgren, Waldemar, op. cit., p. 238

^{6/}Ross, C. P., The Marshall Lake and Warren mining districts, Idaho County, Idaho: manuscript report.

Production of the Warren district, Idaho County
(Compiled under the direction of C. N. Gerry, U. S. Bur. Mines)

<u>Year</u>	<u>Gold Fine oz.</u>	<u>Silver Fine oz.</u>	<u>Total value</u>
1902	221.17	959	\$ 5,072
1903	130.71	----	2,702
1904	2,003.80	1,184	42,071
1905	652.00	1,927	14,642
1906	2,291.79	6,556	-----
1907	541.10	130	11,271
1908	795.93	2,038	17,564
1909	422.22	116	8,788
1910	443.04	120	9,223
1911	575.20	359	12,081
1912	391.29	166	8,194
1913	491.51	267	10,323
1914	162.64	38	3,383
1915	2,188.88	807	45,657
1916	1,659.47	677	34,749
1917	601.82	431	12,796
1918	1,023.32	351	21,505
1919	155.01	53	3,265
1920	113.58	19	2,370
1921	609.75	250	12,855
1922	793.50	410	16,813
1923	910.41	509	19,237
1924	2,294.42	879	27,347
1925	1,272.32	737	26,813
1926	570.64	205	11,923
1927	456.46	190	9,543
1928	809.52	542	17,051
	<u>21,581.30</u>	<u>18,910</u>	<u>\$ 407,184</u>

The following table is compiled from figures furnished by the U. S. Bureau of Mines and shows the lode and placer production of silver and gold from 1929 through 1935:

Production from the Warren district
in the period 1929 through 1935, inclusive

<u>Year</u>	<u>From placers</u>	<u>From lodes</u>
1929	\$ 300	\$ 25,328
1930	315	8,330
1931	55,000	353
1932	162,154	43
1933	338,029	-----
1934	537,264	1,938
1935	500,000	2,000
	<u>\$ 1,593,062</u>	<u>\$ 37,992</u>

The 1936 production figures are not yet available, but the district during that year probably contributed more than half a million dollars worth of gold and silver.

The greatly increased production starting in 1931 reflects the general revival in placer mining in part due to the depression. The upward trend of the production

curve is intensified by the installation of one, two, and finally three bucket dredges in the district. The greater value of the metal produced after 1933 is in part because of the greatly increased price of gold.

Warren is now a busy and prosperous community. Three dredges, one lode mine, and several smaller operations, are active.

PLACER DEPOSITS

The older gravel, younger gravel, glacial moraine, and alluvium, described on pages 10-19, all contain some gold that was derived from the erosion of the older rocks. Where enough gold was contained in areas that were eroded and where transportation and deposition, described in the pages just cited and in the section on "Tertiary structure and development of topographic features", (pp. 20-23) of the material that came from these areas resulted in enough concentration of the gold, valuable placer deposits were formed.

Much of the placer gold clearly had its source in the now eroded parts of the gold-bearing quartz veins of the district. In some places within the district, and at many other places in north-central Idaho, are found placer gold deposits that can not be definitely related to any known quartz veins. The evidence seems good that some of the gold in these deposits was originally sparsely disseminated through large volumes of the quartz monzonite of the batholith. On page 8 it was pointed out that many joints in the quartz monzonite were solution channels for late hydrothermal solutions that altered the rock outward from these channels. Possibly the rock alteration along and outward from the joints was accompanied by the deposition of some gold. This is undoubtedly the case in the Florence district, which lies to the northwest of the Warren district.

Erosion and deposition by glaciers and by glacial streams do not ordinarily permit enough concentration of the heavier material in the matter transported and deposited to result in the formation of workable placer deposits. In north-central Idaho no placer in glacial moraine is known to have been operated successfully. Therefore, although the moraine mapped along Steamboat Creek probably contains some gold, it is not considered here as being a probable source of any considerable production.

In the following discussion the placer deposits are grouped into several types, based on the unconsolidated formations in which they are found.

Deposits in older gravel

The distribution of the older gravel within the district, but largely outside the mapped area, and the presence of similar material in the Nezperce National Forest have been mentioned in the section describing the older gravel. The existence of much more older gravel is suspected in the drainage basin of Secesh River, particularly west of War Eagle Mountain and in the region lying between the Secesh River drainage basin westward to and perhaps beyond the Little Salmon River. Enough geological work has not been done in the latter areas, however, to definitely determine its existence or extent.

Where the older gravel is known, it has been locally placer mined and some placers, in the areas in which it is suspected, are believed to be in it.

As has already been described, the older gravel includes a great variety of material formed in a number of different ways, including landsliding, glacial action, and sedimentation along streams and in lakes. So far as is known from

the limited study of the older gravel, only that part of it that is of stream origin and some re-concentrated surface material contain workable gold deposits. In the Warren district the Buck placer on Houston Creek and the Shissler Creek placer were visited. These two and an old placer near the head of Rabbit Creek and east of Cottontail Lookout constitute the known placer work in the older gravel within the district (see fig. 1). At the Shissler Creek placer exposures indicate that the stream in the channels of which the gold is found flowed southward in a broad valley transverse to the present stream, which flows eastward. Not enough work has been done to trace out the course of the old gold-bearing channels in this vicinity. At the Buck placer where bedrock is ~~not~~ exposed in the pit the gold is reported to be found mostly in the upper 6 feet of slope wash material that is crudely banded parallel to the hillside at a considerable angle to the nearly horizontally-bedded older gravel and in the nearly flat sediments well up in the section (see fig. 5).

The whole pit at the Buck placer is estimated by the owner to have carried about \$0.02 per yard, but most of the pit is very lean material and the pay dirt, therefore, must run much higher. Most of the gold is coarse and rough, but some rounded pellets have been recovered.

The gold from the channel at the Shissler Creek placer ranges from coarse to fine. A little of it is flake gold. Most, however, is found in irregularly shaped pellets which in size approach the size of small shot. Some grains were observed with attached fragments of quartz. Production and the amount of ground handled for a two-year period indicate that the gravel runs from about \$0.07 to about \$0.17 per yard. The gold is estimated as about 800 fine.

Placer mining of the older gravel in the Warren district is fraught with many hazards; (1) most of the older gravel is high above the present streams and sufficient water for hydraulicking is hard to obtain except in the spring and for a short time in the fall, (2) the locations and extent of old channels, which appear to constitute the best ground, are not yet sufficiently known, (3) much of the pay dirt is deeply buried beneath almost barren material (with the exception of a concentrated layer in slope wash material as at the Buck placer), (4) much of the material that must be handled is full of large boulders and angular blocks, which are moved with difficulty and expense.

In spite of these disadvantages, which are not insurmountable, the locally rather high gold content and the possibility of some rather long (several miles) segments of old channels, the ease with which the coarse shot gold can be saved, and the presence of plenty of dump room in most places, seem to indicate that further investigation of the older gravel in this and other districts in north-central Idaho, with the possibility of large-scale operations in mind, may be justified.

Deposits in younger gravel

Placer gold deposits in the younger gravel were mined extensively in the early placer days and were very productive. So far as is known, only one placer in this gravel has been operated in the current period of activity in the district, and that one is now shut down pending an attempt to mine the ground by dredging. Some of the younger gravel was very rich and was ideally situated for mining by hydraulicking or by ground-sluicing. This type of ground was largely worked out many years ago.

Bench and hillside deposits

The deposits of bench gravel are remnants of more extensive deposits formed during the complex development of the Warren Basin. The transportation of material from areas of erosion, which contained gold in veins and disseminated through

the rock, and its deposition in the basin offered an excellent opportunity for the concentration of the gold into workable deposits. These bench deposits were particularly widespread around the Warren Meadows, and large volumes of them still remain unplaced along the western side of the meadow, along Thomas Creek, and just below the moraine along Steamboat Creek. A few small bench deposits at other places have never been worked.

Many of the bench deposits were very thin and placer operations have removed them entirely. The extent of the old placer work leads to the suspicion that unplaced bench deposits in a position suitable for cheap hydraulicking are probably not very rich or they too would have been worked. Unplaced bench deposits not favorably situated for such mining may be rich enough for working now by methods not practicable in the early placer days.

Little is now known of the amount and character of the gold that was present in the deposits of bench gravel before they were worked. Near McGovern's and Hackney's hydraulic pit along the western edge of the Warren Meadows, the low bench gravel was rich enough so that some of it was mined by drifting many years ago. In 1935, McGovern and Hackney were operating in some rich ground. Reported results from test holes at other places on the broad bench west of the Warren Meadows indicate that the ground may be spotty.

Study of the old bench placers indicates that, except locally, they contained few boulders more than 1-1/2 feet in diameter; that they were relatively thin, mostly probably less than 50 feet thick; that they had ample fall, because of their elevated positions, for the setting of sluices and for dump room; and that the bedrock was deeply weathered and soft, thus permitting a layer of it to be moved during placer mining, thereby insuring little loss of the gold in cracks in the bedrock.

One of the disadvantages of the hydraulic mining of the bench already mentioned that lies west of the Warren Meadows is that it is too low-lying to permit easy disposal of tailings. It is reported that an attempt will be made to dredge this area.

Normal erosion unassisted by placer mining has completely removed the gravel from some of the benches in the Warren area. Some of these rock benches supported deposits of placer gold, residual from the former gravel deposit. Similar gold deposits were formed on the hill slopes below bench gravels as the bench deposits were being removed. Locally also workable placer deposits were formed on hillsides below outcrops of gold-bearing quartz veins. These deposits are the hillside or "skim" deposits. Some of them were worked with great ease and were exceedingly rich. The soft bedrock permitted good recovery.

It is probable that little if any of this type of bonanza ground still remains.

High-meadow deposits

So far as is known, no placering has ever been attempted in the sediments of the high meadows such as Martinace and Keystone meadows. Deposits of this type would not be suitable for working by any of the methods employed in the early days. The meadows are swampy and their bedrock floors are below ground-water level. They probably do not contain ground rich enough to be attractive for small-scale work even if the water problem did not exist, but this, however, is not definitely known for they have been very inadequately tested. The reported results from a few small pits show values great enough to indicate that their further investigation, with the idea in mind of placering by some moderate-scale machine method, may be well justified.

Deposits in alluvium

Meadow deposits

The Warren Meadows and other flat, alluvial areas along Warren, Thomas, Steamboat, and Stratton creeks, all contain placer gold. The gold in the alluvium includes that which came directly from veins or from other places in the bedrock, as well as that which has been deposited once, or more times, before in older unconsolidated sediments. These areas were extensively worked in former periods of placer activity and have produced a large proportion of the gold recovered from the district.

Where the alluvial valley fill was shallow enough and the grade great enough, the gravel could be washed well and most of the gold recovered. Farther downstream, near and in the meadows, where the grade is slight and the gravel deeper (up to about 20 feet), placering was difficult because of the problems of the disposal of tailings and of keeping the pits dry, and considerable gold was not extracted. No attempt was made to placer the lower part of the meadows, although it has long been known to carry good values.

It is from these alluvial, relatively flat areas that the gold dredges, introduced in the district in 1931, have reaped a rich harvest. It has been found practicable to dredge not only the deeper, formerly untouched ground but also much of the gravel worked or partly worked in the early days of the camp.

The gold from the meadows is mostly coarse shot gold and is readily caught in the dredges. The relatively small amount of fine gold and flake gold is mostly caught by the quicksilver behind the riffles. Partly rounded pellets are the rule, although some angular gold with adhering quartz has been observed. No large nuggets have been found, but small ones, about the size of small navy beans, are recovered occasionally.

The tenor of the alluvium is, according to reports, greatly varied from place to place. Lindgren ^{1/}, describing a placer operation in Warren Meadows a little below the mouth of Steamboat Creek, says, "The gold occurs in streaks, showing deposition by currents, and lies mostly on the concave or short side of the stream. It is fairly coarse, and its value is \$15.00 per ounce, or 710 to 720 fine". Dredged ground on Steamboat Creek is reported to have run in places more than 50 cents per yard. Lindgren, in speaking of the placer operation just cited, says that the lower 8 feet of an 18-foot section is said to run 40 cents per yard. Between 20 cents and 50 cents a yard may be a reasonable figure to denote the tenor of much of the virgin ground left in Warren Meadows. A large proportion of the gravel already washed in that area probably came within those limits. The Thomas Creek meadow ground is said to be relatively lean and very spotty, but the presence of at least some gold there is indicated by old bench placer cuts above the creek and by some placer openings in alluvium along the creek. In general, of course, the virgin ground is richer than that already placered. Old tailings in the "Old China Cut" in Warren Meadows between the mouths of Stratton and Guard creeks are reported to carry from as low as 2 cents to as much as 17 cents a yard. Old tailings around and above the town of Warren are commonly considered as being relatively rich. The gold recovered by dredging from Steamboat Creek alluvium appears to be about 730 fine, whereas that from Warren Creek is about 745 fine.

A considerable area of dredging ground remains in the Warren Meadows below the mouth of Guard Creek and along the lower part of Thomas Creek. When the district was visited in the summer of 1936, the year after the map (pl. 1) was made, the dredge on Steamboat Creek was near the mouth of Hall's Gulch and was

^{1/} Lindgren, Waldemar, op. cit., p. 241.

working in a relatively narrow band of alluvium. It probably cannot operate above the lower end of the moraine about two-thirds of a mile farther upstream, and may not be able to progress that far. In 1936, the smaller dredge on Warren Creek was above the town, near the mouth of Slaughter Creek. How much farther this boat can successfully be floated up Warren Creek is not known, but it probably cannot pass the mouth of Mayflower Creek. It possibly could be used also for a little distance along Slaughter Creek.

The narrower, shallower, more bouldery ground farther up the flat, alluvial areas will shortly terminate dredging in that direction. Downstream, in the lower part of Warren Meadows, the ideal dredging conditions so far encountered in the district will probably continue.

Gulch deposits

The thin strips of alluvium along the gulches tributary to the flat, alluvial areas of Steamboat Creek and Warren Creek have been largely placered in the mapped part of the Warren district, between Steamboat Creek and Warren Creek, above its junction with Steamboat Creek. Much of this ground has been worked over several times. At a few places in the district outside of the area just mentioned, certain gulches have been worked on a small or moderate scale. The localization of the gulch placers, largely in the same area as the Warren vein system, indicates that most of the gold came from the veins.

These gulch deposits were exceedingly rich and have contributed much of the district's placer production. Although most of the ground of this type has been worked, there has been a little recent activity along some of the gulches. Occasionally small unplacered areas and ground from which only part of the gold has been recovered may still be found.

Large-scale methods were not, and never could be, applicable to these gulch deposits because of the small volumes of gravel and the large, irregular boulders and talus blocks that at many places so choke the gulches that placering consisted of gophering out the rich gravel with small tools from around the big blocks.

The gold is reported to have been mostly coarse and easily saved.

The placer concentrates

In the Warren district, as in other placer mining districts, a heavy-sand concentrate collects with the gold behind the riffles of gold-saving machines. The heavy sand of the Warren district is voluminous, and within a few hours after a placer operation starts, following a clean-up, the riffles are full and the gold particles must work down through the heavy sand to be saved.

The following description represents a preliminary, qualitative study of a few heavy-sand concentrates from the various types of gold-bearing sediments in the Warren district. The study was made to determine the presence or absence of minerals of economic value, other than gold, and to determine, if possible, whether gold either as fine particles or locked up in some other mineral would be likely to be lost by ordinary placer-mining methods.

A large quantity of monazite, which carries appreciable amounts of thorium oxide, and a lesser quantity of zircon, could be recovered from placer operations in the district, but the present demand for these minerals is such that it probably would not be practicable to save them. Most of the placer gold of the Warren district is coarse enough and so shaped that practically all of it can be saved by ordinary methods. Any consequential loss from well planned operations

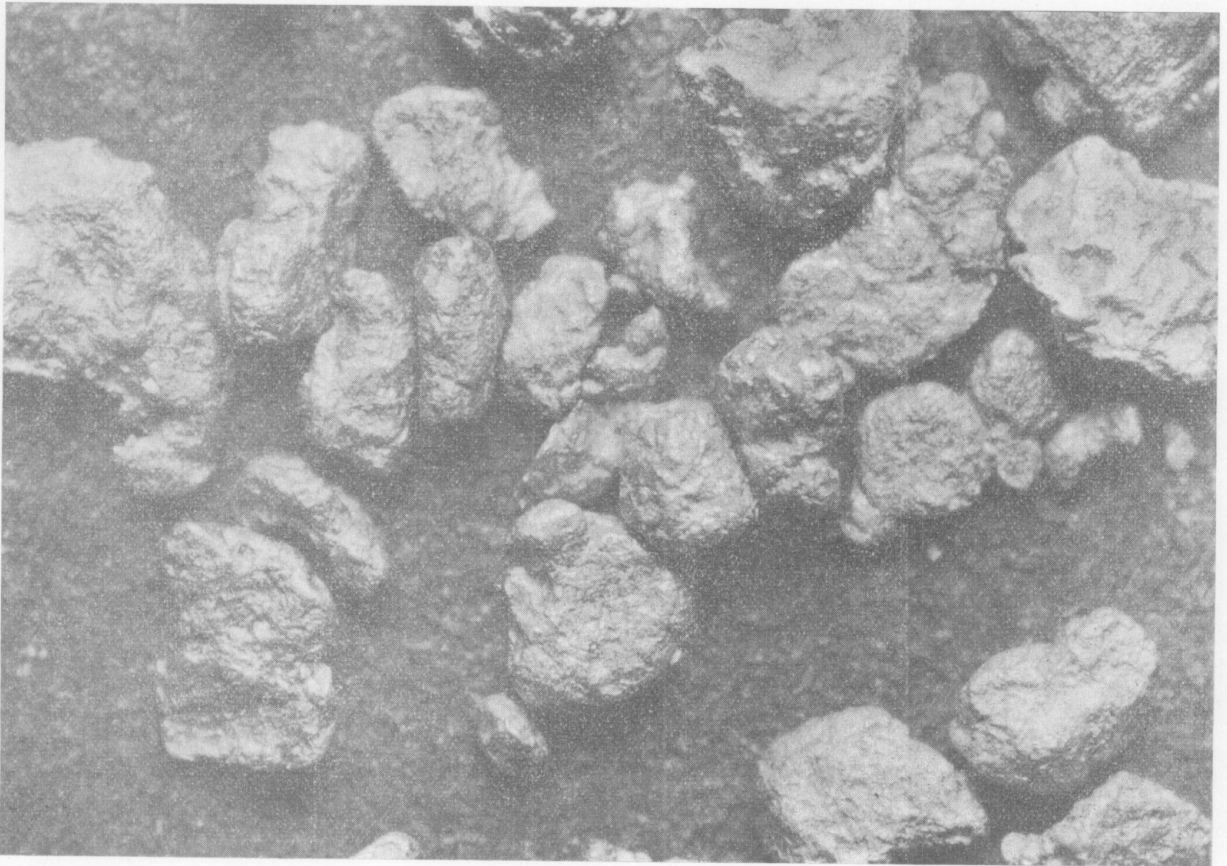


Fig. 8. Typical gold from the Shissler Creek placer. (Grains magnified about 30 times.)

are and probably will continue to be from the failure of some gold particles to work down through the heavy sand packed behind the riffles. Such loss can be decreased by more frequent clean-ups, although small losses would not justify the time and expense of too many clean-ups.

The concentrates from the various auriferous sediments of the district are similar. Those collected from Warren Creek above Mayflower Creek differ recognizably from the others, but this may be a local feature and not applicable to all the gulch alluvium as distinguished from the material of broader alluvial areas. Nine concentrates from the following localities were studied: One from the Shissler Creek placer in the older gravel north of the mapped area; two from McGovern's and Hackney's placer in bench gravel west of Warren Meadows; two from the dredge of the Idaho Gold Dredging Company in the alluvium of Warren Meadows; one from the Pearl placer in gulch alluvium along Warren Creek a short distance above the mouth of Mayflower Creek; three from gulch alluvium along Warren Creek between the mouths of Webfoot Creek and Franklin Gulch. In addition were studied several picked mineral specimens from the clean-up tub of the dredge in Warren Meadows and one from the Buck placer, which is in the older gravel.

The following minerals were recognized in the concentrates. They are listed in the estimated order of their abundance in an ordinary concentrate, but enough material was not studied to make the order of listing significant for any but the abundant and common groups.

Table showing relative abundance of minerals
in auriferous gravel concentrates

<u>Number</u>	<u>Mineral</u>	<u>Composition</u>	<u>Group</u>
1	Monazite	$(\text{Ce, La, Di})_2\text{O}_3 \cdot \text{P}_2\text{O}_5 \cdot \text{Some ThO}_2 \cdot \text{SiO}_2$ $(\text{Oxides of Mg, Fe, Ca, Al, Mn}) \cdot 3\text{SiO}_2$ $\text{FeO} \cdot \text{Fe}_2\text{O}_3$ $\text{ZrO}_2 \cdot \text{SiO}_2$	) Abundant
2	Garnet		
3	Magnetite		
4	Zircon		
5	Limonite (goethite?)	$\text{Fe}_2\text{O}_3 \cdot \text{H}_2\text{O} + n\text{H}_2\text{O}$ $\text{Au} + \text{some Ag}$ $\text{Ca}_2(\text{Al, Mn, Fe})_3\text{Si}_3\text{O}_{12}(\text{OH})$	) Common
6	Gold		
7	Epidote (possibly clinozoisite)		
8	Corundum	Al_2O_3 TiO_2 $9\text{CaO} \cdot 3\text{P}_2\text{O}_5$ $\text{Y}_2\text{O}_3 \cdot \text{P}_2\text{O}_5$	) Uncommon
9	Rutile		
10	Apatite		
11	Xenotime		
12	Tourmaline	$(\text{Na, Ca})(\text{Mg, Fe, Al, Li, Mn})_3(\text{Al, Fe})_6$ $\text{B}_3\text{Si}_6\text{O}_{27}(\text{O, OH, F})_4$ $\text{Ca}_4\text{Na}_2(\text{Mg, Fe})_{10}\text{Al}_2\text{Si}_{14}\text{O}_{44}(\text{OH, F})_4$ and $\text{Ca}_4\text{Na}_2(\text{Mg, Fe})_8\text{Al}_6\text{Si}_{22}\text{O}_{44}(\text{OH, F})_4$ FeS_2 U_3O_8 $\text{Al}_2\text{O}_3 \cdot \text{SiO}_2$	) Rare
13	Hornblende		
14	Pyrite		
15	Uraninite (pitchblende)		
16	Sillimanite		

Monazite

The monazite of the Warren district collects behind the riffles as fine, yellow sand. The microscope shows most of the grains to be whole individual crystals, but most of the crystal faces are roughened and the edges are rounded as a result of abrasion during transportation and deposition. Monazite grains can be easily recognized in the heavy sand by the use of an ordinary hand lens. The mineral is characterized by its yellow color, dull waxy luster, and abraded crystal faces and edges.

The size of the monazite crystals is generally much smaller than the sizes of the other abundant minerals with the exception of zircon. Therefore, simple screening serves to greatly increase the proportion of monazite in the fraction that passes the screen. Most of the Warren monazite will pass a 0.5 millimeter screen and will not pass a 300-mesh screen. The smallest monazite crystal observed is .096 millimeter long and .056 millimeter thick.

Monazite is the most abundant mineral of all the concentrates studied and in some samples it probably forms more than 50 per cent of the bulk.

Uses and consumption.

Monazite is valuable principally for the thorium and the cerium that it contains. These elements have a restricted use for gas mantles; electric light filaments; flash light powders; sparking agents for lighters, miners' lamps, etc.; medicines, dyeing mordants, and luminous paint. They are used also in small quantities in chemical laboratories, and in the tanning, photographic, and ceramic industries.

The United States does not at present, and has not for several years, produced any monazite sand. The following table of imports for the period 1931-1935 therefore gives a good picture of the United States consumption.

Monazite sand imported for consumption in the United States

1931-1935 ^{1/}		
<u>Year</u>	<u>Short tons</u>	<u>Value</u>
1931	1,698	\$65,080
1932	1,569	48,639
1933	56	1,935
1934	112	4,867
1935	1,299	51,495

To show the amount of ThO_2 contained in some monazite sands, in order to have a basis for evaluating the Warren sand, a table was made up from information published by Santmyers. ^{2/}

^{1/} U. S. Bur. Mines, Minerals Yearbook, pt. 3, p. 1069, 1936,

^{2/} Santmyers, R. M., Monazite, thorium, and cerium: U. S. Bur. Mines, Information Circular 6321, pp. 3-4, Aug. 1930.

Table showing ThO₂ content of some monazite sands

<u>Locality</u>	<u>Degree of concentration</u>	<u>Per cent monazite</u>	<u>Percent ThO₂</u>
North Carolina	Crude sand	- ----	less than 3
" "	" "	+ 67	0.13 to 6.54
" (av. of 18 samples)	" "	-----	2.60
Centerville, Idaho	Artificially concentrated	-----	2.41 to 5.2
Brazil (Coastal)	As marketed	92	5 to 7
" (Inland)	" "	-----	4 to 5.7
Travancore, India	Somewhat concentrated	62	5 to 6
India	As marketed in U. S.	90	9
Ceylon	-----	48	4.5
"	-----	96	8.39
"	Artificial concentrations	45-87	5 to 7.3
	from pegmatites		
Malay	-----	58	-----

The cerium produced as a by-product of the recovery of ThO₂ from monazite has so far been more than enough to meet all industrial demands.

Ordinary riffle sand from the dredge in Warren Meadows, which was passed through a 20-mesh screen, but was otherwise unconcentrated, is estimated by Wells ¹ to carry about 1.7 per cent ThO₂. The material that would not pass the 20-mesh screen appears to contain only small amounts of monazite. Wells estimates a ThO₂ content of 2.8 per cent in Warren riffle sand that passed a 60-mesh screen. The monazite content could be still further increased by simple methods of separation, such as those using magnets or tables.

A single dredge in the Warren district could probably produce in a few days as much monazite as the United States used in 1935. Nevertheless, it seems unfortunate that concentrates containing monazite and other minerals that have little present value must be turned back into the dredge ponds and covered. The future uses of thorium and of the rare earths in monazite appear at present unpredictable, but some may be developed.

Garnet

The abundant garnet of the Warren sands is readily recognizable by color and by crystal shape. The garnets found have a wide color range from yellow, through red and purple, to black. Red is the predominant color. The indices of refraction range similarly from 1.74 in the yellow varieties to a large but undetermined amount about 1.80, the index of the highest-index immersion oil available. The range of color and of index of refraction no doubt reflect a more fundamental range in chemical composition. Some garnets from the concentrates are more than one-fourth inch in diameter. Most are too large to pass a 60-mesh screen. Many of the garnets are perfect euhedral crystals, the faces of which are bright and show little or no abrasion. Some show partial alteration to limonite or goethite.

The Warren garnets are probably of no economic value.

Magnetite

Magnetite is not as universally abundant in the Warren sands as are monazite and garnet. For example, pannings from virgin ground at McGovern's and Hackney's placer in the bench gravel west of Warren Meadows contained only a small proportion of this mineral. The magnetite is not of commercial value and can easily be separated from the other heavy minerals by a weak magnet.

¹Wells, R. C. Personal communication.



Fig. 9. Native gold in uraninite from the Buck placer, Warren district, Idaho.

Zircon

Brilliant, euhedral zircon crystals form a conspicuous component of the concentrates. The luster of the crystals and their shape serve to identify them. Most of the zircon crystals are clear and colorless. Two distinct crystal habits are represented, resulting in stumpy crystals about twice as long as they are thick and acicular crystals about four times as long as they are thick. Their size range is similar to that of the monazite crystals.

Only an occasional crystal will not pass a one-millimeter screen and very few are small enough to go through a 300-mesh screen. The smallest stumpy crystal observed is .144 millimeter long and .08 millimeter thick. The smallest acicular crystal is .272 millimeter long and .064 millimeter thick. Several prism faces are present on most crystals and an even larger number of pyramid faces.

The proportion of zircon crystals in a concentrate can be considerably increased, just as the proportion of monazite crystals can be, by simple screening.

Uses and consumption.

No zircon is known to have been produced in the United States for several years. ^{1/} The following paragraph on the uses of zirconium and the table of imports is taken from the work cited.

"Zirconium powder is used in flashlight mixtures and in ammunition primers. Pure, wrought metal is marketed by the Foote Mineral Co., the wire being used in radio tubes and sheet metal in spinneret cups for rayon manufacture. Zirconium-silicon and zirconium-ferrosilicon are finding a growing use in steel-making. From a tonnage standpoint, however, the main uses of zirconium compounds are in enamels and for electrodes for welding-rod coatings. A new product developed in 1935, known as TAM Hy-Opax, permits pound-for-pound substitution for tin oxide as an opacifier for vitreous enamels of all types, and at about one-half the price".

Zirconium ores imported for consumption in the United States
1931-1935

<u>Year</u>	<u>Pounds</u>	<u>Value</u>
1931	1,124,034	\$ 18,945
1932	26,506	437
1933	568,581	5,306
1934	1,706,192	27,197
1935	5,756,726	76,923

It seems doubtful that under present conditions zircon could be profitably extracted from the Warren sands.

Gold

The gold of the placer concentrates has already been discussed in preceding section on placer deposits.

^{1/} Tyler, P. M., and Van Siolen, A. P.; U. S. Bur. Mines, Minerals Yearbook, p. 540, 1936.

Uraninite (pitchblende)

Uraninite has been definitely determined in concentrates from the Buck placer on Houston Creek and from the Warren Meadows. Examination of most concentrates fails to reveal any uraninite. This is particularly puzzling in view of the fact that one angular piece from each of the localities cited weighed several grams. These large uraninite fragments should be accompanied in the sands by many smaller pieces, but only a very few have been found.

The uraninite fragment from the Buck placer contains native gold in fractures.

The great value of uraninite and the fact that two large pieces have been found appear to make further search for this mineral, both in the sediments and in place, desirable.

Other heavy minerals

The other minerals listed on Page 31 are not discussed in detail for two reasons. None of them is of commercial value in the quantities in which they are found in the Warren sands. None of them is abundant enough to present any special problem of removal from minerals that may have commercial value (such as the removal of valueless garnet from monazite). Several non-magnetic opaque minerals were encountered during the incomplete investigation of the concentrates. These may be ore minerals from the veins, but they were not definitely determined. Some concentrates contain also such heavy particles as lead shot, fragments of brass, tacks, and amalgam lost during earlier placer operations.

LODE DEPOSITS

At least forty fissure veins have been discovered in the Warren district. The better known veins include the following:

Arlise **	Minnehaha *
Charity *	Mohawk ***
Delaware *	Monitor *
Gayety *	New Era (Tramp) *
Goodenough ***	Rainier *
Iola ****	Rescue *
Knott *	Silver King *
Little Giant ***	Silver Monarch (Keystone?) *
Lucky Ben **	Summit *

* Named on Plate 1.

** Shown on Plate 1, but not named.

*** Not shown on Plate 1.

**** Outside mapped area.

Some of the names may refer to different parts of the same vein, although instances of such duplication are probably not many. Thus, the Goodenough and the Rescue are probably the same and the Rainier and the Summit may be the same.

The veins have produced probably less than \$2,500,000 worth of gold and silver, as against about \$17,000,000 worth from placers.

Warren vein system

Most of the known veins of the Warren district can be grouped geographically and structurally into a closely-knit system herein called the Warren vein system.

With four exceptions, all of the better known veins, and, therefore, presumably the more extensive ones, and most of the smaller ones, lie in the area between Steamboat Creek and Warren Creek. The Silver King, Gayety, Bear Track, and Iola lie east of Warren Creek, but not far from it.

The veins trend easterly, most of them between S. 70° E. and N. 70° E. . Nearly all dip to the south at angles between 45° and vertical. The veins appear to fill fissures developed in the well-defined joint system mentioned on Page 19.

Several of the veins have been traced with only slight interpolations over a horizontal extent of more than 2,000 feet. The Rescue vein has been traced on the surface and followed by mine workings for an aggregate distance of at least 3,800 feet and the Little Giant vein has been followed continuously underground for more than 1,200 feet. The Rescue vein has been developed in the Unity mine for about 600 feet vertically. The Little Giant vein has been proven for more than 300 feet vertically, and several others for at least 200 feet.

The veins are typically lenticular and the quartz lenses range up to 3 feet thick. Locally, certain veins are reported to be much thicker. Between the lenses the veins are commonly represented by gouge-filled fissures up to about 1 foot thick. The vein walls are free, but ordinarily less than one-half inch of gouge intervenes between vein and wall rock. At some places several inches of gouge are present.

At many places the wall rock of both the hanging and foot walls is intensely altered and sheared for as much as 20 feet from the vein. This alteration is discussed in more detail on Page 7. The alteration is not uniform and at many places adjacent to veins little if any has taken place.

As mentioned on Page 20, the joints of the major set are off-set by movements along joints of a northwesterly-trending younger set. The veins occupy joints of the older set and apparently were emplaced before the movements along the minor set, for the veins are off-set by the movements. The displacement of the veins along the faults transverse to them is with but few exceptions to the left. This result would be attained if the block on the northeast side of a northwestward-trending fault moved down relative to the block on the southwest side. It would also be attained by horizontal movement if the northeast block moved northwest. At no place was it possible to determine satisfactorily whether the movement was vertical, horizontal, or had both vertical and horizontal components.

Field observations and the microscopic study of vein specimens both indicate that the vein filling was a composite process that took place during or between periods of relative motion of the vein walls. At some places fractured and crushed quartz is common. The vein walls are striated at many places. The ore minerals and a little later quartz apparently came in along the crushed and fractured zones in the earlier quartz. Although underground workings are not extensive enough to permit sufficiently numerous observations to form a safe basis for generalization, the ore appears to have formed in shoots in fractured zones in early quartz. Some shoots appear to pitch steeply eastward.

The vein quartz is commonly banded and the bands are in most places about 3 inches thick, but in some places are thicker and in others thinner. Comb quartz and small vugs are not uncommon. Some surface oxidation of sulphides has taken place, but at many places abundant sulphides are present in vein outcrops. Therefore, secondary alteration does not appear to have been an important process and no appreciable change in tenor of the ore is predicted for moderate depths below the lowest altitude now reached by mine openings (about 5,800 feet in the Unity mine at the bottom of the winze on the Rescue vein, see Fig. 13).

It was pointed out on Page 8 that the age of the Idaho batholith is probably Cretaceous. The veins are clearly younger than the batholith, and, equally clearly, older than the lamprophyre dikes, which are believed to be of Middle Miocene age (see Page 10). Assuming that the uraninite from the Buck placer came from a vein of the age of the Warren system veins and that the gold in it is not much younger than the uraninite, then mineralization of Upper Cretaceous age is strongly suggested.

Gold, galena, sphalerite, tetrahedrite, stibnite, and pyrite are the primary metallic minerals that were recognized in the Warren veins. In addition to these, Lindgren ^{1/} reports silver (rare), arsenopyrite, and ruby silver (rare). Ross ^{2/} observed chalcopyrite and that the tetrahedrite is in part freibergite. According to Lindgren, the Charity vein contains scheelite, and Ross mentions it from the Unity mine.

Muscovite and calcite are gangue minerals present in small quantities at most places. Calcite is locally abundant.

Alteration products of the metallic minerals include hydrated oxides of iron, chalcocite, malachite, anglesite, antimony oxide, mottramite, and mimetite(?)

The ore minerals constitute a very small proportion of the vein material. Lindgren ^{3/} says that sulphides rarely reach 2-1/2 per cent of the ore. Some ore taken recently from the Unity mine yielded about 6 pounds of concentrates to the ton. The concentrates, although small in quantity, are of high grade.

DESCRIPTIONS OF DEPOSITS AND MINES

Placers

In the following descriptions of specific placers some operations which were not visited in outlying parts of the district are omitted. The following table is included to enable one unfamiliar with the geography of the district to find from the name of a placer, placer-mining company, or owner or operator, the geographic heading under which the placer is discussed.

^{1/} Lindgren, Waldemar, op. cit., p. 245.

^{2/} Ross, C. P., op. cit., p. 24.

^{3/} Lindgren, Waldemar, op. cit., p. 245.

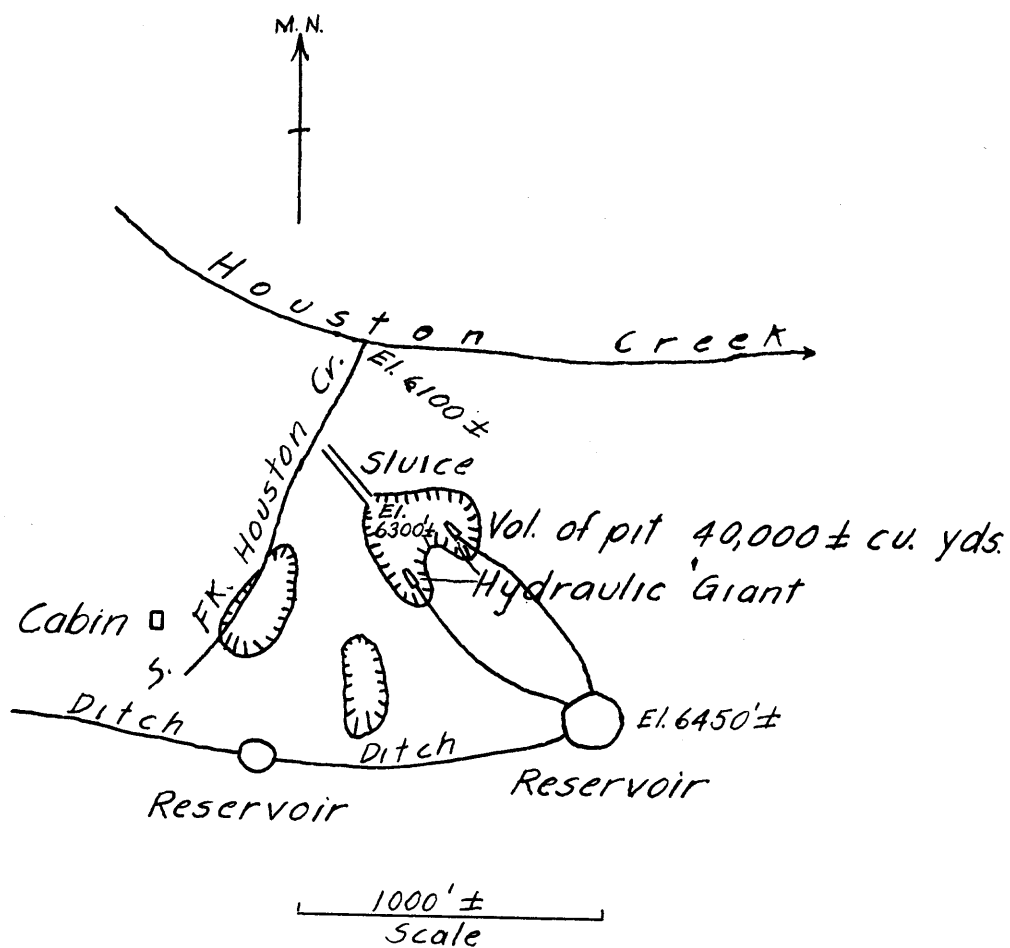


Fig. 10. Sketch of Buck placer.

Table showing geographic headings
under which are discussed placer-mining operations

Placers	Names of owners and operators	Discussed under geographic heading
Buck placer	John Becker	Houston Creek
McGovern's and Hackney's placer	J. J. McGovern and C. W. Hackney	Bench west of Warren Meadows
Pearl placer	W. R. McDowell, Frank Gallagher, Richard Coykendall	Warren Creek (above Mayflower Creek)
Shissler Creek placer	L. A. Baker, Edna Kusky, Dick Slocum	Shissler Creek
Companies	Names of owners and operators	Discussed under geographic heading
Idaho Gold Dredging Co.**	E. T. Fisher and A. F. Baumhoff	Bench west of Warren Meadows, Steamboat Creek, Warren Meadows, Warren Creek (Steamboat Creek to Mayflower Creek)
Linton Mines Co.**	Geo. Eipp, R. H. Stillwell, S. F. Parr, Lindel, Donnelson, E. A. Wilcox	Warren Creek (above Mayflower Creek), Webfoot Creek.
Warren Creek Dredging Co.	Andrew Anderson, Joe Ferris, J. W. Marchbank	Steamboat Creek

* Organization of company discussed on Pages 44 and 45.
 ** Organization of company discussed on Page 65.

Deposits in older gravel

Houston Creek.

The Buck placer of John Becker lies on the south side of Houston Creek in the northern part of T. 23, N., R. 6 E. (unsurveyed). See Fig. 1.) The placer is outside the mapped area and is about 6 miles in a direct line northwest of Warren, from which place it is reached by road and trail.

The property consists of eight claims and has been owned and operated by Mr. Becker for more than 30 years. The total production is not known and no estimate can be made of the amount of gold that came from small old operations along the creek below the present workings. Within the past 5 years, however, it is estimated that several thousand dollars worth of gold has come from the hydraulic pits.

Equipment and development work include two large hydraulic pits, numerous smaller pits, old workings along Houston Creek, two miles of ditch from Houston

Creek, two small reservoirs, 1,800 feet of hydraulic pipe, and a 3-inch and a 4-inch hydraulic giant (fig. 10). It is estimated that between 35,000 and 40,000 yards of gravel were washed at the Buck placer in 1935.

At the Buck placer, Houston Creek has dissected the older gravel and cut about 100 feet into the underlying quartz monzonite and other bed-rocks. The dissection of the older gravel resulted in the reconcentration of some of the gold originally in the older gravel in places along the present rocky canyon bottom. These small but relatively rich deposits were worked many years ago and led to the discovery of the leaner older gravel.

The older gravel is about 350 feet thick at the Buck placer. The materials of which it is constituted and their distribution in the section are described on Page 11 (see also figure 5). On Page 27, it is pointed out that the older gravel so far washed is reported to have averaged about \$0.02 a yard. Most of the gold is said to have come from the upper 6 feet of slope wash material and from some relatively rich beds near the top of the exposed section of older gravel. The gold in the surface layer, which is parallel to the hillside, probably is that left behind as older gravel and was carried away by Houston Creek during the cutting of its valley.

Shissler Creek.

The Shissler Creek placer lies on Shissler Creek about a mile north of the mapped area near the center of T. 23 N., R. 6 E. (unsurveyed). It may be reached from Warren by automobile except in wet or snowy weather as the road is steep and rough.

This placer (formerly the Cook placer) is now owned and operated by L. A. Baker, Edna Kusky, and Dick Slocum, who obtained it in 1934. The property consists of eleven unpatented claims. Shissler Creek has been worked for many hundreds of feet below the site of present operations. The placering along the creek and much of it at a large pit where the present work is being done was carried on many years ago. According to reports, work started on Shissler Creek in the '60's.

The production from the Shissler Creek placer is not known. Mr. Baker reported a clean-up of about \$2,000 worth of gold in the season of 1934 and about \$1,200 worth up to the middle of July, 1935, when the property was visited. Mr. Baker estimates that about 12,000 yards of gravel were washed in 1934 and about 16,000 to the middle of July, 1935.

Placer operations have included, in addition to the old work along the creek, the excavation of a large pit about 500 feet long and 250 feet across through which the creek flows. The banks of this pit rise in places as much as 30 feet above the stream. The recent work has been done along the southern side and near the southwest corner of the old pit. No work has been done along Shissler Creek above the large pit.

Water for placering is brought from Shissler Creek through a ditch about 1,000 feet long. When visited, the placer was being operated by a 4-inch hydraulic giant under a head of 160 feet. Another giant on the property was not set up. By the middle of July, the flow of Shissler Creek ordinarily is not great enough to supply water for the continuous operation of one giant. When visited, the small reservoir filled in about two hours and collected enough water for a 20-minute run with the giant, with enough by water to nearly fill the long sluice, which is about 3 feet square. Block riffles are used in the sluice, and Mr. Baker reports that practically all of the gold is caught in the first three of the 12-foot boxes.

The Shissler Creek placer is in older gravel, except for the older workings along the creek below the pit, which are in alluvium brought down from the older gravel. The creek has not cut so deeply into bed rock as Houston Creek has at the Buck placer. The bottom of the pit is on bed-rock, however. The bed-rock is quartz monzonite. One small outcrop of schist was seen and quartzite crops out on the hilltop between Shissler and Thomas creeks.

The geologic setting at the Shissler Creek placer is described on page 11.

Deposits in younger gravel

Bench and hillside deposits.

Bench west of Warren meadows.

The gravel-covered bench west of Warren Meadows is described briefly on Page 13. This bench extends for a little more than 2 miles from Stratton Creek to Thomas Creek. It has a maximum width of about 1,800 feet.

Small parts of the bench have been placered, but most of it has not been worked. The most extensive work was done in a former period of activity, probably shortly before 1900, on the southern part of the bench northwest of the mouth of Stratton Creek. This ground is believed to have been handled, at least in part, by steam shovel. Lindgren ^{1/} describes, and his sketch map shows, the steam shovel as located in the alluvial flat. The pit outline in the sketch indicates that the shovel also moved gravel of the bench.

Several tunnels, now caved, were seen along the face of the bench in the northern part of Sec. 3 (unsurveyed), T. 22, N., R. 6 E. Apparently these were driven on bed-rock in the lower part of the gravel of the bench. Local reports are to the effect that ground must be rich to be worth working by such a method.

Two old hydraulic pits lie along the west edge of Warren Meadows at the edge of the bench about a mile north of the mouth of Steamboat Creek. Study of the pits indicates that the bed-rock lies so low there that attempts to clean it by hydraulicking resulted in difficulty in disposing of tailings.

McGovern's and Hackney's placer: In the summer of 1935, J. J. McGovern and C. W. Hackney were operating a hydraulic placer along the west edge of Warren Meadows just north of the north line of Sec. 3 (unsurveyed), T. 22 N., R. 6 E. About six men were employed in the operation of the mine. The placer is on ground leased from the Idaho Gold Dredging Company.

Equipment included a pipe line about 2,800 feet long, and three small giants, one of which was used as a stacker (fig. 11). To reach the pipe, water from Stratton Creek was led by ditch and flume to a short tunnel through the ridge. The head of the pipe is about 250 feet above the placer.

The ground is reported to be rich, but spotty. According to a local resident familiar with the operations, the clean-up from one 10-day run consisted of \$3,100 worth of gold.

Difficulties attending hydraulic mining at this place include an insufficient supply of water during the dry season and the necessity of elevating tailings because of the low position of the bed-rock. The use of a stacker giant to elevate the tailings results, of course, in a still greater shortage of water for mining.

^{1/} Lindgren, Waldemar, op. cit., pp. 240 and 241, and fig. 28.

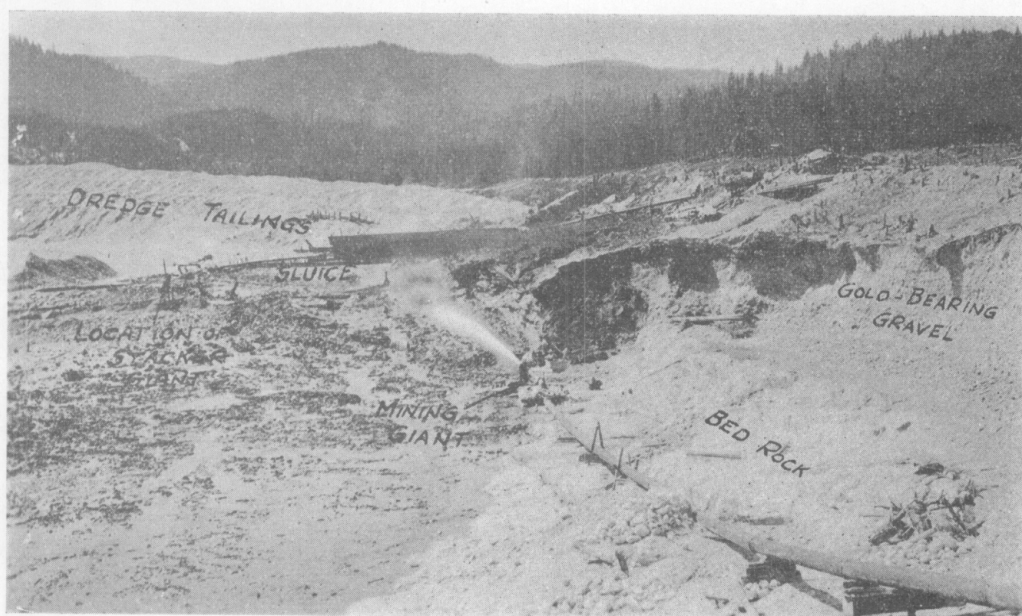


Fig. 11. Photograph showing mining at McGovern's and Hackney's placer.

Information furnished about the bench west of Warren Meadows by early and recent mining operations has been supplemented by data from numerous test pits and drill holes widely distributed over the bench. It is reported that the Idaho Gold Dredging Company, which owns or controls a large part of the ground, will attempt to mine the bench by dredging.

One feature of the terrace is the variety of materials present on it. These include sand, gravel, clay, and peat. Some of the sediments are well sorted, others are not. At some localities, pebbles of quartzite are present to the almost complete exclusion of those of quartz monzonite. At other localities the opposite is true. The differences in composition and size of materials, and in degree of sorting, should be considered in planning placer operations.

At several places, exposures indicate a rather abrupt rise of the bed-rock floor of the meadows to the bed-rock floor of the terrace. This rise is well shown at McGovern's and Hackney's pit (see fig. 11). In general, at the front of the terrace the bed-rock may lie about 10 feet above the gravel surface of the adjacent Warren Meadows. In general, the surface at the terrace is about 20 feet above the "meadows". Thus the thickness of the gravel terrace at its outer edge is at many places about 10 feet.

The bed-rock reaches the surface of the ground at the back of the terrace at an altitude of about 5,850 feet. Thus a general depth of gravel decreasing from 10 feet at the front of the terrace toward the back is indicated. Test pits and drill holes, however, show gravel several times that deep at some places. At McGovern's and Hackney's pit the bed-rock surface, after the first abrupt rise from beneath the Warren Meadows, appears to slope gently down toward the west, thus further complicating hydraulic mining. The old placers just northwest of the mouth of Stratton Creek show a bed-rock hill that before placering was thinly covered with gravel. Deeper ground surrounds this low hill. This evidence indicates that the bed-rock floor of the terrace is deeply scored with old channels of Warren Creek and its tributaries.

This conception of the form of the bed-rock surface is consistent with the reports of the wide differences in gold values at different places. Most of the gold lies near bed-rock.

Gayety Hillside.

Two small, old placered areas lie on the hillside sloping toward Warren Creek in the vicinity of the Gayety mine in Sec. 24, T. 22 N., R. 6 E. Both of the areas are in very small, shallow valleys. The material that was washed is estimated as being 90 per cent quartz monzonite and 10 per cent quartz. A few pieces of lamprophyre dikes were seen.

Most of the material is sub-angular, but some is well rounded. Boulders of quartz monzonite larger than 6 feet in diameter are not common. The largest quartz boulders seen are about 3 feet in diameter. Most of the material is much smaller.

It seems likely that the source of the quartz and the gold was the Gayety vein and other veins in the vicinity.

Steamboat Creek (benches near mouth).

Near the mouth of Steamboat Creek are four large placered areas that together make up about 50 per cent of the worked bench and hillside deposits in the districts. One of these areas is on the point between Steamboat and Warren

creeks, south of their confluence; another, on the other side of Warren Creek, extends upstream to within one-fourth of a mile of Warren. The third occupies the end of the low ridge between Warren, Steamboat, and Stratton creeks, and the fourth is on the south side of Steamboat Creek, about one-half mile upstream from its mouth. The combined areas of these old placers is about one-eighth square mile.

Little is known about these placers except that they were operated before Lindgren's visit in 1897. Speaking of the area east of Steamboat Creek and west of Warren Creek, Lindgren says - "On the south side of Meadow (now Warren) Creek, one-half mile from Warren, begins a bench deposit of granitic sand and scattered gravel. At the mouth of Steamboat Creek it rises to 30 feet above the creek, or to about the level of Warren. The entire bench has evidently been covered by pay gravel and worked over". All of the four areas are reported to have been richly productive.

Much of the work apparently was done by ground-sluicing, and remnants of many old ditches at different levels still remain on the slopes above the placers. The quartz monzonite of the bed-rock at these placers is very soft and crumbly. At many places placer cuts reached a depth of several feet into the bed-rock.

The unconsolidated materials at all four placered areas is very much the same. At some places there was apparently several feet of gravel and at others virtually nothing but quartz monzonite sand formed by the disintegration of the bed-rock or of boulders and pebbles. On Page 14 are described some of the sediments on the benches on both sides of the mouth of Steamboat Creek.

Thomas Creek.

There has been a moderate amount of old placering and a little recent work along both sides of Thomas Creek in the NW 1/4 of Sec. 27 (unsurveyed), T. 23 N., R. 6 E. Both bench gravel and alluvium have been washed. The highest point reached by the old work is about 5,900 feet or about 50 feet above Thomas Creek. The Thomas Creek placers are reported to have been less productive than those along Warren and Steamboat creeks. This report is strengthened by the results of test pits and holes in the wide band of alluvium that borders Thomas Creek to the vicinity of the old placered ground. These are said to indicate irregularly distributed, spotty, and generally low values in the alluvium to which the terrace gravel has contributed.

The pit on the north side of Thomas Creek reveals poorly sorted material made up of a matrix of clay and micaceous sand in which are embedded boulders less than 3 feet in diameter. Quartzite boulders predominate over those of vein quartz and gneiss. A few boulders of quartz monzonite and of pegmatite were observed.

Along the creek, and in the pit on the south side of the creek, boulders of quartz monzonite are more numerous than on the north side, but are subordinate to those of quartzite. The horseshoe-shaped pit south of the creek has penetrated 2 feet to 8 feet of sediments and some cuts are several feet in the deeply weathered quartz monzonite.

Warren Creek (benches at and near lower end of Warren Meadows).

Extensive old placers lie on the benches east of Warren Meadows and north of Guard Creek to a short distance beyond Maloney Creek. Another large, old placer occupies a bench on the west side of Warren Creek at the north end of Warren Meadows. No recent work has been carried on at any of these old placers. They are reported to have been productive and the gold-bearing ground was largely worked out.

The geologic features of these areas are outlined on Page 14.

High-meadow deposits.

Keystone Meadows (Webfoot Meadows).

So far as is known, no placering has ever been done in Keystone Meadows at the head of Webfoot Creek except a little at the outlet of the meadows at an altitude of between 7,100 feet and 7,200 feet. Keystone and Martinace meadows are described briefly on Page 15. Their placer possibilities are mentioned on Page 28.

Martinace Meadows.

Martinace Meadows is similar to Keystone Meadows. It lies at a slightly higher altitude, between 7,400 feet and 7,500 feet. It is described on the same pages as is Keystone Meadows (15 and 28). The northern end of Martinace Meadows covers the Minnehaha vein.

Deposits in alluvium

Meadows deposits.

Slaughter Creek.

Slaughter Creek, a tributary to Warren Creek from the northeast a short distance upstream from Warren, has been placered for about 1,400 feet upstream from its mouth. An alluvial flat of about the same length, but narrower, which lies upstream from the placered ground, has not been worked. Although the placered area is not extensive, it is reported to have been very rich and to have been worked over at least three times by white and Chinese miners. Placer operations were carried on with difficulty because of the slight grade of the creek and the considerable depth of the gravel. Consequently, good values are said to still lie in the tailings and alluvium along Slaughter Creek.

Since Warren was last visited, in July, 1936, the dredge of the Idaho Gold Dredging Company, which was then working in the old tailings above the town, is reported to have been dismantled and moved to a site in the Boise Basin. It is not known whether or not the dredge worked up Slaughter Creek.

The alluvium along Slaughter Creek is largely granitic sand with some clay. Pebbles and boulders make up about one-third of the material. Of these, very few are more than 6 inches in diameter and most are between 2 and 3 inches in diameter. Three-quarters of them are quartz monzonite and the rest largely vein quartz and quartzite.

Steamboat Creek.

When the Warren district was mapped in 1935, the alluvial flat along Steamboat Creek had been dredged for about 2,000 feet upstream from the mouth of the creek. Since then the dredge is reported to have worked as far as the mouth of Hall's Gulch, a total distance of about 1-1/2 miles. At the mouth of Hall's Gulch, the dredge turned around and has started digging back through its own tailings to eventually reach the mouth of Stratton Creek, and, after working some ground there, to start digging the gravel of the bench west of Warren Meadows.

Warren Creek Dredging Company: The dredge on Steamboat Creek was the property, from 1932, when the dredge was put in operation, to early in 1936, of

the Warren Creek Dredging Company. Joe Ferris was the president of this company and A. Anderson the manager. After Mr. Anderson's death in January, 1936, the equipment and property of the Warren Creek Dredging Company were acquired by the Idaho Gold Dredging Company.

The Steamboat Creek dredge is powered by electricity purchased from the Unity Gold Production Company. It can handle about 3,500 cubic yards per day. A caterpillar tractor was used in clearing the ground ahead of the dredge. Occasionally it is necessary to shut down this dredge in the coldest winter weather because it is not large and powerful enough to effectively dig the deeply frozen ground.

The dredge was built in 1932 and put in operation in October of that year. Since then it has operated continuously except for minor shut-downs. The production from the dredge has been large, probably in excess of three-fourths of a million dollars.

Steamboat Creek was an ideal stream for dredging. The flow of the creek was sufficient to form a pond, even in the dry season. The volume of available gravel was considerable and its tenor on the average high. Some of it is said to have carried in excess of 50¢ worth of gold to the cubic yard, averaging about 12 feet in depth and containing very few boulders too large for a small dredge to handle. The quartz monzonite of the bed-rock was soft and could be effectively cleaned by the dredge. On Page 18 are given the results of an examination of typical tailings from the Steamboat Creek dredge. It is not known whether the dredge was forced to turn around because of too narrow alluvium, too high bed-rock, too low values, or too many large boulders. Upstream from Hoodoo Creek large boulders and outwash material from the glacial moraine become increasingly abundant.

Warren Meadows.

Warren Meadows has long been known to contain considerable amounts of placer gold. An area was being worked by steam shovel near the mouth of Stratton Creek at the time of Lindgren's visit in 1897. ^{1/} A little farther downstream, about opposite McGovern's and Hackney's hydraulic pit, a large area was worked many years ago by great numbers of Chinese miners. This place is now known as the old China Cut. For the most part, however, the gravel was too deep and the water level too high to permit systematic placer mining.

Idaho Gold Dredging Company. Warren Meadows has been the scene of the principal operations in the Warren district of the Idaho Gold Dredging Company (see fig. 3). In 1931, this company, which is owned by E. T. Fisher, A. F. Baumhoff, and their associates, dismantled a dredge near Granite, Oregon, transported it by truck, and set it up in Warren Meadows. The dredge was put in operation in October, 1931, and has operated with only minor shut-downs since then.

The dredge has a wooden hull and until early in October, 1936, it was powered by steam. It was equipped with two Lentz boilers, each of which developed about 90 horsepower and required about 2-1/2 cords of wood a day. In October, 1936, the dredge was electrified and the company now buys power for it from the Unity Gold Production Company. It is reported that the electrification of the dredge effects a considerable saving in operating cost. The dredge can handle about 5,000 cubic yards a day and ordinarily can work summer and winter.

The Idaho Gold Dredging Company also owns the dredge on Steamboat Creek, and the dredge which operated on Warren Creek above Steamboat Creek. In addition to the three dredges the company has in the Warren district three caterpillars, several trucks, a complete machine shop, and other necessary equipment.

^{1/} Lindgren, Waldemar, op. cit., pp. 240-242.

From 1931 through 1936 the dredge in Warren Meadows has worked an area of about one-third square mile. From this ground probably was recovered between three-fourths of a million and one million dollars worth of gold and silver. About an equal area of alluvium still to be worked remains at the north end of Warren Meadows and along Thomas Creek (if that alluvium is rich enough to dredge). The amount of unworked ground indicates that the dredge will probably operate for several more years in the district. If it proves practicable to dredge the bench west of Warren Meadows, and if the dredge now in Warren Meadows is used there, its period of productivity will be lengthened greatly. It is understood that the immediate plan is to first complete the dredging of the old China Cut (area in Warren Meadows indicated on Plate 1 as "Placered by methods other than dredging"). It is reported that the dredging of this area was nearly finished in the fall of 1936. Next the dredge is to dig through its tailings to the east edge of the Meadows and from there dig northward in the narrow strip of alluvium left along that side to the unworked part of the Meadows, beginning near the mouth of Guard Creek.

Dredging conditions in Warren Meadows are similar to those on Steamboat Creek, described on Page 44. The principal differences are (1) Warren Meadows has a larger area of deeper gravel, and (2) the Steamboat Creek gravel was probably somewhat richer.

A description of the alluvium of Warren Meadows is given on Pages 16-18.

Warren Creek (Steamboat Creek to Mayflower Creek).

Warren Creek, from the mouth of Steamboat Creek to about one-fourth mile above the mouth of Mayflower Creek, has been placered extensively. Recovery from this area is reported to have been large, but, as was the case with other meadow deposits, difficulty was encountered in attempting to use hand or hydraulic methods in an area with little grade and a water table near the surface. Consequently, much of the alluvium of this part of Warren Creek still contained enough gold to warrant the construction of a dredge there in 1934.

This small electric dredge has an operating capacity of about 2,500 cubic yards per day and was operated practically continuously from July 15, 1934, to late in the summer of 1936, when it was moved to the Boise Basin and placed in operation there. When the Warren district was briefly visited in July, 1936, the dredge was working near the mouth of Slaughter Creek. In the period of its activity in the district of a little more than two years, it possibly produced in the order of magnitude of one-fourth million dollars worth of gold and silver. Electric power to operate the dredge was purchased by the Idaho Gold Dredging Company, the owner, from the Unity Gold Production Company. The reason that the dredge was not used to rework the alluvium of Warren Creek as far as the end of the meadow-land about one-fourth mile upstream from Mayflower Creek is not known.

Near Warren the alluvium was reported to be about 12 feet thick and the bed-rock was soft and easily scraped clean. A short description of dredge tailings along Warren Creek a short distance below the mouth of Slaughter Creek is given on Page 18.

Gulch deposits.

Arlise Gulch.

Along Arlise Gulch a narrow strip of alluvium about 750 feet long was worked for gold many years ago. This area of placered ground is in the NW 1/4 Sec. 15, T. 22 N., R. 6 E., and lies at an altitude of between 6,700 and 6,750 feet. No

records are now available of production from Arlise Gulch. The placered area lies at a place that could be reached by gold brought down from the western ends of the Knott and Delaware veins and from the small vein west of Arlise Gulch, near the SW corner of the NW 1/4 of Sec. 15.

The downstream termination of the placered area was apparently caused by the abrupt increase in the grade of the gulch and the resultant absence of any alluvium for about 1,800 feet below.

Charity Gulch.

Charity Gulch, in the southwestern part of Sec. 13, T. 22 N., R. 6 E., has been placered throughout its entire extent, from its head at an altitude of about 6,900 feet to its mouth in Warren Creek at an altitude of 6,500 feet. No recent work has been done in Charity Gulch. The placered area is narrow and in a few places only is wider than 200 feet.

The gulch contains many large angular and slightly rounded blocks of quartz monzonite, as well as quantities of finer material. Near the head of the gulch the alluvium is estimated as being 95 per cent quartz monzonite and 5 per cent quartz. The proportion of quartz in the material becomes larger farther downstream. Fragments of lamprophyre dikes are not uncommon in Charity Gulch. Some of these no doubt came from the dikes near the head of the gulch.

The Charity is the only quartz vein that was recognized in the drainage basin of the gulch. That others exist is attested by pieces of vein quartz in the alluvium upstream from the Charity vein.

Halls Gulch.

The old placers in Halls Gulch, a tributary of Steamboat Creek, are not extensive, but are reported to have been productive. The gulch has been worked continuously, except where the grade was too steep for alluvial material to collect, from an altitude of about 6,850 feet near the Knott vein to its mouth. The end of placer operations just upstream from the group of veins that includes the Delaware, Knott, and others indicates that these veins were largely the source of the gold.

Hoodoo Creek.

A small amount of placer mining has been done along Hoodoo Creek near its mouth, about three-fourths of a mile upstream from the mouth, and at few places in the alluvium between. The work is all old except a small amount, which appeared to be less than 5 years old, at the area three-fourths of a mile above the mouth of the creek. Most of the alluvium appears to be material from adjacent hillsides. It is made up largely of quartz monzonite fragments less than 2 feet in diameter. A few well rounded, yellow, quartz pebbles were seen. These may have been brought in from areas of older gravel now completely removed.

No quartz veins were observed in the drainage basin of Hoodoo Creek. The source of the gold is not known. Possibly it came from gold deposited in joints in the bed-rock by hydrothermal solutions.

Smith Creek and its tributaries.

Smith Creek and its tributaries, except near their heads, have been placered along their entire lengths. The main creek, like the tributaries, flows at most places in a steep, narrow canyon. For example, the creek has a fall of 1,100 feet in the two miles from the New Era vein near the SW corner of Sec. 14, T. 22 N., R. 6 E., to its mouth at Warren.

The amount of gold that has come from this creek is not known, but it is generally considered as having been an important producer. Very little recent work has been done on Smith Creek, as there are only small areas of unworked ground left there. In the summer of 1935, a prospector was working along Smith Creek near the SW corner of Sec. 11, T. 22, N. R. 6 E. He was handling largely old tailings, but was finding a few small areas of virgin ground. He was able to handle less than 15 cubic yards a day by shoveling into a small sluice. Water was scarce and he was troubled also by large quantities of monazite during clean-ups. He was finding considerable amalgam and reported that the gulch had been worked at least twice by white and Chinese miners. The better ground that he was working ran about \$1.00 per cubic yard.

The old tailings piles in the Smith Creek drainage basin indicate that much of alluvium consisted of quartz monzonite sand. Many large angular blocks of quartz monzonite are present also at numerous localities. At some places there are small quantities of well-rounded gravel. Partly rounded pieces of vein quartz are common. An undisturbed section of alluvium at the head of a placer near the New Era mine is described on Page 18. The drainage basin of Smith Creek contains parts of at least eight of the recognized veins of the district. These are believed to have been the source of most of the gold.

Stratton Creek.

Downstream from the lower end of the reservoir on Stratton Creek the creek has been placered for about 1,200 feet. This is all old work. It was a typical gulch placer and ranges in width from 25 feet to 125 feet. According to reports, this placer was productive, but not unusually rich. Below the placer the gradient of the stream is greater and there is no alluvium along it except large boulders until the stream reaches the wide alluvial flat near its mouth.

Warren Creek (above Mayflower Creek).

Above the alluvium of the meadow land, which ends a short distance up Warren Creek from the mouth of Mayflower Creek, the gulch alluvium of Warren Creek and its tributaries has been placered extensively. Much of the ground has been worked over several times. These gulches are reported to have been very productive. At many places, the old placers are less than 100 feet wide. They are several hundred feet wide, however, at some places, particularly where major tributaries, such as Charity Gulch, Webfoot Creek, and Franklin Gulch, enter the main stream.

In earlier periods of activity most of the virgin ground along these gulches was washed; consequently, there has been little recent activity there. The Pearl placer along Warren Creek between Mayflower Creek and Charity Gulch has been a producer for several years. A little placering was done also near the mouth of Franklin Gulch in 1935 by the Linton Mines Company.

Upper Warren Creek is perhaps characterized by more gravel and less quartz monzonite sand than some other gulches of the Warren district. At most places, the gulch alluvium was thin, ordinarily less than 12 feet. The alluvium at most places consisted of poorly sorted quartz monzonite gravel, with occasional pebbles of gneiss, schist, pegmatite, lamprophyre, and vein quartz. Boulders and pebbles less than 6 inches in diameter are ordinarily better rounded than larger boulders and irregular blocks. At most places, boulders more than 4 feet in diameter are not common.

Pearl placer. The Pearl placer is on Warren Creek, about 1-3/4 miles upstream from Warren. The property consists of seven claims in two groups along Warren Creek. The owners are W. R. McDowell, Richard Coykendall, and Frank Gallagher.

The ground is worked by hydraulicking, using a 2-inch giant which operates under a 110-foot head on water brought from both Warren and Mayflower creeks. These creeks furnish sufficient water except during the dry season of late summer. The sluice is 3 feet square in cross section and consists of twelve boxes, each 12 feet long, set on a grade of 6 inches to a box. The gold is caught with block riffles. Large boulders and rocks are moved with an overhead cable powered with a 35-horsepower donkey engine. Some of the ground now being placered is old tailings and considerable amalgam is recovered. During June and July, 1935, about 2,000 cubic yards of material were washed and the clean-up is reported to have yielded 80 ounces of gold.

The quartz monzonite bed-rock is very irregular. It is cut by the joints of two prominent sets and these joints form natural riffles in which much of the gold is found. According to McDowell, some of the gold is found several feet above the bed-rock.

Webfoot Creek.

Webfoot Creek has been placered near its mouth in Warren Creek and from an altitude of 7,100 feet upstream into the lower end of Keystone Meadows. A tributary from the south, which enters Webfoot Creek at an altitude of about 7,150, has also been worked extensively.

About 1,000 feet upstream from the mouth of the creek a little work was being done in 1935 on a claim of the Linton Mines Company. The placer ground is about 50 feet wide. An abundance of subangular quartz monzonite boulders up to 4 feet in diameter there lie in a matrix of gravel and brown, clayey dirt.

The tailings of the placers along Webfoot Creek above an altitude of 7,100 feet contrast strikingly with those farther downstream. The composition of this higher material is largely quartz and feldspar pebbles, with a considerable proportion of quartz monzonite sand. The pebbles are in general not well rounded.

Lodes

Named veins

Arlise vein.

The vein believed to be the Arlise vein is on the northeast side of Arlise Gulch, about 1/2 mile upstream from its mouth. This vein has been known for many years. It is reported to have been worked by S. A. Willey up to about 1905. The ore was milled at the Little Giant mill. The production from the Arlise is not known, but it is said to have produced some very rich picked ore. The two tunnels seen, one near the level of the creek and the other about 75 feet higher, were both inaccessible.

The vein is reported to be thin and where seen it was only about 1 inch thick. Its trend where read is N. 84° W. and it dips south at 83°. The vein fills one of the prominent joints in the quartz monzonite country rock. Both walls are altered and stained with hydrous oxides of iron. Lindgren saw zinc blende and arsenopyrite in quartz in a specimen from the Arlise vein. ^{1/}

Charity vein.

The Charity vein, which was developed by the Charity mine, is in the eastern part of Sec. 14, T. 22 N., R. 6 E. It crosses the Tailholt trail and can be reached by automobile from Warren over a fair road that leads up Charity Gulch.

^{1/}Lindgren, Waldemar, op. cit., p. 249.

The ground covering the known part of the Charity vein is now owned by the Unity Gold Production Company. The old Charity workings are now inaccessible. Old stopes on the vein reach the surface on the slope toward Charity Gulch below the Tailholt trail. According to Lindgren, ^{1/} 3,000 tons of ore that averaged \$15.00 are said to have come from the Charity.

Lindgren notes also that the vein is traceable for 1,500 feet and dips 80° S. He reports the thickness of the vein to be 2 feet, with a pay streak 6 to 18 inches thick. In 1935, it was possible to trace the vein, mostly by old caved stopes and float for about 1,000 feet.

Specimens of the vein collected from the dumps show banded quartz, with sparse sulphides, that adheres tightly to the partly altered quartz monzonite wall-rock. One small piece of ore contains coarse free gold visible to the unaided eye. Lindgren and Bell both report scheelite from the Charity vein. ^{2/}

Delaware vein.

The Delaware vein lies in the central part of Sec. 15, T. 22 N., R. 6 E. Most of the known part of the vein is in the drainage basin of Hall's Gulch, but small parts of it are in the basins of Arlise Gulch and Smith Creek. The Delaware vein runs through claims now owned by Theo. Mauersberger of Warren.

Considerable development work was done on the Delaware vein many years ago and some production is reported from it. The old workings, however, are now inaccessible. More recent work consists of two small tunnels. There is a small mill on the east side of Hall's Gulch just north of the Delaware vein and a cabin on the west side of the gulch. The Delaware vein is most easily reached by the trail from Steamboat Creek at the mouth of Arlise Gulch. This was formerly a wagon road and a small amount of repair work with some relocation in the steeper places would make Hall's Gulch accessible by automobile over this trail.

The vein was traced by old caved stopes and by float for a total distance of about 2,800 feet. The east end of the Delaware vein was opened by the Hic Jacet mine. Caved stopes testify to the former presence of ore there. On the ridge top between Hall's Gulch and Smith Creek the vein appears to be offset about 30 feet by a northward-trending fault.

Caved stopes extend a large part of the distance from the old shaft on the divide westward to the old shaft and winze near Hall's Gulch. From a point near the creek below the mill, a new crosscut has been driven which intersects the vein west of the old winze. Where cut, the vein contained no ore, but a short drift has been driven eastward and some ore shows in the breast. The owner plans to drive on eastward to a point about 30 feet under the old winze, re-timber the old winze and shaft, and work out ore through them to the mill.

The vein is exposed in another new drift a short distance north of the cabin. There it is thin and trends N. 84° E. The dip is steep and toward the south.

Dewey vein.

The Dewey vein is opened by the Dewey prospect on the west side of the west branch of Arlise Gulch, in the SE 1/4 of Sec. 16, T. 22 N., R. 6 E. It is not known whether the tunnel on the east side of the creek is part of the Dewey

^{1/}Lindgren, Waldemar, op. cit., p. 245.

^{2/}Bell, R. N., Idaho rare metals; Mining and Contracting Review, vol. 37, no. 47, pp. 5 and 6, Nov. 26, 1935.

workings or not. Both tunnels are inaccessible. No production is recorded from the Dewey. The direction of the tunnel on the west side of the creek indicates that the vein trends N. 86° E. Well-developed cross joints in the vicinity trend in about that direction and dip about 70° to the south.

Study of specimens of quartz from the dump of the Dewey revealed the presence of pyrite, stibnite, and galena. Mottramite is an alteration product. A little late quartz and the sulphides are associated in crushed zones in earlier vein quartz.

Gayety vein.

The Gayety vein is near the center of Sec. 24, T. 22 N., R. 6 E. Two tunnels along the trail from Warren Creek at an altitude of about 7,150 feet do not show on Plate 1. The Gayety group of claims (formerly the Getty or Troll group ^{1/}) is now reported to be owned by Mr. Flynn and partner. In 1922, when the Gayety claims were the property of the Gayety Mountain Gold Mines Company, development consisted of about 1,100 feet of underground work, principally tunnels. A small mill was installed at the property that year. ^{2/} No record is available of any run of the mill and it is now out of repair.

Practically all of the Gayety workings are now inaccessible. One tunnel was entered for about 50 feet, where a 4-inch quartz vein strikes east and dips 75° S. Most of the sulphides in the quartz on the dumps have been oxidized. The vein quartz is banded, the banding being caused principally by alternations between massive, white quartz and comb quartz, with numerous vugs, the crystals of which are oriented at right angles to the bands. Pieces of lamprophyre dikes are common on the dumps.

Goodenough vein.

The Goodenough vein has long been known in the Warren district, but the Goodenough mine, which is on the east branch of Smith Creek near the southern line of Sec. 11, T. 22 N., R. 6 E., has not been worked for many years. The trend of the Rescue vein from Trahl Gulch westward through the part of the vein opened by the Unity mine is directly toward the Goodenough mine, which is believed, therefore, to be on the Rescue vein. The Goodenough mine is now inaccessible. It is reported to have produced about \$10,000 worth of metal. Lindgren ^{3/}, in describing the Goodenough vein, says - "The vein, consisting of solid quartz, is from 2 to 8 inches wide, with well-defined walls. ***** At one place a fault throws the vein, going east, 8 feet to the left".

Hornet vein.

The Hornet vein is on the west side of Hall's Gulch, in the northern part of Sec. 15, T. 22 N., R. 6 E., directly east of the Mineral Monument shown on Plate 1. The Hornet claim is patented and, according to a plat nailed on a tree on the property, the owner is J.A. Czizek. There is no record of any production from the Hornet vein.

The vein is developed by several tunnels, all of which were caved in 1935. As traced by old caved workings and by float, the vein runs about N. 80° W. The dip was not determined. The vein trends toward the Arlise vein. They may be the same vein, but about 1/2 mile separates their nearest known points, and such interpolation is not safe.

^{1/}Pointon, B. S., Warren mining district: Northwest Mining Truth, vol. 6, no. 13, p.4, Aug. 19, 1921.

^{2/}Campbell, Stewart, Mining Industry of Idaho for the year 1922: Report of the State Inspector of Mines, p. 93, 1923.

^{3/} Lindgren, Waldemar, op. cit., pp. 247-248.

No quartz was seen on one of the dumps on the Harnet claim, but the quartz hematite is of the altered type. A few pieces of quartz with a maximum diameter of about 4 inches lie on another dump.

Iola vein.

The map of the Warren district was not extended far enough to the south and east, because of the limited time available for the work, to include the Iola vein, which is not far distant. The Iola group of claims is reported to be owned by Sigo Myers of Atlanta, Ga. ^{1/}

The Iola vein is one of the early productive veins of the camp. Some estimates place its production at about \$100,000 worth of gold and silver. It has probably not produced since about 1898.

Lindgren ^{2/} describes the Iola vein as follows: "The Iola, on which an arrastre was working in 1897, is situated 2 miles above Warren. A 10-stamp mill was erected in 1898. It is a wide vein, showing a clean quartz with some copper stain. The developments consist of 2 tunnels - the lower 470 feet, the upper 250 feet long. A considerable amount has been stoped".

Knott vein.

The Knott vein cuts the western slope of Hall's Gulch west of the central part of Sec. 15, T. 22 N., R. 6 E. The vein lies a few hundred feet south of the Delaware vein. The outcrop is now covered by claims of Theo Mauersberger.

This vein was discovered early in the history of the district, but the Knott mine has not been active for many years. It is reported to have been operated at one time by S. A. Willey and to have produced in aggregate about \$23,000 worth of metals. None of the workings is now accessible, and the old mill on Hall's Gulch is in ruins. Lindgren says ^{3/} - "The ore contains from \$16 to \$40 in gold. The value of the bullion is only \$12 to \$13 per ounce. Work has been started at intervals for a long time. The pay shoot is said to be 200 feet long; it dips eastward. The mine is opened by means of three tunnels. The lowest is 650 feet long, opening the vein 190 feet below the discovery shaft, while the two upper tunnels, respectively 50 and 90 feet below the discovery, are 300 and 470 feet long. In 1897, work was progressing on the middle level".

The vein was traced by old caved stopes and float for about 1,000 feet horizontally and about 200 feet vertically. Good looking float is present west of the westernmost Knott workings for a few hundred feet down the slope toward Arlise Gulch. According to Mauersberger, the vein was never found in place there. An offset of about 100 feet in the float streak just west of the Hall's Gulch-Arlise Gulch divide may indicate a fault that displaces the vein to the left. The Knott vein has never been recognized east of Hall's Gulch.

Little Giant and other veins.

The Little Giant has been one of the most productive veins of the Warren district. The vein lies about one-half mile south of Warren. All the known extent of the vein is now covered by claims of the Unity Gold Production Company. The more recent work of this company has been done on the Rescue vein and the company will be discussed under that heading.

^{1/}Campbell, Arthur, 37th Ann. Rept., of the Mining Industry of Idaho, p. 202, 1936.

^{2/}Lindgren, Waldemar, op. cit., p. 249.

^{3/}Lindgren, Waldemar, op. cit., p. 249.

Practically all the work on the Little Giant vein has been done in two mines, the older work in the Little Giant and the newer in the Unity. These two sets of workings are now connected by the Czizek connection (fig. 13).

The following extract about the Little Giant mine is from Lindgren:^{1/}

"This mine has been worked continuously for the last 14 years, 1883-1897, and paid a dividend above the running expenses each year. During these 14 years, 1,665 tons of ore have been milled, averaging \$117 per ton. Some lots of 50 tons contained \$250 per ton, and other small lots as much as \$2,000 per ton. The yearly production has ranged from 16 to 400 tons. The total production is \$178,000 in gold and \$16,000 in silver, giving an average of \$107 in gold and \$9.85 in silver per ton. The relative proportion of gold and silver is somewhat variable, however, some lots of ore containing, for instance, \$60 gold and \$8 silver per ton, others \$90 gold and \$25 silver. The surface ore contained relatively more silver than that mined at present".

A more recent estimate of production from the Little Giant vein, an estimate which includes the production from the Unity mine on the Little Giant vein, is \$500,000 worth of metals. This figure is perhaps high, but is probably of the right order of magnitude.

Apparently little or no work was done in the Little Giant mine after 1898. The Little Giant vein was struck by the Unity crosscut in 1919^{2/}, and from then on intermittently yielded a considerable production. No work has been done on the Little Giant vein for several years.

Development on and near the Little Giant vein includes about 4,000 feet of drifts, crosscuts, raises, shafts, and stopes (see fig. 13). This figure does not include the part of the main Unity crosscut between the portal and the Little Giant vein, which is about 2,500 feet long. Most of the workings on the Little Giant vein are now inaccessible. The inaccessible parts include all of the old Little Giant mine. When surveyed in 1935, the Little Giant vein could be followed westward from the Unity crosscut toward the old workings about 200 feet only.

Geology.

The country rock in the vicinity of the Little Giant vein is the typical quartz monzonite of the district. The wall rock of the vein, where seen, is altered, with different degrees of intensity at different places, in the manner described on Pages 7-8.

Surface exposures in the area near the Little Giant vein are so soft and crumbly that no observations of strike and dip of the foliation of the quartz monzonite were made. In the Unity crosscut the rock is seen to be foliated, but so slightly that reliable readings of its attitude are taken with difficulty. The best observation made was about 200 feet in from the portal of the crosscut, where the foliation of the quartz monzonite strikes N. 35° W. and dips 55° NE. This attitude is consistent with the regional attitude of the foliation.

The country rock throughout the Unity mine, as elsewhere in the district, is cut by numerous joints. Many of the joints may be grouped into two definite joint-sets (see pp. 19 and 20). The joints of the more conspicuous set in the

^{1/}Lindgren, Waldemar, op. cit., p. 244

^{2/}Bell, R. N., Twenty-first Ann. Rept. of the Mining Industry of Idaho for the year 1919, p. 117, 1920.

vicinity of the Little Giant vein have an average trend of about N. 80° E. and an average dip of about 60° S. Some individual joints that appear to belong to this set differ in attitude considerably from the average, in strike from about N. 64° E. to S. 69° E., and in dip from about 45° S. to 80° S. Commonly the joints of this set carry a little gouge and show other evidences of movement between the two walls such as striations and local brecciation. At several places the striations were observed to pitch about 70° E. in the plane of the joint.

The joints of the less conspicuous set have an average strike of about N. 10° W. and an average dip of about 53° E. The range is from about N. 10° E. to N. 34° W. in strike and from 37° E. to 70° E. in dip. Many of the joints of this set have displaced joints of the more conspicuous set. The displacements observed ranged from 2 inches to 4 feet as measured horizontally and in nearly every instance the displacement is to the left. One joint of the less conspicuous set that offsets a joint of the more conspicuous set, about 950 feet in from the portal of the Unity crosscut, is striated down the dip of the joint.

The observed part of the Little Giant vein trends about S. 79° E. Figure 13 shows that the vein in the inaccessible part of the workings trends about east. The dip, so far as known, ranges between 47° S. and 68° S.

According to Lindgren ^{1/}, the vein can be traced on the surface for 2,000 feet. It has been followed by mining for about 1,300 feet. Its proven vertical extent is about 300 feet. Where observed, the maximum thickness of the vein is 8 inches and the minimum 5 inches. Lindgren ^{2/} gives 8 inches as the average thickness in the old Little Giant mine. The vein matter breaks easily from the walls, but only locally does gouge separate the two. The maximum observed thickness of gouge was one-fourth inch.

The vein material was apparently introduced into a well developed joint of the more conspicuous set before the offsetting of the joints of that set by the joints of the less conspicuous set. Figure 13 shows that the vein is displaced horizontally in the Little Giant mine by three such faults, respectively about 50 feet, about 20 feet, and about 90 feet. On the crosscut level similar but smaller displacements offset the vein respectively about 15 feet in the inaccessible part of the mine and about 2 feet and 8 feet near the east end of the drift driven eastward from the crosscut. All the known displacements of the vein are to the left.

As stated on Page 20, the minor joints were favored channels of ingress for the lamprophyre dikes.

Two lamprophyre dikes are known to cut the Little Giant vein on the crosscut level. One of these is near the east end of the drift driven eastward from the crosscut and fills the joint along which the vein is displaced from one side of the drift to the other. The other dike cuts the vein in the inaccessible part of the mine, but was observed where intersected by the main crosscut and in the Messing crosscut.

The first-mentioned dike is 18 inches thick. The dike itself is faulted about 2 feet along a nearly horizontal plane. The other dike is 2 feet thick in the main crosscut and 1 foot in the Messing crosscut.

Practically no stoping has been done on the Little Giant vein in the part of the workings now accessible. The caved ground near the winze along the drift westward from the main crosscut beyond the end of the Messing crosscut

^{1/}Lindgren, Waldemar, op. cit., p. 246.

^{2/}Ibid.

that prevents progress farther west appears to be at the east end of an old stope. Lindgren states that the entire vein in the old Little Giant mine appears to constitute one ore shoot. He further states as follows: "The ore contains native gold, often visible and somewhat pale in color. The bullion is from 580 to 641 fine. The quartz further contains a small amount of tetrahedrite, galena, brown zinc blende, and arsenopyrite, as well as a few grains of pyrite. As shown by thin sections, it is normal vein quartz with well-developed individual crystals. It is shattered and re-cemented by secondary quartz containing green spots of copper carbonates. Tellurides, argentite, bromide of silver, and native silver, are also said to have been found".

The quartz in the accessible part of the mine is said to be low-grade and hence was not stoped. Near the winze at the western limit of the accessible workings some crushed quartz containing a little sulphide and stained with copper compounds is reported to be good ore. The microscope shows the sulphides and a little later quartz to have been introduced in crushed zones in earlier, coarse-grained quartz.

Other veins.

Other veins have been intersected by the main Unity crosscut between the portal and the Rescue, or No. 6, vein. These are shown on Figure 13, and are mentioned here only briefly as not enough work has been done on any of them, except vein 2, to warrant much comment. Still other veins farther in the mine on which little exploration has yet been accomplished are discussed under the heading "Rescue and other veins".

Vein 1, about 370 feet from the portal, has not been developed, although where exposed it is 14 inches thick. It is reported to be of low-grade.

Vein 2 is cut by the crosscut at about 1,440 feet from the portal. Considerable work has been done on it since the mine was surveyed in 1935. The following information, including the sketch (fig. 12), is from Eyman: ^{1/}

"This vein (vein 2) is quite characteristic of the others previously developed, yet shows several points of additional interest, ***. The west fault, aside from its 12-inch off-set of the vein, is not so pronounced as the others, but so far the exposure on same would indicate a vertical dip and striking in the direction as shown. There is no evidence of its passing into the footwall side. The middle fault is more in evidence and has been traced as shown in practically a true plane surface and faults both vein and dike. The east fault is the most marked of all and carries considerable evidence of talc and alteration on both sides of the slip proper, with the latter surface showing slickensides, the striations of which dip to the northeast.

The dike rock is characteristic of the several other exposures of this formation as found elsewhere in the mine, with the exception that the general dip is steeper, which point, however, may be a local variation due to its close proximity to vein and fault.

The vein segments between the faults are very erratic in size and with many variations in strike and dip, and with a vein-filling of a fine-grained normal quartz with very little fracturing and alteration in evidence. The vein walls are well defined and usually are separated

^{1/} Eyman, T., Letter to author dated Dec. 8, 1936.

^{2/} Lindgren, Waldemar, op. cit, p.246.

from the vein-filling by a very thin coating of talc. Above the dike intersection the vein contains inclusions of 'waste horses' of decomposed and crushed granite with occasional stringers and lenses of quartz, as shown by the mottled areas in sections at b and at c (fig. 12).

The work to date would indicate that the distribution of ore values is contained in the section of the vein lying above the dike and within the confines of the fault planes as shown; however, the bulk of the ores to date has come from the west end of the stope and with only a small scattering of values in the vicinity of the present section at c. Also, the ore values are confined to lenses and small veinlets following planes of fracturing in the vicinity of the footwall side of the vein.

The ore consists entirely of quartz containing oxidized vugs and streaks of limonite and frequent bunches of galena, both of which carry the bulk of the gold and silver values *****".

Eyman's careful and detailed observations constitute a convincing picture of an example of the relation between veins and dikes in the Warren district.

Vein 3 is about 1,800 feet in from the portal of the crosscut. About 200 feet of work has been done on and near it. Evidence of movement is apparent on some thin quartz veins occupying joints that strike and dip in different directions. The relations there are not clear.

In the vicinity of vein 5, about 400 feet farther in the Unity crosscut than the Little Giant vein, are several thin quartz veins. Vein 5 itself is a strong fissure carrying fault gouge up to 12 inches thick, but no quartz. The country rock is intensely altered in the neighborhood of vein 5.

Lucky Ben vein.

The Lucky Ben vein runs nearly parallel to and just south of the north lines of Sec. 16 (unsurveyed) and Sec. 15, T. 22 N., R. 6 E. The claims covering the known extent of the vein are reported to be owned by J. A. Czizek of Boise.

The Lucky Ben vein was discovered in the early days and was developed by the Lucky Ben mine, now long abandoned and totally inaccessible. It is reported to have produced about \$12,000 worth of metals.

The foliation of the quartz monzonite in the vicinity trends about N. 22° W. and dips about 55° NE. The vein strikes nearly east and dips 75° S. It was traced by old caved stopes, mine dumps, prospect pits, and float, for about 900 feet horizontally, and over a vertical range of a little more than 200 feet.

Small bunches of very rich ore are reported to have come from this vein.

Minnehaha vein.

The Minnehaha vein is in Sec. 22, T. 22 N., R. 6 E., near the divide between the heads of Webfoot Creek and Hall's Gulch. The vein is accessible in the summer by a fair mountain road from Warren and by a little more than one-half mile of trail.

The only development work on the vein is on the Minnehaha claim of Clarence Pickell and Mrs. G. M. Waterhouse. The vein has not produced ore. The principal development is a shaft, 70 feet deep, a short distance north of the center of the section at the end of the trail. Other openings include trenches and prospect pits and a shaft 40 feet deep.

The vein was followed, with some interpolations, by float and prospect openings for about 2,400 feet. Mr. Pickell is said to have traced it about $3/4$ of a mile each way from the shaft. The vein strikes a few degrees north of west at the shaft and dips steeply south at 68° .

At the shaft, where the vein is best exposed, it ranges from about 2 feet to about 4 feet thick. It is separated from the walls by very thin gouge. The vein is typically banded and the bands are conspicuous because of the staining along them by hydrated oxides of iron. The interior part of the vein is white, but layers several inches thick along each wall are very dark quartz. According to Mr. Pickell, the white interior quartz is nearly barren, but the dark quartz carries about 20 ounces in silver and one-half ounce in gold to the ton. The dark color of the quartz along the walls of the vein is probably due to finely disseminated sulphides since small specks of some sulphide were seen with a hand lens. Locally, staining by copper compounds is conspicuous.

Mohawk vein.

The Mohawk vein is covered by the Mohawk claim of Clarence Pickell and Mrs. G. M. Waterhouse. The vein lies between the Monitor and Summit veins, in the northern part of Sec. 22, T. 22 N., R. 6 E. The small workings on the Mohawk claim were not visited. According to Mr. Pickell, the vein is thin and can not be traced very far on the surface.

Monitor vein.

The Monitor vein is the northernmost of the four veins that are covered by claims of the same names (Minnehaha, Summit, Mohawk, and Monitor) of Clarence Pickell and Mrs. G. M. Waterhouse. The Monitor vein and claim are near the head of Hall's Gulch.

A tunnel was started near the eastern headward tributary of Hall's Gulch with the idea of striking the Mohawk, Summit, and Minnehaha veins. The altitude of the tunnel portal is about 7,300 feet and that of the divide near which the other veins crop out a little more than 7,500 feet. When the tunnel had been driven about 300 feet, it intersected a vein now called the Monitor. This is probably the same vein on which a little prospecting was done years ago along the western headward tributary of Hall's Gulch about 600 feet farther west.

Where intersected by the tunnel, which has not been driven farther, the Monitor vein trends east and is about 6 inches thick. Several splits from it, each from one inch to 2 inches thick, extend into the north or footwall.

New Era (Tramp) vein.

The New Era vein, formerly the Tramp, is developed by the old Tramp mine and by some more recent work. Claims covering the vein are now held by Thad Adams. The New Era vein crosses the head of Smith Creek in the SW $1/4$ of Sec. 14, T. 22 N., R. 6 E.

According to Lindgren ^{1/}, the ore from the New Era vein is similar to that from the Knott. He notes also that 100 tons of ore from the New Era vein were treated in an arrastre in 1881.

The main tunnel of the Tramp mine is on the west side of Smith Creek and only about 15 feet above the creek. It is about 440 feet long and is a drift along the vein. In addition to the main tunnel there are numerous prospect openings in the vicinity. Some old stopes above the tunnel have caved to the surface.

^{1/} Lindgren, Waldemar, op. cit., p. 249.

The vein was not traced definitely except as exposed in the main tunnel. The interpolated extent as shown on Plate 1, particularly that part east of Smith Creek, is based on a few prospect openings and may be incorrect. The fact that the vein strikes about N. 80° W. and dips 60° S. in the main tunnel throws some doubt on the vein's projection east of Smith Creek as shown because the projection of the vein as plotted by using its dip and strike would appear farther north on the hillside east of the creek.

At some places in the tunnel the vein is represented by a thin gouge seam only. At other places, it is made up of 1-1/2 feet of quartz.

Rainier vein.

The Rainier vein crosses the Tailholt trail near the divide between Webfoot and Smith creeks in the western part of Sec. 23, T. 22 N. R. 6 E. Part of the vein is covered by the Missouri claim of Clarence Pickell, which was staked in 1923.

Newer development work includes a crosscut about 300 feet long from a point near the head of Smith Creek to the vein. An old short crosscut about 400 feet farther east on the Webfoot side of the divide gave entrance to a small stope that was drawn to the surface from a depth of about 30 feet. No production record is available for this old work. A shaft about 90 feet deep a short distance east of the stope is partly filled with water. The workings mentioned and other prospect openings form the basis for tracing the vein about 1,700 feet, partly west of Smith Creek.

The 300-foot crosscut near the head of Smith Creek was not studied. Mr. Pickell reports that where the vein was found it consisted of a gummy fissure only, with no ore. In the shaft east of the old stope the vein is vertical. There the vein consists of about 1-1/2 feet of white quartz, which is distinctly banded. The banding is accentuated by staining with hydrated oxides of iron. According to Mr. Pickell, the Rainier vein, like the Minnehaha, has richer ore along both walls and leaner ore in the central part.

Where seen, the quartz is separated by very thin gouge from the walls and the quartz against the gouge is deeply striated.

Rescue and other veins.

The Rescue vein lies about 5/8 of a mile south of Warren and extends between Trahl Gulch and the main eastern tributary of Smith Creek. The principal mines that have been developed entirely or in part on the Rescue vein are the Unity, Goodenough, and Rescue.

All of the property covering the known extent of the Rescue vein, with the exception of that of the Rescue mine, is now owned by the Unity Gold Production Company. This company is one of the claimants of the Rescue mine, the ownership of which is reported to be in dispute.

Unity Gold Production Company.

The Unity Gold Production Company is, and has been for a number of years, the largest and most active lode mining enterprise in the Warren district. Alexander Potter and Loren M. Hart, both of New York City, are president and secretary, respectively, of this company. The company controls, in addition to the Unity mine, the older Little Giant (see pp. 52-55), Goodenough, and Charity mines. It also is one claimant of the Rescue mine (see above). According to Campbell 1/

1/ Campbell, Arthur, Thirty-seventh Ann. Rept. of the Mining Industry of Idaho for 1935, p. 200.

the company owns 8 patented and 14 unpatented claims. Company holdings include an electric power plant on the South Fork of the Salmon, about 8 miles south of Warren, complete mine and surface machinery and buildings, and a mill located at Warren at the portal of the main tunnel of the Unity mine, with an operating capacity of 25 tons per day. Electric power is used in the mine and on the surface, and surplus power is sold for town use and to the Idaho Gold Dredging Company.

The mill consists of a primary crusher (jaw breaker), a Marcy ball mill in closed circuit with a Dorr classifier and with an amalgamator between the ball mill and the classifier, a flotation unit, rougher, and cleaner. According to Eyman ^{1/}, the mine superintendent, the capacity of the mill would be considerably increased by the addition of a larger primary crusher.

Unity mine. The portal of the main tunnel of the Unity mine is at Warren at an altitude of 6,000 feet (fig. 13). The part of the mine between the portal and vein 5 has already been discussed. The main tunnel, the Unity crosscut, is about 5,250 feet long. This carries it about 1,300 feet beyond the Rescue vein.

Accessible workings on the Rescue vein, mostly drifts, raises, and a winze, and mostly on six levels, aggregate about 4,200 feet. The air and power raise on the Rescue vein goes through to the surface from the crosscut level. Several hundred feet of workings are now inaccessible. Development on other veins, except the Little Giant, is insignificant.

Rescue mine.

A large part of the workings in the Rescue mine are now inaccessible. When visited in 1935, it was possible to follow a crosscut from the surface about 700 feet to the vein. The drift along the vein was open 80 feet eastward to the breast and 340 feet westward to where it was caved. The crosscut entered was apparently driven since Lindgren visited the district, for he describes the mine as follows: ^{2/} "The vein is opened near the creek by a crosscut 475 feet long. Drifts extend 300 feet east and 600 feet west on the vein. East of the crosscut the vein has been stoped to surface, and also for 50 feet below the drift, while on the west side but little stoping has been done". This mine is probably the one shown on Plate 1 about 100 feet higher on the hill above the Rescue tunnel at the end of the road that branches southward from the road along the northeast side of Warren Creek near the mouth of Slaughter Creek.

History and production.

Two of the mines opened on the Rescue vein, the Rescue and the Goodenough, go back to the early days of lode mining in the district. Of these two, the Rescue appears to be the older, as Lindgren mentions that it yielded \$13,000 in 1869. ^{3/} The earliest mention of the Goodenough that could be found was 1897 when the mine was being operated by the Idaho Consolidated Gold Mining Company.

Between 1898 and 1916 these mines were operated intermittently, but apparently did not produce very much. In 1915, important ore shoots are said to have been discovered in the Rescue. ^{4/}

In 1916, the Unity Gold Mines Company was formed. The property of this company included the old Little Giant and Charity mines. This company was one of the prominent developments in the state between 1916 and 1933. During that time,

^{1/} Eyman, G. T., personal communication.

^{2/} Lindgren, Waldemar, op. cit., p. 247.

^{3/} Lindgren, Waldemar, op. cit., p. 239.

^{4/} Bell, R. N., Seventeenth Ann. Rept. of the Mining Industry of Idaho for the year 1915, pp. 100 and 103.

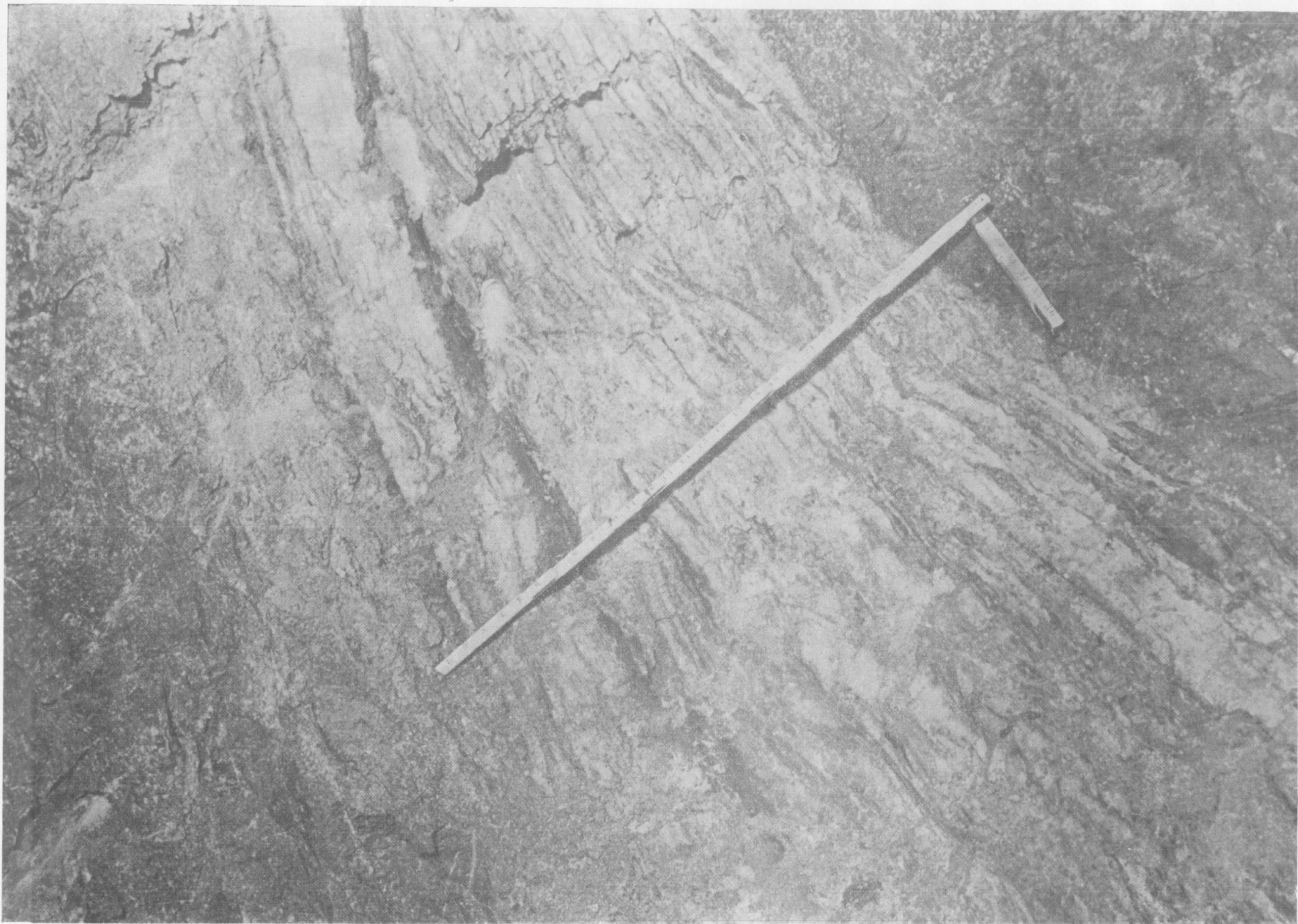


Fig. 14. Rescue vein on 100-foot level 60 feet east of winze, Unity mine. (Photograph by G. T. Eyman.)

the mine was shut down occasionally for short periods. It is mentioned in nearly all of the mine inspector's reports covering that interval.

In 1917, the Rescue mine was known as the Standard mine ^{1/}, and the property is said to have included also the Goodenough mine.

Just when the Unity Gold Mines Company acquired the Rescue and Goodenough mines is not entirely clear. According to some reports, it was in 1916 when the company was formed. This does not appear to agree with the State Mine Inspector's report for 1917, just cited. One report states that the Rescue mine was active from 1913 to 1918 as the Idaho Standard Mines Company.

From 1922 to 1933, the mine inspector in his annual reports lists the Rescue group as belonging to the Unity Gold Mines Company.

In 1933, the Unity Gold Mines Company was re-organized to the Unity Gold Production Company, the present operator.

The production from the Rescue vein is difficult to estimate, principally because the considerable production of the Unity mine came partly from the Little Giant and partly from the Rescue vein.

Lindgren ^{2/} gives the total production from the Rescue as between \$100,000 and \$150,000 up to 1899. The Goodenough is said to have produced \$10,000. A more recent estimate gives the total from the Rescue mine as \$200,000.

Geology.

The geology in the vicinity of the Rescue vein is similar to that near the Little Giant vein (see pp. 53 and 54).

Unity mine. The Rescue vein trends in general in the Unity mine between N. 70° E. and N. 80° E. Its dip averages about 65 degrees to the south and is fairly uniform. Dips between 49° S. and 70° S. are not uncommon. The vein has been opened in this mine for about 900 feet horizontally (the aggregate distance that the Rescue vein was traced from the west end of the Unity workings eastward to Trahl Gulch is about 3,600 feet) and for more than 700 feet vertically.

In the Unity mine the Rescue vein differs considerably at different places, both in thickness and in character. Typical ore, such as accounted for most of the production from this part of the Unity mine, was probably not seen in any abundance in the survey leading to this report because most of it has been stoped out and even the stopes from which the ore has been removed are for the most part inaccessible.

In the part of the mine east of the crosscut and on and above that level the vein in many places is represented by a strong fault with little quartz. The fault zone is commonly about 2 feet thick and consists principally of crushed quartz monzonite mixed with gouge and a little crushed quartz. Locally, thin quartz veinlets lie in this crushed material and in a few places such veinlets are frozen to either hanging or footwall. At some places in the part of the mine mentioned the vein is thinner and carries a larger proportion of quartz. At one place on the crosscut level it consists of 6 inches of quartz with no gouge.

^{1/} Bell, R. N., Nineteenth Ann. Rept. of the Mining Industry of Idaho for the year 1917, p. 93.

^{2/} Lindgren, Waldemar, op. cit. p. 246.

On the +200-foot level west of the crosscut, the vein is represented by a crushed zone and is similar to the 2-foot crushed zone described above. On the crosscut and +100-foot levels, however, the vein is thinner but carries more quartz. At one place it consists of 3 inches of banded quartz and 2 inches of gouge. At another it is made up of 5 inches of banded quartz frozen to the foot-wall and separated from the hanging wall by 2 inches of gouge.

Parts of the vein exposed in the two levels below the crosscut level are probably more typical of that which furnished the earlier production from this mine than any other seen. Most of this work on the lower levels has been done since the mine was surveyed in 1935. Eyman ^{1/}, in describing the vein on the 100-foot level (below the crosscut level), says that, from a point 41 feet east of the winze to a point 91 feet east of it, it averaged 24 inches in width (fig. 14). Nearer the winze the vein was about 12 inches thick.

In the accessible part of the Unity mine, on the Rescue vein, the vein does not appear to be as much disturbed by later movements along the northwestward-trending joints as is the Little Giant vein.

There is a zone passing northwestward through the intersection of the Unity crosscut and the Rescue vein that appears to have been especially susceptible to caving and has blocked further entrance westward into old workings on the +100, +200, +400, +450, and +500-foot levels. Eastward progress on the part of the +200-foot level accessible by the raise west of the crosscut is blocked also by the same caved zone. This zone is lagged tight on the crosscut level and, hence, could not be observed there. It was best seen on the +200-foot level a short distance east of the top of the raise west of the crosscut. The visible part is brecciated quartz monzonite, with numerous shears and considerable gouge.

The caved zone may be along a fault, and the movement on the fault may have brecciated the rock and rendered it susceptible to caving. If this is correct, either the movement was not very great or else it was largely parallel to the vein, because there is no great offsetting of the vein across the caved zone. A small displacement of the vein to the left is noticeable on the crosscut level and on the +200-foot level.

According to Eyman, this same crushed zone was encountered on the 100-foot level about 90 feet east of the winze. This place had not been opened at the time of the survey in 1935.

A small fault, which may be related to the crushed zone just described, was encountered at a depth of 34 feet in the winze below the crosscut level and on the 100-foot level, 41 feet east of the winze. The vein on the 100-foot level is offset about 1 foot to the right, according to Eyman. The vein is thicker east of this small fault, as stated above.

About 350 feet west of the crosscut on that level a fault cuts off the vein. The vein shows drag along the fault toward the left, which indicates that the faulted segment lies that way. Further prospecting westward appears to have been along a strong crushed zone, which is not believed to be the Rescue vein.

The ore on the Rescue vein in the Unity mine appears to have been localized near the crushed zone or fault already described. In the part of the vein above the +200-foot level, most of the ore lay east of the zone, but below that level to the crosscut level, good ore was stoped from both east and west of the fault (fig. 15).

^{1/}Eyman, G. T., personal communication.

Work below the crosscut level indicates good ore between the crosscut level and the 100-foot level, and some good ore between the 100 and the 200-foot levels. The greater part of the vein between the 100 and the 200-foot levels appears to be barren.

Mineralogically, the ore from this part of the Rescue vein is typical of other ore of the Warren district (see page 37). Calcite was observed in the vein west of the crosscut on that level and on the +400-foot level.

Three cars of ore from the winze near the 100-foot level gave a return of \$96 to the ton. This ore yielded about 6 pounds of concentrates to a ton and the concentrates are reported to be correspondingly rich. A sample cut across the 28-inch thickness of the vein at a point 60 feet east of the winze on the 100-foot level (see fig. 14) assayed 1.92 ounces in gold per ton.

Rescue mine. Only about 420 feet of tunnel along the Rescue vein were accessible in the Rescue mine in 1935 (see page 58). The quartz monzonite of the walls is altered for several feet each way from the vein. The accessible vein segment strikes about east and dips south at between 44° and 58° . This part of the vein is similar to the vein where exposed in the Unity mine. At most places it is about 18 inches thick and consists of crushed quartz monzonite with crushed vein quartz and gouge. Locally, small quartz veinlets up to 10 inches thick are enclosed in the crushed material. These veinlets are lenticular and ordinarily are only a few feet long. In places, the vein quartz is frozen to one or both walls and at other places is separated from the walls by gouge or crushed material. The veinlets are ordinarily banded, the bands being defined by color differences from white through gray to nearly black, and the banding is caused by different amounts of finely divided sulphides.

The stoped parts of the vein may have been different from the parts described above. Lindgren ¹ describes the vein where he saw it in the upper levels as follows: "The vein forms a belt of crushed granite 1-1/2 to 2 feet wide, schistose in places and containing small veinlets of quartz inclosing minute foils of free gold, together with a little zinc blende, galena, and probably also tetrahedrite. The average width of the vein is said to be 3 feet, of which about 18 inches constitute the pay streak. In thin section, the quartz proves to be an entirely normal, well-crystallized vein quartz. The yield of the ore is from \$20 to \$50 per ton.**** The vein cuts a dark dike (minette) on the west side and faults it 4 feet. The dike contains much calcite, which is also common in the vein near the dike". This is the only known instance in the whole district where a lamprophyre dike is offset by a vein.

Silver King vein.

The Silver King vein lies on the hill east of Warren in the northern part of Sec. 12, T. 22 N., R. 6 E. Claims covering the vein are reported to be patented and to belong to the Sigo Myers estate of Savanna, Ga., the owner of the Iola.

The vein is said to have been worked between 1900 and 1906, and to have produced about \$35,000 worth of precious metals, much of it silver. It was opened by several crosscut tunnels from the hillside facing Slaughter Creek and three of the tunnels are located on Plate 1. The tunnel nearest the creek is reported never to have reached the vein. All of the crosscuts are now inaccessible except for the first few hundred feet and, hence, the vein was not seen underground.

The country rock in the vicinity of the Silver King vein is considerably altered and in many places contains tiny veinlets of quartz. Pegmatite in joints is common in the accessible parts of the crosscuts.

¹Lindgren, Waldemar, op. cit., pp. 246 and 247.

The vein was traced on the surface for about 1,300 feet and it trends about N. 67° E. The dip is to the south. The vein appears to follow a distinct zone of fracturing in the quartz monzonite. In many places the zone is at least 5 feet thick and the fractures are filled with white vein quartz, in places as much as one foot thick. The veins and veinlets in the fractures are everywhere observed sharply separated from the walls and show no gradation into the walls. At places, the vein quartz contains angular fragments of quartz monzonite. The white quartz contains sparsely disseminated, fine-grained sulphides.

Silver Monarch (Keystone) vein.

The Silver Monarch vein, formerly the Keystone, lies west of Keystone Meadows, in the SE 1/4 of Sec. 22, T. 22 N., R. 6 E. The property covering the vein consists of three patented claims owned by Joseph Pischke, Roy C. Curtis, Joe Mulligan, and Mrs. Belle C. Curtis.

The old workings are not accessible now. There are several tunnels and a shaft, with a large dump, on the property. Old stopes, caved to the surface, testify to some production, the amount of which is not known.

The quartz monzonite in the neighborhood of the Keystone vein strikes about N. 20° W. and dips about 58° NE. The dumps on the property are conspicuous for the large proportion of altered quartz monzonite which they contain. Some of it is intensely silicified.

The vein was followed, largely by old stopes and prospect pits, for about 800 feet. The trend of the vein, as indicated by a stope near the shaft, is N. 82° W. and the dip is 50° S. The vein quartz on the dumps is white and only occasionally could any sulphides be seen in it. According to Lindgren ^{1/}, this vein is one foot thick and carries much silver as well as gold.

Summit vein.

The Summit vein is covered by a claim of the same name belonging to Clarence Pickell and Mrs. G. M. Waterhouse. It lies in the northern part of Sec. 22, T. 22 N., R. 6 E., between the Minnehaha and the Monitor veins. Development on the vein consists of a shaft about 60 feet deep and numerous prospect pits. The vein was traced for about 1,300 feet in a N. 85° W. direction. At the shaft the vein is about 6 inches thick.

Unnamed veins

Veins near the head of Maloney Creek.

East of the northern part of the area covered by Plate 1, near the head of Maloney Creek, is the Lucky Day group of 12 claims belonging to Stephen Jacy. This group of claims was not visited. The vein is said to trend east.

The Brown group of claims, north of Warren and reached from there by the Bemis trail, was visited by Ross in 1930. He reports the following: ^{2/}

"There are numerous cuts, pits, and short tunnels scattered over the property, but little development at any one place. The shallow workings show that there are several veins, some of which are several feet wide cutting the quartz monzonite. The veins consist of coarse, white quartz, containing some stibnite, galena, sphalerite, and pyrite. Scheelite is reported to have been found. The quartz contains numerous vugs, and some of the stibnite is in fine needles found in these cav-

^{1/}Lindgren, Waldemar, op. cit., p. 249.

^{2/}Ross, C. P., The Marshall Lake and Warren mining districts, Idaho County, Idaho; (unpublished manuscript, p. 51).

ities. Stephen Jacy has a lease on part of the group and is attempting to recover gold from the quartz with the aid of a portable mill".

NW 1/4 Sec. 26, T. 23 N., R. 6 E.

A small prospect pit has been dug on a vein northwest of Maloney Creek, in the NW 1/4 Sec. 26, T. 23 N., R. 6 E. (unsurveyed), between the creek and the trail on the ridge. According to a location notice, this is on the Last Chance claim, staked in 1931 by C. J. Robertson and J. M. Webb. The vein was traced by float for about 100 feet and appears to trend about N. 45° E. and to dip steeply. In the pit, the vein is 6 inches to 36 inches thick, and consists of white, locally vuggy quartz. The vein is frozen to the walls, which are altered quartz monzonite. A few specks of fine-grained sulphides were observed in the quartz.

Three-eighths of a mile north of NW corner of Sec. 34, T. 23 N., R. 6 E.

A quartz vein about 12 inches thick is exposed in a small pit about 3/8 of a mile north of the NW corner of Sec. 34 (unsurveyed), T. 23 N., R. 6 E. This is about on the unsurveyed line between Sections 27 and 28. The vein strikes N. 71° E. and dips 75° S.

Veins in the eastern part of Sec. 33, T. 23 N., R. 6 E.

Three quartz veins were observed in the eastern part of Sec. 33 (unsurveyed), T. 23 N., R. 6 E. One lies N. 30° W. about 4,450 feet, another N. 44° W. about 2,400 feet, and the third N. 27° W. about 550 feet from the southeast corner of the section.

The first-mentioned vein strikes about N. 80° E. The second was not well enough exposed to determine either its strike or dip. The vein is about 8 inches thick and locally vuggy.

The third vein strikes N. 67° E. and dips 56° SE. It is about 24 inches thick and encloses a 2-inch layer of quartz monzonite near its center. The quartz is white and vuggy, and carries a considerable amount of sphalerite, galena, and tetrahedrite. The sphalerite and galena are coarse. A yellow alteration product on the surfaces of some quartz crystals in the vugs contains arsenic and may be mimetite.¹

Veins in western part of Sec. 1, T. 22 N., R. 6 E.

Two quartz veins were seen near the Bemis trail and south of it about 1/2 mile and about 1 mile respectively north of Warren. These places are both in Sec. 1, T. 22 N., R. 6 E. At the place farther from the town the vein consists of four veinlets, each between 1/2 inch and 1 inch thick, separated by thin quartz monzonite layers. They trend N. 75° W. and dip 58° N., and, therefore, apparently do not fill joints of the major joint set of the district.

At the locality nearer to Warren the vein is 8 inches thick and strikes N. 59° W. It dips 40° S. The vein is principally massive white quartz. It contains some thin tabular fragments of quartz monzonite oriented about parallel to the vein. Some sulphides were noticed in the quartz along its contacts with the walls of quartz monzonite.

SE. of Steamboat Creek in the SE. 1/4 of Sec. 3 and the SW. 1/4 of Sec. 2, T. 22 N., R. 6 E.

Several prospect pits were seen on the point between Warren and Steamboat Creeks, in the SE. 1/4 Sec. 3 and the SW. 1/4 of Sec. 2, T. 22 N., R. 6 E.

¹/Schaller, Waldemar, personal communication.

One of these is a tunnel, now caved, which, from the size of the dump, must be several hundred feet long. The quartz on the dump indicates a banded vein of vuggy, white quartz about 8 inches thick. The vein matter adheres tightly to the quartz monzonite walls.

NE.1/4 Sec. 9, T. 22 N., R. 6 E.

A 4-inch quartz vein crops out about 700 feet S. 15° W. from the NE. corner of Sec. 9, T. 22 N., R. 6 E. The vein strikes N. 59° W. and dips 55° N. The vein contains fragments of quartz monzonite and a little disseminated sulphide. Pegmatite is associated with the vein.

Along the trail near center of Sec. 12, T. 22 N., R. 6 E.

There are several prospect pits and a caved tunnel near the trail that runs eastward from the confluence of Warren and Slaughter creeks. The tunnel is at an altitude of about 6,100 feet. The direction of the tunnel is N. 86° E., and this may indicate the strike of the vein. There is a considerable quantity of quartz on the dump. The size of some pieces show that the vein was about 8 inches thick. The quartz contains a small amount of sulphides.

NW. 1/4 Sec. 15, T. 22 N., R. 6 E.

A vein was traced for about 450 feet in the NW. 1/4 of Sec. 15, T. 22 N., R. 6 E. This vein is between Hall's Gulch and the trail west of it and between the Hornet and the Delaware veins. Two tunnels, neither of which were accessible, were seen on the vein. The trend of the vein appears to be about N. 70° W.

Northern part of Sec. 18, T. 22 N., R. 7 E.

The quartz monzonite in the northern part of Sec. 18, T. 22 N., R. 7 E., mostly east of the mapped area, is in many places sheared and silicified. The joints and shear surfaces are commonly filled with quartz veinlets up to several inches thick and there also is much silicification of the country rock apparently not controlled by such surfaces.

Grandview group of claims.

This area is largely covered by the Grandview group of claims belonging to Anthony Mohr. The group includes 5 claims, and they have been held by Mr. Mohr since 1922.

The lower or No. 5 claim is reached by a road about 1/2 mile long that leads up Willey Creek from the Warren-Edwardsburg road. Development consists of 5 tunnels ranging from about 30 feet to about 400 feet long, and numerous prospect pits and trenches. All 5 tunnels are in quartz monzonite, which is locally sheared and at some localities replaced by veinlets of quartz. No gouge separates the veinlets from the walls to which the quartz adheres tightly. At no place could the attitude of the veinlets be definitely determined. The most quartz was seen in the upper or No. 1 tunnel, which is at an altitude of about 7,200 feet.

NE.1/4 of Sec. 22, T. 22 N., R. 6 E.

A quartz vein is opened by several prospect pits about 900 feet S. 70° W. from the NE. corner of Sec. 22, T. 22 N., R. 6 E. The vein was traced for about 400 feet. Its strike is about N. 81° E. Sulphides were seen in the quartz, which ranges between 4 inches and 24 inches thick.

SE.1/4 of Sec. 14, T. 22 N., R. 6 E.

Near the trail forks in the SE.1/4 of Sec. 14, T. 22 N., R. 6 E., a quartz vein is exposed by two prospect pits. The vein strikes N. 75° W. and dips 45° S. Where seen, it ranges from 3 inches to 12 inches thick. It contains a layer of quartz monzonite up to 4 inches thick in its central part.

SE.1/4 of Sec. 23, T. 22 N., R. 6 E.

Quartz veinlets have been prospected in the SE.1/4 of Sec. 23, T. 22 N., R. 6 E., on the northwest side of Warren Creek.

Linton Mines Company.

This locality is covered by the 14 unpatented claims of the Linton Mines Company. Joint owners are George Eipp, R. H. Stillwell, S. F. Parr, Lindel Donnelson, and E. A. Wilcox. Mr. Eipp was in active charge in 1935. The property was accessible in 1935 over a poor road about 1-1/2 miles long that branched from the Tailholt trail in the SE.1/4 of Sec. 14, T. 22 N., R. 6 E. In addition to several prospect pits and cuts made by sluicing with water from a ditch above the prospects on the hill, development consists of 2 tunnels, 180 feet and 100 feet long respectively. The longer tunnel is about 10 feet above the creek and the shorter one about 90 feet above the lower one.

Mr. Eipp reports a return of about \$1,000 from sluicing overburden near the tunnels.

Both tunnels are in quartz monzonite, which locally has thin gouge seams along joints. In the face of the lower tunnel is exposed a gouge seam that strikes N. 85° W. and dips 50° S. A quartz veinlet about 1 inch thick, which has a similar attitude, is exposed in the upper tunnel. This veinlet is displaced by a fault about 3 feet to the left near the face. The fault carries drag ore.

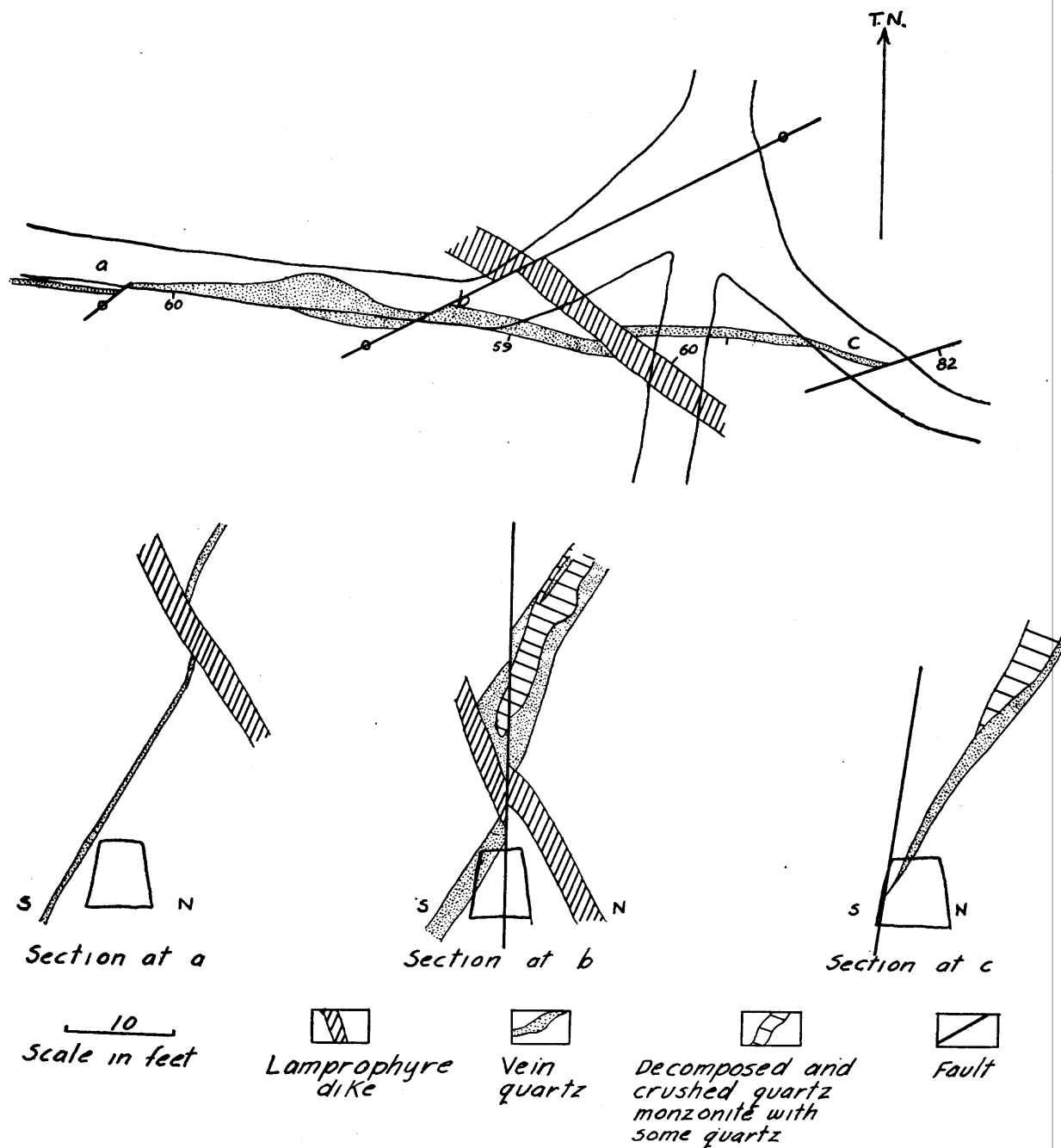


Fig. 12. Sketch showing geology in the vicinity of the intersection of vein 2 and the Unity crosscut, Unity mine, Warren, Idaho. (After G. T. Eyman.)

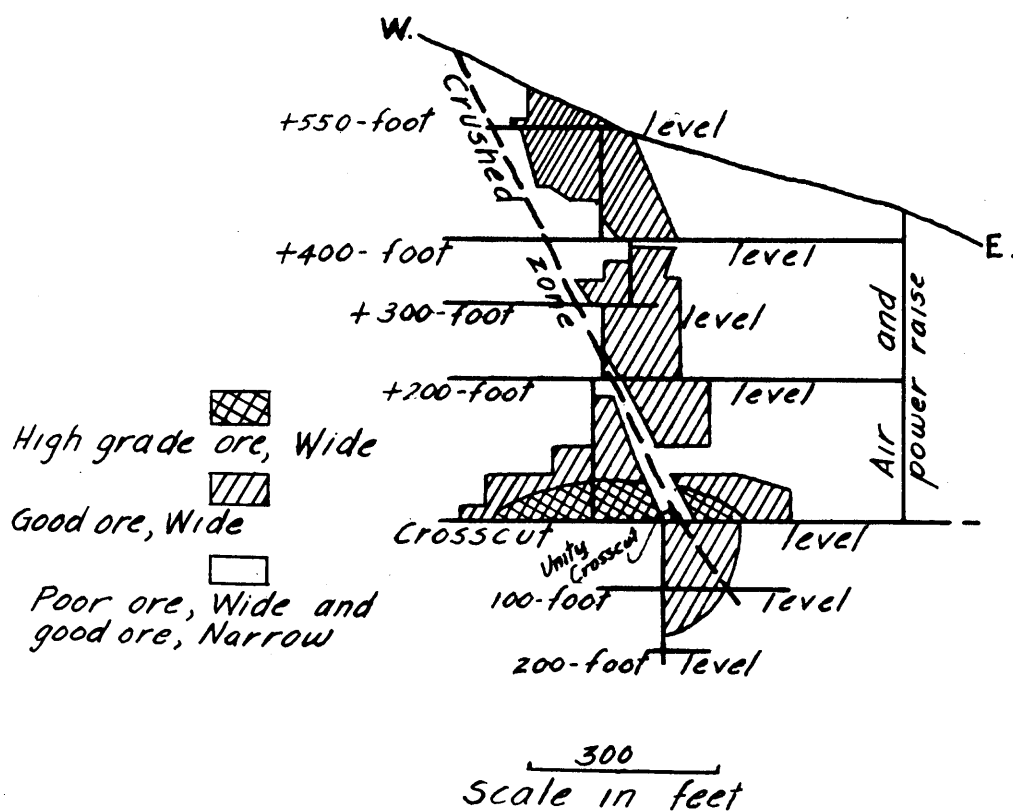


Fig. 15. Sketch of stopes, showing relative grades of ore, on Rescue vein, Unity mine. (From G. T. Eyman)

Work below the crosscut level indicates good ore between the crosscut level and the 100-foot level, and some good ore between the 100 and the 200-foot levels. The greater part of the vein between the 100 and the 200-foot levels appears to be barren.

Mineralogically, the ore from this part of the Rescue vein is typical of other ore of the Warren district (see page 37). Calcite was observed in the vein west of the crosscut on that level and on the +400-foot level.

Three cars of ore from the winze near the 100-foot level gave a return of \$96 to the ton. This ore yielded about 6 pounds of concentrates to a ton and the concentrates are reported to be correspondingly rich. A sample cut across the 28-inch thickness of the vein at a point 60 feet east of the winze on the 100-foot level (see fig. 14) assayed 1.92 ounces in gold per ton.

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The stoped parts of the vein may have been different from the parts described above. Lindgren¹ describes the vein where he saw it in the upper levels as follows: "The vein forms a belt of crushed granite 1-1/2 to 2 feet wide, schistose in places and containing small veinlets of quartz inclosing minute foils of free gold, together with a little zinc blende, galena, and probably also tetrahedrite. The average width of the vein is said to be 3 feet, of which about 18 inches constitute the pay streak. In thin section, the quartz proves to be an entirely normal, well-crystallized vein quartz. The yield of the ore is from \$20 to \$50 per ton.**** The vein cuts a dark dike (minette) on the west side and faults it 4 feet. The dike contains much calcite, which is also common in the vein near the dike". This is the only known instance in the whole district where a lamprophyre dike is offset by a vein.

Silver King vein.

The Silver King vein lies on the hill east of Warren in the northern part of Sec. 12, T. 22 N., R. 6 E. Claims covering the vein are reported to be patented and to belong to the Sigo Myers estate of Savanna, Ga., the owner of the Iola.

The vein is said to have been worked between 1900 and 1906, and to have produced about \$35,000 worth of precious metals, much of it silver. It was opened by several crosscut tunnels from the hillside facing Slaughter Creek and three of the tunnels are located on Plate 1. The tunnel nearest the creek is reported never to have reached the vein. All of the crosscuts are now inaccessible except for the first few hundred feet and, hence, the vein was not seen underground.

The country rock in the vicinity of the Silver King vein is considerably altered and in many places contains tiny veinlets of quartz. Pegmatite in joints is common in the accessible parts of the crosscuts.

¹/Lindgren, Waldemar, op. cit., pp. 246 and 247.