STATE OF IDAHO
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IDAHO BUREAU OF MINES AND GEOLOGY
A. W. Fahrenwald, Director

THE DIXIE PLACER DISTRICT, IDAHO

By
S. R. Capps

with

NOTES ON THE LODE MINES

By
Ralph J. Roberts

Prepared in cooperation with the United States Geological Survey

University of Idaho
Moscow, Idaho
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THE DIXIE PLACER DISTRICT, IDAHO

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Abstract

This report presents the results of one of a series of studies of placer mining districts of central Idaho, carried out by the cooperation of the U. S. Geological Survey and the Idaho Bureau of Mines and Geology. Although mining was conducted largely by primitive methods in almost inaccessible areas, this region produced large amounts of placer gold in the last half of the nineteenth century. The richest deposits were soon exhausted, but better transportation, greatly improved mechanical equipment, and an increased price for gold have revived interest in the region.

In the mountains of central Idaho there are many high, gravel-floored basins, not yet deeply incised by the canyons of the Clearwater and Salmon rivers and their tributaries, some of which are known to contain workable placer deposits and others which may have commercial possibilities. If the potential value of these basins is to be assessed in advance of actual detailed prospecting and mining, an understanding of the physiographic history of the region is essential. In order to decipher that history, it seemed necessary to study a number of these basins in detail. The basins at Warren, Florence, and Elk City have been so studied. The present report deals with the Dixie Basin.

The Dixie district lies in the Clearwater Mountains of central Idaho about 90 miles southeast of Grangeville, the terminus of the nearest railroad. Placer gold was discovered in 1864, and mining was vigorously carried on for the next few years. The richest ground was soon exhausted, and for more than 50 years only desultory mining was done. In the 1890's, the district again came into prominence as a lode camp; a great number of claims were staked and ore was milled from a number of properties. Interest in lode mining has continued to the present time with varying degrees of activity. Within recent years, the great improvement of transportation to the district by the construction of a wire grade road up the South Fork of the Clearwater River to the vicinity of Elk City, and the revaluation of gold have stimulated interest in both placer and lode mining.

The present investigation included the mapping of about 7-1/2 square miles of the district on a scale of 1:24,000, an area which includes all of the placer mines and most of the lode mines of the vicinity. The prevailing bedrock includes granitic rocks of the Idaho batholith of probable Upper Cretaceous age, and considerable areas of ancient gneiss and quartzite, the host rocks of the batholith, which presumably may be correlated with the Belt rocks of northern Idaho. It was found that the Dixie Basin is a part of an old erosion surface which was faulted or warped below the general level of that surface, and which was partly covered to a depth of more than 700 feet by an ancient valley fill. The recent canyon of the major
stream, Crooked Creek, has now breached that depression, much of the old fill has been removed, and the headward tributaries of the stream have begun to intrrench themselves into the deeply weathered rocks of the old surface. The placer deposits are of two types: (1) residual placers, and (2) reconcentrations along the intrenched valleys.

The physiographic history of the district is discussed, the placer deposits are described, and a brief description is given of the more important lode mines and prospects.

INTRODUCTION

This report is one of a series of studies of mining districts in Idaho, carried out during the last few years by the cooperation of the U. S. Geological Survey with the Idaho Bureau of Mines and Geology. Much of that work was done by P. J. Shenon and J. C. Reed, whose attention was given principally to the lode mines and to areal geologic mapping. The output of precious metals, mainly gold, from central Idaho has, however, been produced principally from placer gravels at such camps as Florence, the Boise Basin, Pierce, Warren, Newcomb, and Elk City. Some of these camps yielded enormous returns during the Civil War and ensuing years, but, with the exhaustion of the bonanza diggings, activity waned, for only rich ground could be profitably worked in a region which at that time was almost inaccessible. Recently, however, that situation has changed. The revaluation of gold in terms of the dollar has made possible the exploitation of ground that before was too lean to be profitable. Furthermore, the perfection of such power-driven mining equipment as the dredge, the dragline scraper, and the bulldozer has decreased the cost of moving ground on a large scale. These changes have come at a time when great activity in road-building has made it possible to move heavy machinery to areas that earlier were almost inaccessible.

With these altered conditions in mind, it seemed timely to carry out a broad study of the alluvial deposits of central Idaho, with particular attention to the physiographic history of the region, for gold placer deposits are the direct result of the working of physiographic processes upon areas in which gold lodes occur. The physiographic history of this area is highly complex. The best approach to its solution seemed to be to make detailed studies of local areas to determine the sequence of events in them, and then to endeavor to correlate the history of these separate areas, and apply the facts learned to broader surrounding regions. Shenon and Reed had already made such detailed studies in the Elk City, Florence, and Warren districts. The study of the Dixie district was begun in 1927 (fig. 1). The following list of publications, while not exhaustive, gives the principal reports that pertain to the geology and mining development in this general area.

BIBLIOGRAPHY


Figure 1. Index map showing location of the Nezperce National Forest (stippled) and the Dixie district.


PRESENT INVESTIGATION

The field work upon which this report is based was begun on June 22, 1937, and ended on September 6. The writer was assisted in the field by Ralph J. Roberts and Royal Sorenson, to both of whom he is indebted for conscientious and able work. During all but the last few days of the season they were engaged in the preparation of a topographic map of the Dixie placer district which covered about 7-1/2 square miles on a scale of 1:24,000. This map is presented herewith (pl. 1). Unfortunately, time was not available in the field for mapping as much of the district as was desirable. The physiographic picture could have been presented much more clearly if the upper basin of Crooked Creek could have been mapped to its borders, and if the area between Olive Creek and the head of Dixie Meadows could have been completed. It was decided to map the area adjacent to Dixie Meadows, where the key to the structural history of the basin was found, and then to connect that area by a traverse up Crooked Creek with the placer-bearing portions of the upper basin. This map was used, as rapidly as it was completed,
GEOLOGIC MAP OF THE DIXIE PLACER DISTRICT, IDAHO COUNTY, IDAHO.

BY
S. R. Gage and R. J. Roberts
as a base for plotting the geology and the distribution of the placer gravels. The senior author is responsible for the first part of this report which deals with the physiographic history of the district and with the placer mines. During the course of the field work, especially the last week of the field season, Messrs. Roberts and Sorenson visited such lode mines as were active or accessible. Mr. Roberts later assembled the material for the section of this report which pertains to the lode mines. At the beginning of the field work, the writer was accompanied for two weeks by Mr. J. C. Reed, with whom he visited many critical areas in central Idaho. Reed's field work in preceding years in this region gave him an intimate knowledge of the general geology of much of it so that he was able to point out the salient features of the geology and the physiography, and to outline many of the problems which remain to be solved. Grateful acknowledgment is made here to the U. S. Forest Service for cooperation in many ways, and to many inhabitants of the district, particularly Messrs. L. J. Barrows and Gusta Miller of Dixie.

HISTORY AND PRODUCTION

The early history of placer mining in the Dixie district is only vaguely known, and estimates of the placer production are little better than surmises. It is reported that the first discovery of placer gold was made in August, 1864, on Dixie Gulch, apparently by some sympathizer of the Confederacy in the Civil War, then in progress, thus accounting for the name later given to the district. Mining was carried on vigorously on the shallower ground during the next few years, and a considerable settlement known as Midas was built on Fourth of July Creek, one-half mile above the junction of that tributary with Crooked Creek. The principal activity at that time was on Nugget, Dixie, and Upper Fourth of July and Olive creeks, and many ditches were constructed to bring water under head to the ground being mined. Most of the mining was done with simple equipment, using the old methods of ground sluicing the overburden, and hand-shoveling the pay dirt into sluice boxes. One somewhat more ambitious project included the construction of a large timber dam across Crooked Creek above the mouth of Nugget Gulch, and a ditch line from the dam on the east slope of the valley side to a point below the present town of Dixie. This project had for its aim the hydraulicking of the gravels in the valley floor of Crooked Creek, using a hydraulic elevator to lift the gravels sufficiently to give the necessary grade to the sluice boxes, insomuch as the grade of the stream is insufficient for that purpose. A considerable pit was excavated, but, since the gravels were found to be too lean to be profitable, the enterprise was abandoned.

For more than half a century, after the wane of the early placer activity, placer mining in this district practically ceased. The district, however, again came into some prominence in the 1930's, when vigorous prospecting for gold lodes was carried on. Many claims were staked, and active development and mining were done on many properties. This activity continued until about 1945 when it was found that profitable amounts of free gold ore occurred only at shallow depths and the treatment of base ores could not be made to pay in a locality so remote from transportation and from smelters.

The present era of revived interest in placer ground of moderate grade in the Dixie district has come as a result of the increased price of gold and of the road-building campaign which has so greatly improved transportation to this part of Idaho.

No precise record of the placer gold production of the Dixie district is available, and estimates of the amount vary widely. Thomson and Ballard \(^1\) estimate the total gold production up to 1924 as $1,500,000, but that figure also

included the gold produced from lodes, which, from other sources, has been estimated as from $150,000 to $700,000. Considerable placer gold, mined both by the early white miners and later by the Chinese, was never accurately reported or credited to this district.

The U. S. Geological Survey and the U. S. Bureau of Mines have collected statistics of production since 1901, and their figures of the combined lode and placer production from that date through 1936 are given in the following table by 10-year periods.

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<th>Gold Fine ounces</th>
<th>Silver Fine ounces</th>
<th>Total value</th>
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<td>1901-1910</td>
<td>882.65</td>
<td>69</td>
<td>$14,064</td>
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<tr>
<td>1911-1920</td>
<td>397.34</td>
<td>118</td>
<td>6,261</td>
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<tr>
<td>1921-1930</td>
<td>186.26</td>
<td>23</td>
<td>2,048</td>
</tr>
<tr>
<td>1931-1936</td>
<td>2,297.83</td>
<td>854</td>
<td>77,017</td>
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<tr>
<td></td>
<td>3,476.88</td>
<td>1,064</td>
<td>$101,410</td>
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The production by the placer miners in the early days of the camp will never be known. The amount of the lode gold production, as given in the above table, is very much less than that reported by the present owners of the various lode mines. The greatly increased production of the district for the period 1931-36, as shown in the above table, is due to the dragline placer mining operations on Crooked Creek. This increase was maintained in 1937 by the continuation of machine-mining on Crooked Creek and on Hundred Dollar Gulch, but it will fall off again in another year or so when the Crooked Creek ground is worked out.

GEOGRAPHY

LOCATION AND AREA

The Dixie district lies in north-central Idaho, in Idaho County, within the Nezperce National Forest and about 80 miles by road east-southeast of Grangeville, the county seat of Idaho County (fig. 1a). It includes the upper basin of Crooked Creek, a stream that flows southwestward into Salmon River. Although the Dixie district adjoins the Buffalo Hump quadrangle on the east, only a short stretch of Crooked Creek appears in the extreme southeast corner of that quadrangle. The scale of the Buffalo Hump sheet is too small to show the topographic features of that basin adequately for the purposes of this report. In this paper, the term "Dixie placer district" is used to include that portion of Crooked Creek Basin in which placer mining has been done and comprises the area which lies in the basin of Crooked Creek from its head to the canyon at the foot of Dixie Meadows. About 7-1/2 square miles of that area are shown on Plate I, the area mapped including all of the placer gravels which have been considered rich enough to mine. Several lode mines and prospects which lie outside the basin of Crooked Creek are commonly referred to as belonging in the Dixie district. Inasmuch as this investigation was concerned primarily with the placer deposits, the term "Dixie placer district" is here used in a somewhat more restricted sense.

TRANSPORTATION

The Dixie district is 80 miles from the nearest railroad, at Grangeville, which is the center of supplies for this region. The cost of transporting...
supplies for that distance through a mountainous country has always been an important item in mining costs. In the early days of mining, all supplies came by pack trail from Lewiston at the junction of the Clearwater and Snake rivers. Later, railroads were completed up the Clearwater to Stites and to Grangeville.

In 1904, a rough wagon road was finished from Stites into the Elk City district. Since this road crossed two high divides upon which snow lay late, the open season was short. Construction of a road from Grangeville into the canyon of the South Fork of the Clearwater and up the narrow gorge of that stream was begun in 1920. It was completed to Elk City by 1932. This is now an improved water-grade road, which is kept open the year round, from Grangeville to the junction of the American and Red rivers. The road from the mouth of Red River to Elk City is narrower and poorer, but passable. From Elk City an improved road now leads up Red River to the Red River Ranger Station, and a narrow dirt road extends southward to the mouth of Dixie Meadows, by which a truck makes tri-weekly trips with mail and express during the summer months. Although a tractor makes a weekly round trip with mail and supplies in winter, this dirt road becomes closed to ordinary traffic by the heavy winter snows. An extensive program of road-building has recently been carried on in central Idaho by the Forest Service and by the Civilian Conservation Corps so that many miles of roads, mostly narrow, unsurfaced, and with steep grades have been completed. One such road is available to the Dixie Ranger Station by way of Orogrande and Big Creek Valley. Another, now under construction, will run from the Red River Ranger Station past Jack Mountain and down the valley of Little Mallard Creek to the Salmon River. Construction is also under way on a main east-west highway up the canyon of the Salmon and some time this road will doubtless connect with the Dixie road.

As a result of these improvements in transportation during recent years, the Dixie district has at least some communication with the outside during the entire year, and heavy mining machinery can be brought in at a small fraction of what it cost in earlier years.

**TOPOGRAPHY**

The Dixie district lies within the Clearwater Mountains, which are characterized - over large areas in central Idaho - by sky-line ridges with long, nearly level crests, the erosion remnants of an ancient land surface of only moderate relief. That old surface, as originally developed, was a rolling plain with certain prominences, such as Buffalo Hump, Gospel Peak, and other conspicuous landmarks standing well above it as monadnocks, and numerous other minor irregularities. This ancient surface has now been partly destroyed by the deep erosion of the Clearwater and Salmon rivers and their many tributaries, which furrow the mountains with steep-sided canyons and valleys, some of which are now a mile deep.

There is evidence that in the uplift of the region there was minor faulting and deformation which dropped certain areas down below the level of the old surface. In the area west of Buffalo Hump, most of the oldest erosion surface now lies at altitudes between 7,000 and 8,000 feet, with the Buffalo Hump monadnock rising to nearly 9,000 feet. The Dixie district, however, lies in a portion of that surface which has apparently been dropped below its general level. There is a north-south depression from 15 to 20 miles wide, which extends from a point well north of the head of the American River southward to and beyond the Salmon. Most of the summit ridges in this depression lie below an altitude of 6,500 feet, well below the plateau surface to east and to west. In the Dixie district, the placer deposits in the stream beds vary in altitude from 5,050 feet at the foot of Dixie Meadows to 6,900 feet in Little Dixie Gulch. However, the summits of the ridges that border the basin rise to heights of from 6,300 to 6,600 feet. Crooked Creek drains this entire district, rising near Dixie Summit, 8 miles north of the town of Dixie, and flowing south and southwest to join the Salmon River. In the upper 10 miles of its course down to the mouth of Dixie Meadows this stream falls less than 1,000
feet through a basin of moderate relief. Below Dixie Meadows, it plunges into a canyon that becomes progressively narrower and deeper so that in its lower 10 miles the stream descends from an altitude of 5,060 feet to 2,075 feet.

There is abundant evidence that in this portion of the Clearwater Mountains the upper parts of most of the valleys that rise in the higher parts of the region where the summit elevations are 7,000 feet or more contained active glaciers during Pleistocene time. The former presence of glacial ice is attested by conspicuous glacial cirques, glacial lakes, moraines, and striated surfaces. In the Dixie district, however, the altitude of the surrounding ridges is not sufficient to permit the formation of glaciers.

CLIMATE AND VEGETATION

No weather records are available for the Dixie district. Grangeville, the nearest point at which such records are kept, situated outside of the mountains at a considerably lower elevation, has milder winter weather, warmer summers, and considerably less rainfall. It is estimated that the annual precipitation at Dixie is about 40 inches, most of which falls as snow during the winter months when only the main highways are open to traffic. In the higher parts of the country, many of the roads are blocked by snow until late June or early July. Summer precipitation is slight and falls only during violent thunder storms. Most of the summer the weather is dry and the roads dusty. In the summer, the days are likely to be clear and hot, and the nights cool. Killing frosts are to be expected every month of the year. There was heavy frost at Dixie on most nights during August and September of 1937.

The Dixie district is almost completely covered by a thick stand of coniferous trees (pl. II) so that it is difficult to find a point from which a view of the basin as a whole can be obtained. It is reported that in the early days of mining this district was completely burned over, and that the present trees are second growth. The commonest tree is the lodgepole pine, which is present to the exclusion of other trees over considerable areas. There are a few larch, Englemann spruce, and Douglas fir trees. The limber pine grows outside this district at elevations of 7,000 feet and over, and the Ponderosa pine in the canyons below 5,500 feet. Locally, some aspen trees are present. Although in the prevailing lodgepole pine forests travel is not difficult, brushy plants as willows and alders form a heavy underbrush in places. There is no timber in the Dixie area that is valuable for other than local uses. The few meadows along the stream flats furnish summer forage for livestock, but the altitude is such that the growing season is too short for agriculture.

GEOLOGIC HISTORY AND GENERAL GEOLOGY

The bedrock geology of this general region has been described in considerable detail by Lindgren 2, Livingston and Stewart 3, Shonon and Reed 4, and others, and, therefore, is summarized here briefly. This paper is concerned primarily with the gold placer deposits. However, the history of a gold placer deposit includes both the bedrock source of the gold, the later freeing of that gold from the associated gangue and country rock by weathering and erosion, and finally the transportation of the gold by streams and its placement in the gravels in whic


6.
Plate II. View southeastward across upper basin of Crooked Creek, showing dense timber cover.
it is found today. Gold placers can occur only in those regions where there are veins carrying metallic gold which have been exposed to weathering and erosion, and where there has been a concentration of the gold by the removal of lighter and more easily disintegrated and decomposed minerals with which it was associated. This concentration is accomplished because the gold is heavier than the associated minerals and because it is resistant both to decomposition and disintegration.

A short summary of the major events in the geologic history of this region will serve as a setting for the discussion of the placer deposits. Until middle Mesozoic time the prevailing rocks of this part of Idaho were ancient sedimentary beds that included quartzitic sandstones, shales, and limestones that are probably to be correlated with the Belt series, which is so extensively present in northern Idaho. These rocks were invaded at depth, probably during Cretaceous time, by tremendous masses of granitic rocks, now known as the Idaho batholith, which consisted mainly of granodiorite and quartz monzonite. These great intrusive masses profoundly altered the sedimentary rocks into which they were injected. Some of the sediments were so changed and recrystallized that their sedimentary character was almost obliterated. Others, less altered, were converted into quartzites, schists, and gneisses. Perhaps not all of these changes can be attributed to the granitic intrusion, however, for it is possible that some had been accomplished by dynamic metamorphism before the granites were intruded. After the granitic rocks had solidified, gold-and-silver-bearing solutions came in to form the lodes of the region. Later, dikes of a variety of rocks cut the altered sediments, granitic rocks, and veins.

During early Tertiary time, the region was subjected to long and deep erosion. Although large bodies of the altered sediments remain partly or completely surround ed by the intrusive materials, the sedimentary cover of the batholith was partially stripped off to expose the granitic rocks over wide areas. The surface of central Idaho was reduced to a region of moderate relief much nearer to base level than it is now with, however, certain unreduced areas standing as monadnocks above the general level of the rolling lowlands.

There is some evidence that by mid-Miocene time there had been a mild uplift of what is now the mountainous central portion of Idaho, that a second cycle of erosion had reduced portions of the old erosion surface to lower levels, and that it was this somewhat lower erosion surface upon which the Columbia River lava was poured out. Extensive lava flows flooded many thousand square miles of country west of the mountains and lapped against the edges of the mountains themselves, but there is no evidence that they ever reached as far eastward as the Dixie district. During the period of lava effusion, the drainage from the mountains was disturbed so that local gravel deposits and lake beds were laid down in certain basins near the borders of the mountains, and as a result of deformation in other basins within the mountains.

When the extrusion of the lavas ended, there was further uplift of the mountains, probably at the time that the lava-flooded area was sinking, thus raising the mountains high above the lava plains to the west. This movement was accompanied by some faulting and probably some warping within the mountain mass which resulted in the formation of basins having a general north-south trend. Throughout the mountain mass the streams, rejuvenated by the uplift, began to lower their valleys vigorously. It is probable that the uplift of the mountains took place as a series of relatively rapid movements, rather than a single, uniform movement over a long period of time. These intermittent uplifts are reflected in a series of more or less well developed erosion surfaces within the mountains. The last erosion cycle in which the region is now involved probably reflects both a major period of mountain elevation and the deep entrenchment of the master stream, the Snake River, into the lava flows and older rocks of its basin.
The present canyons of the Salmon and the South Fork of Clearwater rivers and their tributaries, while still being actively deepened, had already been cut almost to their present size and depth by the beginning of Pleistocene times. With the recurrent changes of climate which characterized the Pleistocene, glaciers could form in the higher portions of the Clearwater Mountains, and there is evidence that there were at least three distinct periods of glaciation in this region. Our knowledge of the exact age and extent of the two earlier stages is meager, but the evidences of the last stage, the Wisconsin, are still conspicuous as well developed glacial cirques, tarn lakes, moraines, and grooved and striated rock surfaces. The Wisconsin glaciers, radiating from the highland between Gospel Peak and Buffalo Hump, reached out as much as 6 or 8 miles and in places pushed down into the narrow canyons of the tributaries of the Salmon River. None extended much below an altitude of 4,000 feet, and none reached to either the main valley of the Clearwater or the Salmon. Within the Dixie district itself the altitude was insufficient to permit the formation of glaciers, and no evidence of their former presence there was found.

The amount of erosion which has taken place since the end of the Wisconsin glaciation is relatively slight. Some terminal moraines that lie in the narrow canyons still retain their original form; little filling has taken place in the glacial lakes, the bared bedrock of the uplands and the glacial boulders are fresh and little decomposed.

The geology of the Dixie district is shown on Plate I. In interpreting the map, the reader should realize that even on this scale the boundaries of the geologic units which are differentiated here must be generalized, for there are all possible gradations between the various units. For example, the gneissic rocks often include small areas of mica schist, quartzite, granite, and pegmatite; within the areas where quartzite prevails there occur some gneissic, schistose, and granitic rocks and some pegmatite veins; there are all possible gradations between massive granitic rocks and their gneissic equivalents; within areas in which granitic materials greatly preponderate there is some pegmatite and even small bodies of mica schist, some of which appear only in underground workings. Therefore, on the geologic map the patterns show the predominant rocks in the areas covered by them. All of these rocks lie in irregular belts which have a northwest trend, parallel to the foliation of the rocks, the principal structural features that prevail throughout most of the Clearwater Mountains. The structure is highly complex, and much remains to be learned about it. The invasion of the granitic magma was so pervasive that it has obscured the stratigraphic relations of the invaded beds. The following brief description of the bedrock geology of the region is condensed from the fuller report by Shenon and Reed 7, who spent several seasons in the study of adjacent areas. They recognize close folding in the Buffalo Hump area, and state that the folds existed before the intrusion of the igneous material.

Quartz-mica schist, while only sparingly present in the Dixie district, occurs over considerable areas in the Buffalo Hump district to the westward, and is apparently the oldest rock in the region. Its base is unknown for it is everywhere underlain by the granodiorite of the betholith. Locally, it is overlain by thick masses of quartzite. The schist is a dark gray or brown, fine-grained rock which is largely quartz and biotite with smaller quantities of muscovite, amphibole, pyroxene, feldspar, tourmaline, epidote, titanite, zircon, garnet, and apatite. Locally, it contains interbedded marble and in places is cut by pegmatite and aplite dikes. It reaches a maximum observed thickness of at least 1,000 feet. In the Dixie district, schist occurs only in small lenses and patches surrounded by granitic materials - and was not mapped separately.

7Shenon, P. J., and Reed, J. C., op. cit., pp. 10-17.
Quartzite that presents a variety of aspects is widely distributed in this region, and in the Dixie district it is present in considerable amounts from the mouth of Olive Creek to the mouth of Dixie Meadows. It occurs in bands having a northwesterly strike, parallel to the principal structural trend of the mountains. The commonest type is a white, granular rock in which the only obvious minerals are quartz and muscovite mica, but it also contains smaller amounts of a number of minerals that include various feldspars, tourmaline, titanite, zircon, biotite, apatite, amphibole, epidote, and garnet. Probably most of these accessory minerals are the results of alteration and impregnation by materials from the Idaho batholith. If present interpretations of the structure are correct, the quartzite overlies the quartz-mica schist, grades imperceptibly into gneiss and into the granodiorite of the batholith, and is locally cut by abundant pegmatite veins. Farther westward, it has an observed thickness of several thousand feet. Of the rocks in the district, it is the most resistant to decomposition and disintegration. Quartzite pebbles and fragments persist in a fresh state in gravels in which the granitic and gneissic pebbles have disintegrated completely.

GNEISS

The rocks have been classified as gneiss include a wide range of materials. Shenon and Reed 1 have described the various rock types in some detail, and believe that they consist primarily of the sedimentary rocks of the Belt series that have been altered and recrystallized into rocks that fall under the general classification of gneiss. They have been invaded by considerable quantities of the granitic rocks of the Idaho batholith. Just how much of the metamorphism of these rocks had taken place before the intrusion of the Idaho batholith is difficult to say, but it is believed that their metamorphism was already well advanced before that intrusion, and that further alteration and recrystallization took place as the result of the invasion of the granitic rocks. As the sedimentary materials show all degrees of alteration, from beds that are easily recognized as of sedimentary origin — in which only a moderate amount of recrystallization has taken place — to thoroughly recrystallized and impregnated rocks which grade imperceptibly into the granodiorites of the batholith, it is to be expected that the boundary lines shown on the map (pl. I) are drawn somewhat arbitrarily. The gneisses grade imperceptibly into the granodiorite on the one hand and into the quartzite on the other. There are, however, considerable areas in which most geologists would agree to name the rocks gneiss. Those areas have been differentiated, although the exact placing of the boundaries depends to some extent upon the personal judgment of the individual who does the mapping.

Most of the gneissic rocks, as much as several thousand feet thick, although they are in a part contemporaneous with the quartzites, are believed to lie higher in the section than the quartzites. They are certainly much older than the Idaho batholith, and had already been severely metamorphosed and folded before the granitic rocks were intruded. They are thought to represent a part of the Belt series.

The rocks considered as gneiss have been subdivided by Shenon and Reed into three groups, which they describe as (1) well-banded gneiss, (2) augen gneiss, and (3) poorly banded schistose gneiss and mica schist. The well-banded gneiss is composed mainly of oligoclase feldspar and quartz, but contains also biotite, muscovite, microcline, titanite, and apatite. The texture is granular with the micas arranged parallel to the direction of banding. This gneiss — little altered except near veins — is the prevailing type in the Dixie district.

The augen gneiss is characterized by the presence of numerous large microcline crystals and knot-like lenses of aplitic material. This phase is particularly abundant in the Elk City district, and was noted near Dixie Meadows, though

1Shenon, F. Jr., and Reed, J. C., op. cit., pp. 12-18.
it is not abundant.

The poorly-banded schistose gneiss and mica schist are present in minor amounts. It consists mainly of quartz grains associated with oligoclase, biotite, and muscovite, with minor amounts of accessory minerals. There are several varieties of schist interbedded with this gneiss.

GRANITIC ROCKS

Granitic rocks which include granite, oligoclase, granite, granodiorite, and quartz monzonite, and are a part of the great Idaho batholith, are the prevalent rocks in the northern part of the Dixie district. Although neither the lodes nor the placers are entirely confined to them, they form the country rock in which most of the gold lodes occur and in which most of the placer mining has been done. The granitic rocks intrude both the gneiss and the quartzite of the district. They are generally light-colored and are composed mainly of oligoclase, quartz, orthoclase, microcline, and microperthite in varying proportions, with some biotite and muscovite, locally some hornblende, and a suite of accessory minerals that include apatite, siron, titanianite, garnet, tourmaline, epidote, and a little pyrite and magnetite. They are mostly coarse-grained and porphyritic, and in many places show some evidence of gneissic banding. Pegmatite veins are common in them.

There is some difference of opinion as to whether the Idaho batholith is of late Jurassic or early Cretaceous age, or whether it is late Cretaceous or Eocene. Certainly it cuts early Mesozoic sediments, and is overlain by the Miocene Columbia River lavas. The evidence on this question has been summarized and discussed by Ross. 1

DIKE ROCKS

The granitic and metamorphic rocks of the district are cut by numerous intermediate and lamprophyric dikes, most of which are 20 feet or less in width, and trend in a general northeast direction. The varieties noted include augite and amphibole lamprophres, andesites, and quartz-diorite porphyries.

These dikes are similar in mineral composition. The plagioclase feldspars range from sodic oligoclase to sodic andesine. The commonest dark minerals are biotite and hornblende, although augite is present in some dikes. Quartz is present in all the specimens studied, but is abundant in only the quartz-diorite porphyries.

Some of the dikes which cut the old quartz veins and are thus younger than the veins are believed to have had no influence in the mineralization of the veins. This may apply also to all of the dikes, but this relationship has not been proved in all cases. Where dikes were observed cutting quartz veins, the intersections were at almost right angles, and the displacement of the veins was small. In the mine workings, the dikes are much altered, probably by acid waters derived from the decomposition of sulphides in the veins. These altered dikes, called "mud dikes" by the miners, form heavy ground, and, if of considerable size, require timbering.

REGIONAL PHYSIOGRAPHIC HISTORY

The development of the land forms that are now recognizable in central Idaho began after the intrusion of the Idaho batholith, which is generally believed to have taken place in Cretaceous time. Presumably the emplacement of so great a quantity of magma into the upper crust resulted in a domal elevation of the region.

The land so elevated was subjected to a long period of erosion during which several thousand feet of sediments were stripped off the surface, and the granitic rocks exposed over large areas. The region is believed to have been eroded to a rolling surface of moderate relief, or peneplain, above which a few residual hills, or monadnocks, rose to heights of as much as 1000 feet. The remnants of this ancient peneplain form a striking feature of the landscape in the Clearwater Mountains, as viewed from any high point in the area. Just west of the Dixie district there are considerable areas of that surface still preserved, such as Columbia Ridge and the high surfaces between Buffalo Butte and Gospel Peak. Viewed eastward and northward, most of the narrow skyline ridges have fairly level crests and merge into a rolling plain so that they appear to be remnants of a dissected plateau. In the vicinity of Buffalo Butte, that plateau surface has an altitude of between 7,000 and 8,000 feet, and appears to rise to the eastward toward the Bitterroot Mountains. Obviously, at the time that surface was carved there was much less local relief in this region than there is now, and the base level of erosion must have stood only a thousand feet or less below the plateau surface. It is likely that these mountains were then several thousand feet lower than they are at present.

The period during which the development of this peneplain took place is the subject of some controversy. In many places in the western mountains there are indications of extensive peneplanation and traces of many successive ancient surfaces, but it is unlikely that any two mountain ranges had precisely the same physiographic history. The correlation of an old surface in one region with that in another presents many difficulties. Mansfield 1 has discussed this problem and cited the literature that deals with this general region. He recognized a succession of erosion surfaces in southeastern Idaho which date from Eocene time to the present. The erosional history of the region under discussion has not yet been worked out. However, the old plateau surface is considerably younger than the Idaho batholith, and is therefore post-Cretaceous. It is certain also that that surface had been deeply dissected by the canyons of the Salmon and Clearwater rivers before the glacial invasions which took place during the Pleistocene. The portion of the Clearwater Mountains which lies north of the Salmon River in the basin of the South Fork of the Clearwater River, shows two well developed erosion surfaces below the summit level peneplain and above the present canyons of those streams. It appears likely, though not yet finally proved, that the uppermost flows of the Columbia River basalt were poured out upon a surface cut about 1,000 feet below the summit level. If that proves to be the case, then the high plateau surface was developed, was elevated, and a later extensive surface developed below it by middle Miocene time.

Geologic evidence with which to date the events which occurred between the extrusion of the Columbia River basalt and the latest or Wisconsin stage of glaciation is meager. However, we know that among those events there was the first, the block faulting and probably also minor folding of the old plateau surface; second, a probable uplift of the region resulting in the filling by lake and stream deposits of the basins formed by faulting and warping; third, the erosion of a third surface, below the older two already mentioned, with partial removal of the basin filling; fourth, erosion of the deep canyons of the Salmon and Clearwater rivers and their tributaries, perhaps in part as a result of renewed elevation of the mountains, and in part due to the deep cutting of canyons by the master streams, the Snake and the Columbia rivers, with further removal of basin filling; fifth, at least three episodes of Pleistocene glaciation, with the formation of cirques in those highlands that reached an altitude of about 7,000 feet or more; sixth, the deployment of valley glaciers radially from those highlands down to elevations of 5,000 feet or even less.

Since the disappearance of the last Pleistocene glaciers, there has been little change in the surface aspect of the country. Canyon deepening has proceeded, but, by late Pleistocene, the canyons had already been cut almost to their present depth. The Wisconsin glacial moraines are still fresh and little modified by erosion, and the glacially-scoured rock surfaces are fresh and little decomposed.

In discussing ancient erosion surfaces which are still recognizable, many writers seem to make the tacit assumption that those surfaces seen today are actually the same surfaces that existed in times long past. A thoughtful consideration of the facts will convince one that that can not be so. All of the pre-glacial but unglaciated erosion surfaces in this region show deep chemical decomposition and deep mechanical disintegration of the underlying rocks, particularly of the granitic, gneissic, and schistose rocks. The quartzites are most enduring, and show least chemical change, but even they show shattering, fracturing, and comminution to considerable depths. To imagine that old, high surfaces covered by such loose materials have escaped considerable lowering through erosion is to disregard the processes now evident. These old surfaces have been exposed for long intervals to running water, wind, soil creep, and the activities of burrowing animals and insects. No one can state with confidence the rate of this kind of erosion. However, it seems that the oldest plateau surface, possibly of early Tertiary age, has been lowered tens, and perhaps a hundred feet or more during the long ages in which later cycles of erosion developed at least two surfaces a thousand feet or more below the oldest one, and during which the mile-deep canyons of the Salmon and Clearwater rivers were carved. Similarly, but in lesser degree, the two post-plateau but pre-canyon surfaces must also have been lowered considerably during the period of canyon-cutting. The old surfaces we now recognize are, therefore, not the surfaces actually carved in time long past, but are the descendants of those surfaces, somewhat lowered, to be sure, but bearing inherited characters which can still be used to determine their relative ages. Where Pleistocene glaciers were formed, they grew upon all of the older surfaces, extending from the oldest plateau surface down into the relative young canyons of the tributaries of the Salmon and Clearwater rivers. By their rapid erosion, they destroyed those surfaces by imposing on them characteristic cirques of Pleistocene age.

PHYSIOGRAPHIC HISTORY OF THE DIXIE DISTRICT

In attempting to reconstruct the physiographic history of the Clearwater Mountain region the logical approach to the problem seems to be to study certain typical areas in detail, determine the sequence of events in those areas, then to try to correlate those events between such areas and thus to construct a chronology into which the broader features of the whole region can be fitted. Such studies have been in progress for a number of years by Mears, A. L. Anderson, F. J. Shennon, J. C. Reed, and others, in cooperation between the U. S. Geological Survey and the Idaho Bureau of Mines and Geology. Detailed studies have been made of the Elko City, Craigmore, Buffalo Hump, Terminus, Florence, Warren, Thunder Mountain, and Edwardsburg districts of Idaho and Valley counties, and of other districts in surrounding areas. In most of these studies, however, the principal attention of the writers was focussed upon the bedrock geology and the lode deposits, although all made important contributions to the understanding of the development of the land forms. In the present investigation, the emphasis was placed on the physiographic history and its influence upon the placer deposits of the region.

So far as is now known, the chief events in the physiographic history of the Dixie district are as follows:

In early Tertiary time, this district, like the surrounding province of central Idaho, was reduced by erosion to a mature, rolling surface that approached
and has been frequently referred to as a pediplain, above which a higher area, parts of which stood as much as 1,000 feet above the pediplain surface, rose to the west. This pediplain was later elevated about 1,000 feet and a new, lower erosion surface developed over considerable portions of it, although many of the higher ridges and some larger portions of the old plain still survived. In Miocene time, tremendous volumes of basaltic lava were poured out in the Snake River basin to the west of the Clearwater Mountains. As successive lavas were extruded, they lapped up against the base of the mountains, apparently onto the western edge of this second oldest erosion surface. There is no evidence, however, that the lavas ever reached as far east as the Dixie district. Some time after the accumulation of lavas had ceased, the region was subjected to deformation by block faulting, and possibly also by the local subsidence of long, shallow, synclinal troughs. Within the mountains, but near their western edge, block faults with a general northerly trend, which displace the lava flows from a few hundred to a thousand feet or more, have been recognized at several places. Further east, beyond the area to which the lavas reached, faults are difficult to recognize because the stratigraphic horizons useful as data planes are lacking. The physiographic evidence is strong, however, that faults occur there too, and, like those faults that have been mapped, these inferred faults have eastward-facing scarps, with the western edge of the fault blocks depressed. This deformation disturbed the surface drainage, in places forming enclosed, rock-bounded basins into which the streams carried detritus and in some of which temporary lakes formed. The Dixie district itself is such a depression, and may be part of a broad depressed area which extends from the Elk City district south to the Salmon River. Possibly the Dixie area is a portion of an erosion surface that had already been developed well below the higher plateau before it was depressed. The boundaries of this depression are somewhat irregular and its origin is not clear. If it were formed by faulting, the fault scarp has been so destroyed by erosion that it can not now be closely traced. Certain zones of intense shearing along the west side of the basin suggest faulting as the agency involved. In whatever way it may have been formed, the Dixie basin shows certain features which seem best explained by the deformation and depression of a portion of an old erosion surface.

Even a superficial examination of the physiographic features of the basin of Crooked Creek reveals the fact that that basin has had an unusual history. As one descends Crooked Creek from its head, one passes first into a mature landscape of rounded interstream ridges and wide, flat-floored tributary valleys in which there are extensive marshy meadows, as in Horse Flats and in upper Nugget Gulch. Somewhat farther downstream, Crooked Creek and its tributaries flow in rather narrow valleys entrenched 200 to 250 feet below the level of an upland surface characterized by flat-topped interstream ridges of deeply decomposed granite. In this stretch, the tributary streams from the west rise in open meadows which are a part of the upland surface. There are no important tributaries from the east. A quarter of a mile below the village of Dixie, Crooked Creek enters a narrow, steep-walled canyon through which it flows for 3 miles to the head of Dixie Meadows, a wide flat of low gradient that is a mile and a half long, and averages about 800 feet wide. At the lower end of these meadows, the stream plunges into a narrow, steep-walled, rock canyon through which it flows by a steep gradient to its junction with the Salmon River.

An inspection of the accompanying geologic map shows that the features of this basin already mentioned are not the result of the varying resistance to erosion of the different types of bedrock. All of the different rocks in the basin are hard and resistant, particularly the quartzite, yet the Dixie Meadows basin lies largely within a belt of quartzite. The canyon between the village of Dixie and Dixie Meadows crosses alternating belts of gneiss and quartzite without noticeable change in its character, and without being deflected along the strike of the bedrock structure.
Figure 2. Longitudinal profile of Crooked Creek, vertical scale exaggerated, with cross profile of Crooked Creek Valley just below the mouth of Lake Creek.
It is obvious that the erosional history of the various parts of this basin is different. The lower, deep canyon below Dixie Meadows is plainly the result of headward erosion of Crooked Creek in response to the deepening of the Salmon River Canyon (fig. 2), but the basin above that canyon is related to an earlier erosion cycle. However, no obvious bedrock channel for the ancestral stream below the Meadows can be traced. The Crooked Creek basin at the Meadows is carved in bedrock to a depth of about 750 feet and is completely rock-enclosed except for the narrow, youthful canyon which now drains it. The head of this youthful canyon marks the upstream point to which the canyon-cutting of lower Crooked Creek has proceeded.

We have then a stream occupying a basin, the upper half of which is mature (fig. 3), and the lower half very youthful (pl. III-A, III-B). It seems evident that the stream, while developing a mature topography in its upper course, discharged its waters southward beyond Dixie Meadows by some route other than that now followed through the deep, narrow canyon below the meadows. However, no other bedrock outlet, which is sufficiently low to drain the meadows, exists. The only reasonable explanation of this anomalous condition, which seems to satisfy the existing facts, is that the mature, upper basin of Crooked Creek was developed as a part of the ancient landscape before the present canyon of the Salmon River was cut, and while the base level of erosion in this district stood almost 3,000 feet higher than at present. This old, mature land surface was deformed either by faulting or warping, with the result that the portion of Crooked Creek basin in the vicinity of the Meadows was depressed about 750 feet or more below the level of its former drainage outlet, and an enclosed rock basin of that depth formed. If that depression had been formed rapidly, a lake would have resulted; if slowly enough, the basin would have filled with sediments as rapidly as it was lowered, and the stream would have maintained an outlet across the lowest point of the basin rim. The character of the fill in the vicinity of the Meadows indicates that the basin sank slowly. A prospect hole in the Meadows is reported to have penetrated to a depth of about 50 feet without reaching bedrock. No log of this pit was obtained so that it is not known whether or not any of the material excavated was such as would be deposited in a lake. However, the depth reached indicates, first, that the bedrock floor of the basin lies below the rock channel of the creek at the outlet of the Meadows, and, second, that the canyon below the Meadows has not yet been cut low enough to completely drain the basin.

The character of the remaining valley fill on both sides of Dixie Meadows suggests that the subsidence of the basin took place very slowly. As shown on Plate 1, there are large areas on both sides on which there is no rock outcrop, although road cuts give sections up to 10 feet deep through the surface material. That material shows very little gravel, most of the rock fragments being angular, although in places well-washed pebbles may be found up to an altitude of 5,800 feet. Most of the fill is believed to be of local origin, and to have worked its way down the mountain slopes into the basin by a process of surface creep. The bedrock on the ridge tops is deeply weathered and decomposed. Since quartzite is the prevailing bedrock, the fragments in the fill are also mainly quartzite. Road cuts at and above the upper edge of the fill show a gradation from fine, soil-like material at the surface to increasingly coarse and abundant rock fragments at a depth of a few feet. This broken material grades downward imperceptibly into jointed and shattered bedrock. These cuts also show that soil creep on the hill-sides is active, with the rock fragments pulled loose from the fractured bedrock following curving lines of flow down the slope. In the unconsolidated fill of the basin, fragments of quartzite are abundant, but granitic and gneissic pebbles and rock fragments are completely absent even though gneissic rocks containing granitic layers are present in places around the borders of the basin. This absence of granitic materials in the fill is believed to be due to the great age of the
Plate III-A. View northward from foot of Dixie Meadows, showing mature character of this part of Crooked Creek basin.

Plate III-B. View westward from foot of Dixie Meadows, showing narrow, youthful, rock canyon through which Crooked Creek leaves Dixie Meadows.
fill, an age sufficient to have allowed the granitic rocks to disintegrate, leaving the much more resistant quartzite fragments. Throughout this general region the Tertiary deposits are characterized by the complete decomposition and disintegration of all granitic boulders and pebbles.

To review the events of Tertiary time that have been responsible for the development of the features we now find in the Dixie basin, we have the following sequence:

1) The development of a mature erosion surface, or peneplain, probably during early Tertiary time.

2) A lowering of the base-level of erosion and the development of a lower erosion surface about 1,000 feet below the older, high-level peneplain. This lower surface was locally mature, but large areas of the older high surface remained.

3) The outpouring of the Columbia River basalts to the west of the mountains, and the overlapping of the latest flows upon the western edge of an old erosion surface, probably that surface which lies about 1,000 feet below the older summit-level surface.

4) Block faulting and possibly warping, with the development of many narrow depressed basins in the mountainous areas, some completely rock-enclosed.

5) The filling, as fast as subsidence took place, of the rock-enclosed portion of the Crooked Creek basin, mainly with detritus that crept down the steep bordering slopes. This filling reached a maximum thickness at Dixie Meadows of about 750 feet.

6) At the time of maximum fill Crooked Creek was superposed over its present canyon between Dixie and Dixie Meadows, and had an outlet along the general route of the canyon below the Meadows, but at an altitude about 750 feet higher than at present. In its upper basin, it flowed at the level of the inter-tributary ridges.

7) The whole region was rejuvenated by mountain uplift, or by the lowering of the base-level of erosion on the Snake and Salmon rivers, or both; these streams cut their canyons to a depth of almost a mile below the uplands, and their tributaries pushed lateral canyons back into the upland. The canyon of lower Crooked Creek worked headward and began to trench the rock rim of the enclosed basin of Dixie Meadows. As this rim was lowered the basin fill was removed and Crooked Creek above the fill began to cut a trench in the deeply decomposed bedrock. This stage is still in operation. As erosion of the canyon below the Meadows progresses the canyon will work headward through the Meadows, removing the fill to bedrock, and rejuvenation will hasten the valley deepening to the head of the stream.

8) In the higher parts of the region vigorous glaciers formed in Pleistocene times. There is evidence of at least three distinct glacial advances in this general region, but the Dixie district stood at too low an altitude to favor the formation of glaciers, and remained free of glacial ice.
Figure 3-A. Cross profile of Crooked Creek Valley one-half mile north of Dixie. (Horizontal scale same as vertical 1:24,000)

Figure 3-B. Cross profile of Crooked Creek Valley at Dixie. (Horizontal scale same as vertical 1:24,000)
9) The cutting of the canyon below Dixie Meadows proceeded at varying rates, periods of relatively rapid cutting alternating with periods of slower erosion. This resulted in the formation of terraces at various levels in the Dixie Meadows fill (fig. 3-B). At present, erosion is proceeding at a relatively slow rate, and the stream has developed the broad flat which constitutes the Meadows.

ECONOMIC GEOLOGY

The geologic events listed above have had a controlling influence upon the formation of workable lode and placer deposits in the district. The lode deposits are believed to be genetically related to the Idaho batholith, which supplied gaseous and hydrothermal mineralizing emanations that penetrated the chilled and fractured outer portion of the batholith itself and into the enclosing country rock, replacing and altering the country rock, and depositing ore minerals and quartz as veins and as disseminated deposits along zones of shearing. These veins and disseminated deposits constitute the lodes of the Dixie district, and are the sources of the placer deposits. They were formed soon after the intrusion of the Idaho batholith, probably in Upper Cretaceous times. At some later period, but probably before the pouring out of the Columbia River lavas, lamprophyre and other dikes, which cut both the country rock and the lode deposits, were injected, but these apparently had little effect upon the gold lodes.

Inasmuch as the lode deposits were formed at considerable depths below the surface, the long period of erosion which followed the intrusion of the batholith was necessary to strip off the cover deeply enough to expose the lodes, and so make them accessible to the prospector. Likewise, further erosion of the lodes was required before placer deposits could be formed. Still later, the faulting and downwarping of the old erosion surface formed depressions in which ancient placer accumulations were preserved. The latest important physiographic events in the region include the rapid cutting of the deep canyons of the Salmon and Clearwater rivers and their tributaries, and the occupation of the higher parts of the region by glacial ice. The development of the many deep canyons, occupied by rapid, and at times torrential, streams tended to disperse the concentrations of placer gold which had accumulated. The action of glacial ice also removed and scattered any placer deposits which lay in the course of the glaciers. The existing placer, except for certain benches which lie along the canyon sides, are for the most part found in those parts of the old erosion surface that were depressed by faulting or folding; that lies at too low altitudes to have been glaciated; and that have not yet been denuded by the development of deep, youthful canyons through them.

In the Dixie district, there are two distinct types of placer deposits which, however, grade into one another. One type includes the thin, residual placer deposits such as those in the heads of Olive, Fourth of July, Dixie, Nugget, and Horse Flats creeks, in which the rock fragments are angular or little rounded pieces of quartz, lying on deeply decomposed granite bedrock, with pebbles or boulders of granite completely absent. These materials have been scarcely moved by streams. The gold has been released from quartz veins in the immediate vicinity by the disintegration, decomposition, and gradual removal of the surrounding granitic bedrock, the oxidation of the sulphides, and the disintegration and comminution of the quartz. As the lighter rock materials were broken down and removed by erosion, the inert and heavy gold particles remained. When sufficient gold-bearing rock had been worn away, residual placer deposits were formed. Placers of this type supplied much of the richer ground mined in the early days of this camp, and in other areas in the region, notably at Florence, yielded rich diggings. These residual placers have required very long periods of time for their
formation, and are found on portions of the old erosion surface where rock decomposition and removal have been uninterrupted since Tertiary times.

The second type of placer deposit in the district is much younger, and has been formed by the reconcentration by streams of gold from the residual placers. This reconcentration has taken place along the valleys of those streams that have entrenched themselves below the mature upland surface, the incurement being the result of the lowering of the base-level of Crooked Creek by the deepening of the canyon below Dixie Meadows, and the removal of the old valley fill in the Meadows. This rejuvenation has affected Crooked Creek to its head. Through the Meadows the stream flows over the remnants of the old fill and is 50 feet or more above the bedrock floor. Above the Meadows it has entrenched itself into a rock-walled channel which is incised into the old, mature erosion surface. This youthful channel lies in a narrow, steep-walled canyon that extends from the head of the Meadows to within a fourth of a mile of the town of Dixie. Within that stretch Crooked Creek has cut its valley from 200 to 500 feet below the level of the old surface, the depth of the canyon decreasing upstream. At the mouth of Olive Creek the canyon is 450 feet deep. At Dixie, the valley is wider, and the stream flows some 200 feet below the level of the interstream ridges to the west. This depth is maintained nearly to the head of the stream. In the entire distance between the head of the Meadows and the head of Crooked Creek all the important tributary streams enter from the west, and Crooked Creek flows asymmetrically in its broad basin, hugging closely to the eastern edge. In response to the incurement of Crooked Creek below the clear surface, all the tributaries from the west have also deepened their troughs and join Crooked Creek through youthful valleys. This is particularly true of Olive Creek and Hundred Dollar Gulch, which join the Crooked Creek Canyon where it is deepest, and which have consequently steepest gradients. In all of these tributaries, however, rejuvenation is still incomplete, the interstream ridges have fairly flat, little dissected, tops, and the headward reaches of the valleys have mature slopes representing portions of the old erosion surface which have not yet been modified by the incurement of the present youthful erosion cycle. Thus, in the upper portions of these tributaries there is a zone where the old, residual, placer deposits merge almost imperceptibly into the reconcentrated placers that occupy the entrenched portions of the valleys.

In a general way, it may be stated that the residual placers, or "skin diggings," which have been mined, have yielded a larger amount of gold to the cubic yard than have the stream placers. This higher gold content is in part due to the fact that the residual placers are localized in the immediate vicinity of the outcrops of gold-bearing veins, and the gold, therefore, has not been dispersed by streams; and, in part, to the fact that the residual deposits lie at high altitudes in the headward portions of the valleys where it is hard to get water under pressure, where mining by hand methods was expensive, and only the best ground was worked. It is reported that some of the reconcentrated gravels in Dixie Gulch were exceptionally rich.

As has been stated, some of the residual placer deposits grade imperceptibly into the secondary stream placers, and a classification of the placers into these two types can not always be consistent. It is reported that the earliest placer discovery and the earliest mining, in 1864, was in Dixie Gulch where the residual deposits of the upper valley merge downstream into stream placers. All of the residual placer ground which could be mined profitably was worked out during the early days of the camp. Although some ground is said to have been very rich, no reliable reports, either of the tonor per cubic yard or of the total amount of gold recovered, can now be obtained. Soon after the discoveries on Dixie Creek, similar residual deposits were found and worked in the headward basins of Nugget, Fourth of July, and Olive creeks. The most extensive mining of this type was
carried out on Fourth of July Creek, and a settlement known as Midas, now in ruins, was established half a mile above the mouth of that stream. In recent years, only desultory, small-scale mining has been done on the residual deposits. Because placers of this type are not well adapted to mechanical development on a large scale, little interest has been shown in them. In the 70 years or more since this type of mining was active, many of the abandoned pits have been overgrown with brush and trees and the tailings, discharged down the streams, have also been covered with vegetation so that in some places it is now difficult to recognize the areas which have been mined. It is possible that some such areas were overlooked and are not shown on the geologic map.

DESCRIPTION OF PLACER MINES

During the summer of 1937, active placer mining was being carried on by only three outfits which had mechanical equipment, and by a few individuals who were attempting to recover a little gold by the primitive methods of sluicing with rocker or long tom. Preparations were under way by one group to mine by means of a home-made drag line excavator. The following descriptions of the old end of the present mining operations will be given geographically by creeks. The operations on Crooked Creek itself will be described first, and then the tributary streams beginning with Olive Gulch and proceeding northward to the head of the basin. Descriptions of the old, abandoned operations are necessarily brief for most of the miners who worked them have left the camp long ago and the only information obtainable is that which can be gotten by an examination of the old pits.

Crooked Creek

From time to time, since the early days of this camp, attempts have been made to exploit the placer gravels of Crooked Creek, but until recently none of these has been successful. During the boom days of the district, a rather elaborate plan was carried out to mine the flat at the present town of Dixie by hydraulic methods. A large wooden dam was built across Crooked Creek Valley just above the mouth of Nugget Creek, and a ditch was constructed from the dam along the east valley wall to a point opposite the present town of Dixie to supply water under head. A hydraulic elevator was constructed to lift the excavated material for the gradient of the creek is too low to provide a dump for the tailings. The material was piped to the elevator by a hydraulic gant. A considerable pit was excavated, but evidently the grade of the ground was too low to permit profitable mining and the attempt was abandoned. Furthermore, the water supply in an ordinarily dry summer, such as that of 1937, diminishes so greatly that, even with storage behind a dam, sufficient water for piping and sluicing would be available for only a short time each day.

At several places in the canyon between Dixie and the Meadows, the dumps of old placer workings can still be recognized, but nothing can now be learned about those operations. Lately, an attempt was made to open up the ground in the flat just south of Dixie by using a drag line scraper to excavate a bedrock drain. A ditch over half a mile long was opened. Since numerous boulders were encountered and the gold content was disappointingly low, the attempt was abandoned without sluicing any ground.

Dixie Meadows

A lowland area on Crooked Creek, known as Dixie Meadows, lying near the Dixie Ranger Station and above the deep, lower canyon of Crooked Creek, has possibilities for placer mining. The history of the Meadows, formed by the deformation of an ancient erosion surface, has already been discussed. The Meadows occupy an
area which is 1-1/2 miles long and averages 800 feet in width. Although reports state that an old prospect pit was sunk to a depth of nearly 50 feet without reaching bedrock, little is known about the thickness, character, or gold content of the materials of the valley floor. It is evident that the prospector who sank the pit did not consider the ground promising for no mining was attempted, but recent improvements in transportation to the district, increased efficiency of mechanical mining methods, and the increased price of gold, may have changed the outlook. Certainly, there is a large yardage of material in the basin, and the bed of the stream which drains into it, carries gold. It would seem that a test of the gold content of that area is justified. Since the Meadows form the landing field for the district, and afford a pasture for the Forestry pack animals, some difficulty might be encountered in getting a permit from the Forest Service to mine there.

**Dixie Placers**

Much the largest placer operation ever conducted in this district is that of the Dixie Placers, now mining on Crooked Creek. This company is operated by W. M. Beller and L. J. Burrows, who own a continuous stretch of ground 19,000 feet long that occupies the valley of Crooked Creek from a point 2,000 feet below the town of Dixie to the mouth of Horse Flats Creek. Mining began on this ground in 1935, and since then has continued actively during the summers. The crew consists of 7 men, 4 on the day shift and 3 on the night shift. The property is equipped with a 66-horsepower Northwest dragline scraper on treads, with a 45-foot boom and a 3/4 yard bucket. The dragline delivers the gravel to the hopper of a separate screening and sluicing unit (Fl. V), which includes a 23-foot by 42-inch trammel from which the oversize goes to a 36-foot by 24-inch belt stacker, and the undersize to four sets of sluice boxes lined with burlap, covered with wire netting. Tailings from the sluice boxes are elevated and discharged to the stacker belt. Water for the trommel and sluices is pumped from a sump and recirculated for the creek supply is inadequate in the dry season.

In ordinary practice, a 60-horsepower caterpillar bulldozer is used to strip off the surface muck and barren material. During the night shift, the dragline is also employed in stripping and stacking the waste to one side, sluicing being carried on only during the day shift. The ground averages about 10 feet in depth, and of this only the lower one-fourth to one-half is sluiced. The capacity of the plant is 1,000 to 1,200 cubic yards of ground per day. Only about one-third of the material handled is put through the sluice boxes. By September 1, 1937, about 8,000 linear feet of the creek gravels had been mined, the out having an average width of between 200 and 300 feet. About 400,000 cubic yards of material had been moved. Since large granite boulders were so abundant in it that mining was not profitable, a stretch some 800 feet long was passed over between Boulder and Dixie creeks. The average tonor of the ground so far moved is about 20 cents a cubic yard, the gold running from 845 to 875 fine. The gold, some of which is shorty and some flat, is fairly coarse and moderately worn. Numerous pieces weighing as much as one-half pennyweight are recovered, but pieces of one pennyweight are rare. The bedrock throughout the area mined is deeply decomposed granitic material or gneiss, so thoroughly disintegrated that it breaks down into arkosic sand. One and one-half to two feet of the bedrock is customarily mined and washed. In places, andesite and lamprophyre dikes cutting the granitic rocks are encountered. Some of these dikes which have resisted decomposition much better than the enclosing granitic rocks are still hard and firm, and appear in the tailings as hard, angular blocks.

The section exposed in this placer mine shows some interesting and puzzling features. Figure 4 is a representative section which can be duplicated at many
Figure 4. Section of placer deposit on Crooked Creek, one-half mile above mouth of Fourth of July Creek.
Plate V. Dragline excavator and washing plant of Dixie Placers on Crooked Creek.
places along the creek. The deeply decomposed granitic bedrock and the surficial layer of peat and muck in which the stream is now flowing indicate that the deepening of the valley floor has progressed slowly, and that erosion has not been vigorous for some time. The surprising feature is the presence of great, angular, or partly rounded, granitic boulders scattered through the layer of well rounded stream gravels, and through the surface layer of peat and muck. The rounded gravels range in size from pebbles to cobbles a foot or more in diameter, but few are encountered that are too large to put through the trommel. This washed material includes granitic rocks, dike rocks, gneiss, quartz, and a little quartzite, all of which are found in place in this basin. Apparently the gravels are entirely of local derivation. The large boulders, many of which are as much as 6 or 8 feet in diameter, and weigh many tons, occur in the washed gravel, in the muck. Many of the boulders show on the surface, only partly buried in the muck. They are mainly granitic and invariably correspond to the bedrock of the adjacent valley walls. Evidently they have not been moved far by the stream for they are sharply angular. Boulders or blocks 6 feet or more in diameter lie embedded in rounded gravels whose maximum size is 2 feet, without any boulders of gradational sizes between. Moreover, these great boulders and blocks are most abundant in the muck where there is no closely associated washed gravel at all. Local opinion is that these large boulders are of glacial origin, but there is no other evidence that glaciers have ever invaded this basin.

A pertinent fact is that in those places where the valley floor is widest, and where the valley walls have moderate slopes, the great boulders are few or absent. However, in those stretches where the valley floor is narrow and the walls steep, they are most plentiful. Adjoining the stretches of abundant boulders there are rock outcrops in which rounded boulders of weathering stand out in high relief (pl. IV). There seems to be little doubt that the great boulders now found in the valley floor deposits are fragments of the bordering country rock which have reached their present position, either by rolling out onto the stream flat from the steep valley walls or by a process of surface creep. Their presence adds greatly to the cost of mining. In ground where the margin of profit is small, it has been found profitable to leave those stretches, where they are most abundant, unmined. The owners of the ground report, furthermore, that the gold values are less in the bouldery areas than in those stretches where they are few.

Another unusual feature of this placer ground is the surficial layer of peat, muck, and logs through which the stream now flows. This layer indicates that this portion of Crooked Creek has not been deepening its bedrock channel for some time, but has been sluggish and has carried little rock debris. No obvious cause for this period of slow erosion is evident for it would be expected that the gradual deepening of the canyon below Dixie Meadows would keep Crooked Creek vigorous to its head. The possibility is suggested that damming of the valley by beavers for a long period of time may be responsible for its lack of erosive power. Beavers still inhabit the headward portion of the valley above the placer workings, and any one familiar with valleys in which there is a series of beaver dams will realize that in such places erosion is effectively blocked, and that there is every opportunity for silt, muck, and peat to accumulate.

In the history of the development of the present valley deposits of Crooked Creek, it is possible that during the last period of glaciation in this general region this basin, although beyond the area to which glacial ice reached, nevertheless was near the borderline of glacial conditions and had a severe climate in which vegetation was much sparser than it is today, and during which the precipitation may also have been heavier. Under those conditions, erosion may have been rapid, the creeks would have secured to bedrock, and the gold-bearing gravel deposits would have been laid down above bedrock. Although still fairly firm, the
Plate IV. Boulders of weathering near Dixie. Similar boulders have rolled or crept into the gravels and muck of the stream placer deposits.
abundant granitic boulders and pebbles in the gravel show some signs of decomposition and oxidation, which indicate an age that is not older than Pleistocene, but which is considerable, nevertheless. With the amelioration of climate which followed the end of the glacial period, vegetation became abundant, and in this basin in which the summer run-off is very small the vegetation may have retarded stream erosion so that the peat and muck accumulated. Furthermore, as vegetation re-established itself in the higher parts of the area this district again became habitable by beavers. They built their dams and ponded the streams so that erosion was retarded and more peat and muck accumulated.

The owners of Dixie Placers estimate that they have enough ground left to keep their equipment busy during the summer of 1936. Unless other adjacent ground is found to contain pay, such as that of Crooked Creek above the mouth of Horse Flats Creek, or in Horse Flats, the equipment will be moved elsewhere and the enterprise abandoned. In that case, only small, disconnected patches of placer ground will be left on Crooked Creek, and those too lean to justify mining under present conditions. As much as the Crooked Creek gravels can now be profitably mined only by a company supplied with effective machinery and with skillful management, the future of placer mining in the upper basin of this creek does not appear bright.

Olive Gulch

At its lower end, Olive Gulch is a deep, canyon-like valley, incised over 400 feet below the level of the old, high erosion surface of which the bordering ridges are remnants. For 1-1/4 miles above its mouth, the creek bottom is narrow, and the alluvial deposits are thin. In this stretch, there is some evidence of old placer workings, but the extent of the excavations is small and the work was apparently done by pick and shovel methods. No information is now obtainable of the gold content of this ground or of its character.

Like the other tributaries of Crooked Creek from the west, Olive Gulch opens out at its head into a broad basin of moderate relief and the creek branches into a number of forks. In the westernmost and most deeply incised of these, there was some placer mining of a narrow strip of gravels along the creek flat in the early days of the camp. In the northeast portion of the basin, a broad alluvial known as Twenty Thousand Gulch was the scene of considerable mining during the boom days. Much of the ground mined was of the "skim diggings" type in which 4 to 6 feet of decomposed arkosic granite were mined. This ground contained very little well-rounded gravel, the coarse rocks consisting mainly of angular chunks of vein quartz, banded quartzite, or andesite dike rocks, with a few partly rounded or well rounded pebbles or cobbles. Mining was for the most part in the shallow gulches where the gold had been concentrated somewhat, but in many places the hillside was also worked and the gold is said to extend up the slopes to the divides. This is a residual placer deposit and the gold was derived from quartz veins in the immediate vicinity of the placer cuts. Neither the gold nor the rock fragments were transported far from the place of their bedrock origin. The placers were formed by the weathering, decomposition, and solution of the bedrock, and by the removal of the fine material by rill wash without important transportation and sorting by streams. These placers probably do not lie upon the original high erosion surface of this district, but upon portions of a younger erosion surface which was downfaulted or downwarped below its original level. During the present erosion cycle, this upper basin of Olive Creek has not yet been reached by the vigorous headward growth of the canyons.

Conditions similar to those found on Twenty Thousand Gulch are to be seen in the next two tributary gulches to the westward. There, old placer pits in wide, shallow gulches show a surface layer of one foot of fine, dusty soil beneath which
lies a layer 3 to 6 feet thick of arkosic sand containing abundant angular or partly rounded blocks of quartz and dike rocks. This layer overlies deeply decomposed granitic material which is entirely disintegrated to a depth of 15 feet or more. This decomposed bedrock is in places a sheared, gneissic diorite containing rusty quartz veins and oxidized streaks which indicate the presence of a zone of shearing. Fine, angular particles of gold can be panned from this sheared material. It is reported that a considerable area here is gold-bearing, and that the gold, while concentrated somewhat in the gulches, is also distributed over the side hill slopes to the divides. These facts, as well as the angular character of the rocks in the placer deposit, indicate a local origin for the gold. Transportation of material by water has had little effect upon the deposit except to remove the lighter products of rock decomposition.

Olive Creek Placers

During the summer of 1937, an attempt was made to mine placer ground at the forks of upper Olive Creek by a company known as Olive Creek Placers, of which J. L. Stanley was manager. The property was equipped with a 3/4-yard, gas-driven, steam shovel and a locally-built screening and washing unit. Three men were employed. In mid-July, 1937, a cut about 200 feet long and averaging 30 feet wide had been stripped by removing 3 to 4 feet of old tailings and 3 feet of muck. It was reported that the ground contained about 3 feet of gold-bearing material lying on decomposed granitic bedrock. No sluicing had been done when the ground was visited. Because the mechanical equipment proved inadequate, the project was later abandoned.

Hundred Dollar Gulch

Placer mining on a small scale has been done on Hundred Dollar Gulch at various times from the early days of the camp to the present. The lower course of this gulch is deeply incised and canyon-like, but at the upper end it broadens out and merges gradually into the old erosion surface of which the tops of the bordering ridges are a part. Near the mouth of the gulch, stacks of old tailings show that a narrow cut a few hundred feet long was mined many years ago.

Idaho Placers

In 1937, active mining was carried on by the Idaho Placers, of which W. G. Bead was manager. Beginning at a point 2,500 feet above the mouth of the gulch, a cut which varies from 50 to 75 feet wide and from 8 to 10 feet deep, was carried upstream for a distance of over 3,000 feet. The property was equipped with a 1/2-yard dragline scraper with a 35-foot boom, and a screening and washing unit that had a 11-foot by 36-inch trommel and a belt stacker. In vertical section, the creek deposit being mined resembled that of the Dixie Placers on Crooked Creek except for the absence of a layer of well-rounded gravel. In a typical section, the top 4 feet consisted of soil and muck, with some peat, logs, and stumps in which were scattered large boulders and blocks of local granitic bedrock and lamprophyre dike rocks. These overlay about 4 feet of arkosic sand, also containing big blocks and boulders which graded imperceptibly into deeply decomposed granitic bedrock. In mining, the surface layer of muck and peat, and some of the arkosic sand was stripped off and dumped alongside the cut, and only the lower part of the sand and several feet of the rotten bedrock were sluiced. The entire deposit is remarkable for the scarcity of well-rounded, stream-washed gravel. The tailings consist almost exclusively of arkosic sand and of fragments of partly rotten bedrock, with a few large boulders which have not been stream-rolled, but which have rolled down the hillsides onto the gulch floor from the outcrops on the bordering slopes. Mining on this ground was discontinued in mid-August of 1937, when the upper limit of profitable ground was reached.
Upstream from the ground worked by the Idaho Placers, there are small areas of ground on which placer mining has been conducted from time to time. At one place, a cut was made recently with a slack-line scraper, but apparently the returns were insufficient to encourage a continuance of mining. At other localities, small dams have been built and some ground mined by pick and shovel methods. Rounded gravel is conspicuously absent in all these places and the mined ground consisted of arkosic sand containing angular blocks and fragments of the local bedrock. In the dry summer weather, the creek flows as a trickle, and water for sluicing can be had only by storing the run-off behind dams and then sluicing for short periods.

Fourth of July Creek

Soon after the original placer discovery in this camp, on Dixie Creek, shallow "skim diggings" were found on upper Fourth of July Creek, the settlement of Midas was established and active mining began. Most of the activity was centered on the west fork of the gulch above the present Tiawaka mine. This is an area of mature topography in which the valley walls slope gently upward from the main stream flat and the small tributary gulches occupy shallow depressions in the mature upland surface. The placer deposits are distinctly of the residual placer type. Rounded stream-worn gravels are entirely absent, and the material excavated consisted solely of angular fragments and blocks of vein quartz intermingled with arkosic sand, lying on the surface of the deeply disintegrated granitic bedrock. Little water is available here for sluicing, so all the coarser rock fragments were thrown aside and only the arkosic material was washed. The residual material and rotten bedrock were mined to a depth of 2 to 10 feet. Since there was apparently some concentration of gold in them, the workings tended to follow up each shallow depression. It is evident that neither the sands, the rock fragments, nor the gold have been transported far from their bedrock source; that the placers resulted from the breaking down by weathering of the quartz-veined granitic material, and the removal of the lighter rock particles by small streams and rills, leaving the inert and heavy gold behind. The area of the workable placer ground was determined by the size of the area in which gold-bearing quartz veins were sufficiently abundant. Unfortunately, no information is now available, either as to the value per cubic yard of the ground mined on this creek or as to the total amount of gold recovered.

Prospecting pits recently dug in the meadow along the main stream flat, a short distance above the Tiawaka mine, show peat and logs underlain by an undisclosed thickness of arkosic sand, presumably the tailings from the old placer workings. A little mining was done in the past on the main creek in the canyon just below the Tiawaka mine, and a few small cuts were worked on south-draining gulches in the head of the north fork of Fourth of July Creek.

Between the Tiawaka mine and the mouth of Fourth of July Creek, there is considerable ground along the creek which should contain some gold. It is not likely that the early miners failed to prospect this ground, but a gold content which would not have attracted them might yield a profit under modern mining methods. However, the flats along the lower course of this creek are now covered to a depth of several feet with the sandy tailings from the old placer mines. These tailings would have to be removed before the bedrock pay could be reached.

Boulder Creek

From what can now be seen, there is little evidence that placer mining has ever been vigorously carried on on Boulder Creek. Perhaps the name of the creek itself is a partial explanation of this fact. There seems to be an unusual abundance of large boulders of weathering which have moved down the hillside slopes.
out onto the stream flat. These boulders would certainly increase mining costs, and might well be detrimental enough to discourage mining of marginal ground. Nevertheless, a zone which passes through the areas of extensive early placer mining operations on Olive, Fourth of July, Dixie, and Nugget creeks crosses the upper Boulder Creek Basin, and that zone marks a belt of gold-bearing quartz veins as is indicated by the position of the Tlawaka, Ajax, Slip Easy, and L & L mines, and many prospects. From these facts, one would expect, first, that the stream gravels of Boulder Creek would be gold-bearing, and, second, that there would be residual placers in the upper basin of that stream. However, there were signs of old placer workings at only one place, and that in the headward basin where a small patch of ground had been worked. Some old prospect pits were found and some ground has recently been staked in what is locally known as "the wood yard", near the head of the basin. Evidently none of these prospects has been sufficiently encouraging to cause the owners to undertake serious mining. It is reported that prospect holes in "the wood yard" found gold-bearing residual deposits on deeply decomposed bedrock, but that these lay beneath 15 feet of lean or barren overburden so that the cost of removing so much waste was prohibitive. It is possible that with modern equipment some of the valley deposits of Boulder Creek might be mined at a profit. When consideration is taken of the decreased cost of mining by modern methods, a more thorough prospecting of the ground than has been done in the past is justified.

Dixie Gulch

Dixie Gulch, the scene of the first placer discovery in the Dixie district, is an open valley with gently sloping side walls and mature slopes. The valley floor deposits in it were mined from head to mouth in the early days of the camp. No records are now available as to the amount of gold recovered from this gulch, but the ground was rich enough to encourage a small stampede and to yield a satisfactory reward to the miners in what at that time was a remote and difficultly accessible region. All of the mining was done by hand methods, and with a very small water supply. In the late summer of 1937, there was no running water in the valley above the road. The ground mined varies in width from 30 to 100 feet and was shallow, averaging no more than 3 or 4 feet. The underlying granitic bedrock is deeply decomposed and considerable of this rotten bedrock was sluiced. There is almost no rounded gravel in this ground, and the rocks in the dumps consist solely of angular lumps of quartz, andesite dikes, and granitic material, none of which shows the effects of stream transportation. At one point where an andesite dike crosses the valley, blocks and fragments of the dike are abundant in the valley flat, but occur only a short distance downstream below the dike. Although there has been some concentration along the valley floor, the placered ground is essentially a residual placer. Apparently the early miners were so thorough that little ground which is likely to encourage exploitation in the future remains.

Nugget Gulch

Conditions on Nugget Gulch are much like those already described for Dixie Gulch. A narrow strip along the creek was mined from its mouth up to the present road crossing. Above the road, mining was conducted along the main creek and up the left fork to its head. It is said, however, that considerable ground was left by the early miners which now could be worked at a profit. The north fork of the gulch heads in a broad, marshy flat, a part of the old, high erosion surface of the district. In that flat, no mining has been done, probably because the ground is too deep and the grade too flat for operation by ordinary hand methods. Like that on Dixie Gulch, the ground on Nugget Gulch is essentially a residual placer, the creek flats having little or no rounded gravel and the only rocks being angular fragments of quartz, dike rock, or granitic material which show no effects of stream transportation. The bedrock is composed of deeply decomposed granitic or
gneissic material, and the upper foot or two of bedrock was mined along with the overlying arkosic material.

Alpha Placer

In 1937, preparations were under way by the Alpha Placer Company, C. M. Marts and J. R. McInroy owners, to rework the old tailings and some new ground on Nugget Gulch between the road and the mouth of the stream. A home-made dragline excavator, equipped with a 1/2-yard bucket and powered by an automobile engine, was under construction as was a screening and sluicing unit. It was also contemplated that this equipment, which would be in operation by mid-September of 1937, might later be moved to the flat on the north fork of Nugget Gulch.

Horse Flats Creek

Horse Flats Creek, the uppermost important tributary of Crooked Creek from the west, occupies a valley which leads in a broad flat that is a part of the old, high erosion surface of the district. So far as could be learned, no mining has ever been done in this valley, and there are few signs of prospecting. It is probable that the meager water supply, the flat grade, and the depth of the ground discouraged the early prospectors who were searching for placers which could be worked easily by hand methods. All of these disadvantages can be overcome by the use of the modern dragline scraper, and these flats now present an attractive possibility for exploitation. Certainly, they deserve careful prospecting.

SUMMARY OF PLACER POSSIBILITIES IN THE DIXIE DISTRICT

Under the present costs of labor and equipment, with gold at its present price, Crooked Creek from the town of Dixie to its head may be considered to be worked out when the present program of the Dixie Placers will probably be completed by the end of 1938. Then there will be no connected areas of placer ground left in upper Crooked Creek or its tributaries which contains enough yardage to justify the installation of heavy mining equipment. There are, however, smaller areas in upper Olive Gulch, on lower Fourth of July Creek, and on Boulder, Nugget, and Horse Flats creeks that may be rich enough to justify mining with light equipment and small crews of men. All of these areas deserve more careful prospecting than they have had. The valley of Crooked Creek between Dixie and the Meadows may also contain small areas which could be profitably exploited.

The one piece of ground in the district which might support a placer mining operation of some size is that known as Dixie Meadows. The Meadows include a flat area 1-1/2 miles long that averages about 800 feet in width. Little is known of the depth to bedrock in this basin, or of the character of the fill, or its gold content. One prospect hole is said to have been sunk to a depth of 50 feet without reaching bedrock. Inasmuch as Crooked Creek, which flows through the Meadows, carries some gold, it seems possible that the valley deposit may contain workable placer ground. It would be interesting, and it might be profitable, to get definite information on this point.

LODE MINES OF THE DIXIE DISTRICT

Since the main purpose of the study of the Dixie district was to determine the conditions under which the gold placer deposits had been formed, the greater portion of the time of the authors was given to the completion of a large-scale topographic map, to studying the physiographic history of this general region, and to an examination of old and present-day placer workings. Nevertheless, in the course of that work considerable information was acquired about the history of lode mining and prospecting and concerning the geologic setting of the lode de-
posits. About a week was spent by Roberts in the field in visiting such lode mines as were active or accessible, and the laboratory study of the ores and associated country rocks was made by him on his own initiative. He also prepared the rough draft of the description of the ore deposits and of the mines which is presented herewith. A brief discussion of the general geology of the district and of the mineralogy of the various types of country rock has already been given in the introductory part of this report. Inasmuch as the study of the lodes was of secondary importance in this investigation, the descriptions presented herewith make no claim to completeness, nor does the space given to individual properties indicate their importance. The purpose of these descriptions is to make a permanent record of facts which are now preserved only in the minds of the local people and which may be lost unless so recorded.

General statement and history of lode mining

Most of the lode deposits of the Dixie district lie within a north-south belt some 12 miles long which extends from upper Crooked Creek southward to the Salmon River. This belt is about 2 miles wide at its northern end, widens to about 4 miles a mile or so south of Dixie, and narrows again as Salmon River is approached.

The first lodes were staked in the early 1890's, although little ore was mined until about 1900. Between 1900 and 1917, at least three arrastres were built locally, more modern milling equipment was installed at several mines and some ore mainly from the oxidized zone but some containing sulphides, was mined and milled. Between 1917 and 1932, there was little activity in lode mining, many properties were abandoned, although assessment work was kept up on a few. The great improvement in the roads to the district and the increased price of gold between 1932 and 1937 led to the re-staking of many properties, the reorganization of old companies and renewed prospecting for other lodes. All of the ore which has been mined was valued mainly for its gold content, although some silver alloyed with the gold is also recovered.

Since records were not kept during the early years of mining, the total production of lode gold from the district can only be estimated. Although the Bureau of Mines figures are much lower (p. 4), estimates made by men familiar with the district vary between $200,000 and $700,000.

Ore deposits

The broader structural features which controlled the localization of the vein could not be studied in the limited time available, but attention may be called to the fact that while the veins generally strike northwest, they seem to be arranged in echelon in northeast zones. For example, as has already been mentioned (p. 24), the Ajax, Tiawaka, L and L, Slip Easy, and Sixty Four mines lie in one zone, and the Dixie Queen, Bonanza, Penn-Dixie, and Ontario lie in another. The significance of these alignments can not be evaluated at the present time, but they do suggest a northeast structural control in addition to the northwest shearing. The lodes of the district fall into two types; (1) gold-quartz veins, and (2) disseminated deposits, locally known as "dikes". The gold-quartz veins have yielded most of the ore so far mined.

The average strike of the gold-quartz veins is about N. 55° W., and the dip from 55° NE. to vertical. Although there are some exceptions to this trend, the parallelism is marked. Furthermore, their general appearance and mineralogic character are similar, and they evidently belong to a single vein system. They vary in width from a few inches to 10 feet, averaging about 3 feet, and are lenticular and pinch and swell both along the strike and down the dip. The lenticularity is probably due mainly to variations in the width of the fractures or to
contemporaneous movements, but may be in part the result of post-vein movements that have locally broken and shattered the quartz. In some places, quartz is absent and the course of the vein is marked by a thin seam of gouge in a shear zone.

Most of the veins lie within shear zones and are bordered by gouge on one or both walls. The shear zones commonly extend several feet on either side of the main vein, and are characterized by closely spaced parallel fractures containing thin seams of gouge which separate strands of country rock that vary from a fraction of an inch to several inches in width.

Although inclusions of the wall rock are abundant in places, the veins are relatively solid bodies of quartz. Some of these inclusions are irregular in shape; others are lenticular as a result of shearing. They are generally hydrothermally altered and silicified, many having gradational contacts with the quartz.

The earliest generation of quartz has been fractured and microbrecciated, and recemented by later quartz and sulphides. In some places, sulphides are localized along planes of post-quartz shearing so that the veins have a rudely banded appearance.

Mineralogy of the veins

The mineralogy of the quartz veins is simple. Milky quartz is the only gangue mineral in most veins, although a little epidote was found in a specimen from the Ajax mine. The order of deposition of the primary ore minerals is pyrite, sphalerite, galena, and chalcopyrite. Pyrite is the most common ore mineral; it is commonly euhedral, but is locally granular, possibly as a result of crushing by late movements. Arsenopyrite is said to occur in the district, but it was not seen in specimens collected by the writers.

Megascopically visible free gold was not seen in any of the sections studied, but many high-grade specimens which contain abundant visible free gold have been collected in the district. As most of the gold in sulphide ores can not be amalgamated, it probably occurs finely dispersed through the sulphides or is held in solid solution. A specimen from the Fourth of July mine contains an irregular veinlet of gold which cuts pyrite. It is possible that the gold was introduced during two periods, the first along with pyrite and the second at a later time.

The gold-silver ratio by weight in most veins is about 1 to 3, but in those ores which contain considerable galena the percentage of silver is greater. The concentration ratio of the ores varies widely, depending, of course, on the abundance of sulphides. In some ores that contain few sulphides, it is as great as 100 to 1. In other heavy sulphide ores, it is as little as 2 to 1.

Alteration during the vein-forming period

Sericitization

The feldspars of the granitic and gneissic wall rocks are more or less sericitized near the veins. In general, the degree of alteration decreases away from the veins, but, in places, fresh country rock adjoins the veins, whereas at some distance alteration may be intense. The probable reason for this irregularity of alteration is that the movements of solutions were controlled by gouge and brecciated areas in the shear zones. The gouge formed by hydrothermal alteration and by movement within the shear zones evidently controlled the sericitization by directing the course of the hydrothermal solutions along channels in the shear zones. Under continued alteration, the sericite changed to minerals of the kaolin type.
group, and the magnesium-iron minerals were altered to chlorite and then replaced by sericite.

Silicification

Silicification of the wall rocks and of fragments of country rock within the shear zones has taken place at two periods; (1) during the deposition of the earliest quartz, and later during the placement of the later quartz and sulphides. Although in places it is drusy and here and there shows comb structures, megascopically most of the early quartz is milky white and massive. Under the microscope, it is seen to be anhedral with sutured borders, and the milky appearance is found to be due to the inclusion of numerous vacuoles and of kaolinitic material. There is a great range in grain size from cryptocrystalline aggregates to grains one millimeter in diameter.

The later quartz which accompanied the sulphides was deposited in micro-brecciated zones in the early quartz, and is usually recognizable in the hand specimen by its clear, glassy appearance. In thin section, this quartz is seen to be free from inclusions.

History of the gold-quartz veins

The development of the gold-quartz veins took place in several well-defined stages. It must be emphasized, however, that vein formation was probably a more or less continuous process, and that the stages probably overlapped. The history may be summarized as follows:

1. Shear zones with a general northwest trend were formed in the country rock. Solutions rose through the zones, altering the shattered rock to an aggregate of sericite, chlorite, and quartz.

2. Early vein quartz was introduced into the shear zones, replacing the altered country rocks and silicifying the adjoining wall rocks. Movement along these zones continued throughout the vein-forming period.

3. Continued movements within the shear zones fractured and micro-brecciated the early quartz, and provided passageways for the movement of solutions, and openings for the deposition of the later quartz and sulphides. Solutions carrying quartz and sulphides were introduced, filled the openings, and carried silica and, locally, sulphides into the country rock as well. Pyrite, sphalerite, galena, and chalcopyrite were deposited in the order named. Gold was introduced with pyrite, and also later as free gold.

4. The lamprophyre and other dikes were intruded into tensional fractures trending northeast, almost at right angles to the veins. Faulting locally shattered the dikes and displaced the veins, but in most places the movement was small.

5. Erosion removed the upper parts of the veins. The exposed sulphides were oxidized, in most places to a depth of less than 50 feet, leaving a gossan of iron oxides and hydroxides.

Disseminated deposits

Disseminated gold-pyrite deposits are present in several mining districts in central Idaho, and have been described in the Oregonne district by Shenon and
This type of deposit is well represented in the Dixie district by the Robinson "dike", the term "dike" being commonly used in this district for well-defined and mineralized shear zones. The disseminated deposits are wide, mineralized shear zones which trend in the same general direction as the quartz veins. Although these zones carry small quartz veins or lenses in places, the movements that formed the zones were distributed over wide belts. The ore-bearing solutions were dissipated throughout the whole belt of fractured rock, rather than concentrated along well-defined channels as was the case with the larger quartz veins. Pyrite is the only sulphide which was recognized at the Robinson dike, although molybdenite is reported at another property on the same zone. The gangue minerals are quartz, epidote, and carbonates which occur in small veinlets in silicified country rock. The alteration of the country rock is similar to that near the gold-quartz veins, but the stages of alteration are not so sharply defined.

Age of the ore deposits of the Dixie district

The age of the lode deposits of the Dixie district has already been discussed. The veins and disseminated deposits cut the granitic rocks of the Idaho batholith, and are themselves cut by lamprophyre and other dikes. The ore deposits were, therefore, formed at some time between the cooling and fracturing of that part of the batholith in which they occur, and the intrusion of the dikes. Inasmuch as neither the exact age of this part of the batholith nor of the dikes is known with certainty, it is not possible to date the ore deposits closely. It is suggested, however, that they are probably of late Cretaceous or early Tertiary age.

Mine descriptions

Ajax mine

The Ajax mine is situated 3/4 mile northwest of Dixie on the ridge between Fourth of July and Boulder creeks, at an elevation of 5,760 feet. The property includes three patented claims, the Ajax, Monitor, and Mountain Boy. Before 1900, these claims were owned by one Turner, who did some development work and packed ore on mules to the Dillerine arrastre on Bhatt Creek about 4 miles away. The property was later purchased by the Midas Gold Mining Company, operated by Messrs. Finch and Campbell, and mining was actively carried on from 1900 to 1903. A 10-stamp mill driven by steam was built, and it is said that about 3,000 tons of ore were mined and milled. Each five tons of the sulphide ore yielded one ton of concentrates that assayed $60 to $90, and the concentrates were shipped to a smelter. Cyanidation was attempted, but apparently was not successful.

The 365-foot inclined shaft is not now accessible, but it is reported that the vein which lies in a shear zone in granitic country rock varied in width from a few inches to 10 feet. Within 50 or 60 feet of the surface the ore was free milling, but heavy sulphides were encountered at depth, and no ore was mined below 200 feet. Samples of ore from the dump consisted of massive pyrite, with little gangue. Thomson and Ballard report that an assay of heavy sulphide ore gave 1.2 ounce gold to the ton. An andesite dike which crops out a short distance west of the shaft was apparently encountered in the workings for numerous fragments of it occur on the dump. The mine buildings and equipment are now in ruins, and the workings saved.

Black Diamond mine

The Black Diamond group of claims, which lies some 3 miles southeast of Dixie, was operated in 1916-17 by Richard Klesseltal. It is reported that about 400 tons

1/ Shonon, P. J., and Reed, J. E., op. cit., pp. 30-31.
of ore from this property were transported to and milled at the mill of the North Star mine, and that the average recovery was about $22 per ton. Operations ceased when the mine was taken over by the Allen Property Custodian during the World War.

The workings are said to include about 1,600 feet of adits, drifts, and crosscuts. Thomson and Ballard report two converging veins, one of which, striking N. 40° W. and dipping 30° to 60° SW., is faulted and cut off by the other which strikes N. 70° W. and dips S. They also note that the vein was dense, glassy quartz; that two periods of mineralization were evident with pyrite and arsenopyrite the chief sulphides, and that narrow basic dikes intersect the ore bodies.

Bananza (Golden Age) mine

The Bananza group of claims lies 1-1/2 miles south of Dixie on Crooked Creek at the mouth of Hundred Dollar Gulch. The first claims were staked by W. S. Smith in 1896 and were developed by an adit over 200 feet long and by a 120-foot crosscut. Some ore was milled, but the production is not known. The claims were later abandoned and were restaked by Don George in 1930, who sold them to John Leonard and sons in 1932. The Leardons staked several additional claims, increasing the number to eight, and reopened the partially saved adit.

As exposed in the adit, the quartz vein varies in width from 2 to 3 feet and cuts granitic rocks, gneiss, and pegmatite. It strikes about N. 45° W., and dips 55° to 70° N.E. It is said that the vein has been traced for about 1,500 feet on the surface. Streaks of sulphides, mainly pyrite with some chalcopryrite, are irregularly distributed throughout sheared portions of the vein, and a band of sulphides commonly occurs on the hanging wall side of the vein. In most places, the vein is bounded by gouge on both walls, although locally it grades into silicified country rock. The pyrite is partially altered to limonite, and some covellite is present.

Comstock mine

The Comstock group, comprising 12 patented and 15 unpatented claims, lies about 3-1/2 miles southeast of Dixie. The main adit and offices are at an elevation of about 5,560 feet on Comstock Creek. The lode was first located by G. A. Youngberger and E. E. Thompson about 1896. The company was promoted by W. H. Phelps and others, who installed a 4-stamp mill, driven by water power, 1/4 mile below the adit. The amount of ore mined and milled by this company is not known, but is reported to have been several thousand tons, and the recovery is variously estimated at from $60,000 to $250,000. In 1906, Charles Kleesattel installed a steam plant to operate the mill, but little ore was milled. In 1934, a 25-ton flotation mill was installed by the Dixie Comstock Company, and, in 1935-36, several hundred tons of ore were milled with a reported recovery of about $15.00 per ton. In 1937, several new buildings were built on the property, but little mining was done.

In September, 1937, the stopes were not open, but some exposures of the vein in the adit showed stringers and lenses of quartz in a shear zone which trends N. 53° W., and dips steeply NE. The country rock is mainly banded gneiss and pegmatite. The hanging wall of the vein carries about a foot of gouge. Metallization locally extends into the wall rock, but in most places it contains low values. Pyrite, in part oxidized to limonite, was the only sulphide seen, but it is reported that lead vanadate or chromate was found in the oxidized zone. It is said that the vein in the stope above the main adit is shattered and that the ore is bunched. Several lamprophyre dikes which strike northeast cut the vein and the

shear zone, but the dikes are unshaped and evidently were intruded after the vein had formed. It is reported that seven adits on this property have a combined length of 3,350 feet.

Dixie Queen mine

The Dixie Queen mine lies about 2 miles south of Dixie, and about 2,000 feet above the mouth of Hundred Dollar Gulch. It was located in 1893 by F. S. Pritchard and A. W. Brownell, and was leased by them to Thomas and Frank Hye in 1896. The Hye brothers sank a two-compartment shaft 250 feet on the vein and drifted on the 120-foot level. The vein is said to be about 2 feet wide. Some ore was milled in 1901 and 1902 in a steam-driven, 10-stamp mill, but water in the shaft interfered with mining and the property was abandoned. It is reported that several hundred tons of ore from the Ontario claim on Crooked Creek were run through the mill on this property. The ground was re-located in 1932 by J. F. Millins, but little additional development work has been done.

Dixie Royal mine (Gold Miter group)

The Dixie Royal mine, formerly called the Gold Miter group, is situated on Crooked Creek 1/2 mile north of Dixie Ranger Station. It was owned by J. T. Reser and J. S. Danforth and included 8 lode claims and 360 acres of placer ground. In 1906, the lode claims were purchased by the Dixie Royal Mining Company and some development work was done. It is reported that several small pockets of rich ore were found which when milled in an arrastre yielded $5,000 in gold. In 1927-28, A. C. Carpenter installed a 2-stamp mill, operated by water power, and a small tonnage of ore was milled. The mill and buildings are now in ruins. Shenon and Reed, who examined the property in 1932, report as follows: "Some of the workings are inaccessible, but two tunnels were examined, one on the east side of Crooked Creek about 50 feet long, and one on the west side about 300 feet long. A 150-foot drift is burned from the west tunnel."

The country rocks are quartz monzonite, augen gneiss, and quartzite. The vein on the east side of the creek is from one to 4 feet thick, and strikes about N. 45° W. Its dip is not constant, but may average about 50° S. The hanging wall carries as much as one foot of gouge, and the vein is broken by faulting. The quartz is massive and milk-white, and some stained cavities indicate that sparse sulphides have been leached out.

The vein on the west side of the creek cuts quartz monzonite, pegmatite, and quartzite. At one face of the drift the quartzite strikes N. 20° W., and dips 50° SW. The vein strikes N. 45° W. and dips 50° NE. The quartz ranges in thickness from one to 3 feet and is bounded on both walls by heavy gouge. The vein is displaced by cross faults that strike N. 80° E., and dip 50° W.

Eldorado mine

The Eldorado group of 4 claims lies 1-1/4 miles southwest of Dixie in Olive Gulch. It was located by George Trader, who ran a short adit on one vein in what he called the Ironside mine and built a mill at the mouth of Olive Gulch. This mill was equipped with a Huntington mill, Wilfley tables, and cyanide tanks, and was later operated on a custom basis. The Ironside mine contained some rich ore, but it occurred in pockets that were soon exhausted. L. H. Gerard and J. Greenfield have recently leased this ground, and in 1937 were driving an adit to intersect the vein. It is said that there are several other undeveloped veins on the property.

Shenon, P. J., and Reed, J. C., op. cit., pp. 48-50
Fourth of July mine

Four claims of the Fourth of July group, which lies near the mouth of Fourth of July Creek and adjoins the Dixie townsite, were located by Thomas Pritchard in 1895; this property is commonly known as the Pritchard mine. In 1896, Pritchard having driven an adit and developed some ore, built an arrastre powered by an overshot water wheel at the adit mouth and mined this ground until 1909. The ore was roasted before grinding, and it is said that the gold recovery was about $40 per ton. The vein now exposed in the caved workings strikes N. 77° W. and dips 70° to 80° NE. It is from 18 inches to 2 feet wide, and lies in a shear zone in quartz monzonite. Many fragments and lenses of silicified country rock are contained within the vein. The vein is reported to be cut off on both ends by faults, and was worked to a depth of about 25 feet. Pyrite, partly altered to limonite, is the only sulphide seen in the ore.

Mammoth mine

The Mammoth mine of 14 claims lies 7 miles southeast of Dixie Ranger Station. The original discoverers are not known, but the property was re-staked in 1925 by A. C. Carpenter and J. L. Q. McKnight. Soon afterward, R. G. Bailey and others took over the property and active development was carried on. In 1935, the Bunker Hill and Sullivan Company acquired the property under lease and option, and a 25-ton flotation mill powered by Diesel engines has now been installed. The mill began operating in September, 1937. Underground workings total about 2,500 feet.

The quartz vein now being stopped ranges in width from a few inches to 3 feet, and lies in a shear zone which strikes N. 75° to 85° W. and dips about 60° SW. Pyrite, galena, sphalerite, and chalcopyrite occur in streaks in the vein or disseminated through it. A lamprophyre dike 60 feet wide is reported to displace the vein about 135 feet. The country rock includes quartz monzonite, pegmatite, gneiss, and quartzite. Several other veins have been found on this property, but little development work has been done on them.

North Star mine

The North Star group of claims lies 2 miles southeast of Dixie. It was located by Sam Dillinger in 1891, and was later acquired and patented by Thomas and Frank Eys in 1896. The property was bought by George Trader in 1912, and in 1936 was leased to the Keiths Star Mining Company. The old workings have recently been reopened, and in 1937 the mill was being remodeled in preparation for operation.

Two veins are exposed on the property. One, which strikes about N. 80° W. and dips steeply NE. is about 3 feet wide, and is developed by a 400-foot adit driven along the vein. The other vein trends about N. 70° W., varies in width from a few inches to 2 feet, and is developed by a 150-foot adit and a shallow shaft. At the face of the adit, this vein is cut off by a lamprophyre dike. The veins have gouge on both walls and the sulphides occur in sheared quartz on both the hanging wall and the foot wall of the zone of shearing. The country rock is sheared and hydrothermally altered quartz monzonite.

Penn-Dixie mine

The Penn-Dixie group of 8 claims is situated on Crooked Creek a short distance below the town of Dixie. The original discoverer is not known, but the ground was relocated in 1906 by Roy Burke and W. L. Sendker, and sold in 1915 to the Penn-Dixie Gold Mining Company. A stamp mill powered by a steam engine was installed, and several thousand tons of ore mined from a vein on the Snowstorm claim were milled. It is said that the vein averages about 4 feet in thickness,
and that there are some 1,500 feet of workings on the property. The country rock includes quartz monzonite, gneiss, and schist.

Robinson Dike

The Robinson Dike property was discovered in 1904 by Louis N. Larsen, who staked three claims as the Gold Hill group. Larsen sold the claims in 1907 to S. Brown and a Mr. Cox, who sold the ground in 1934 to W. N. and H. Robinson, by whom the Robinson Mining & Milling Company was formed. The property was increased to 10 claims, and a 50-ton steam-powered mill equipped with a ball mill, flotation units, and cyanide tanks was built. This mill was operated from July to October in 1935, treating 35 to 40 tons of ore a day. In 1936, about 4,000 tons of ore from an open cut were treated with a reported recovery of 95 per cent from ore which assayed $2.40 a ton. In 1937, the mill was not operated, but a 90-Foot crosscut was driven north of the open cut. The average tenor of the ore from this crosscut is said to be considerably higher than that from the open cut. It is reported that about 1,600 feet of underground development work has been done on this property, but most of the workings were caved and inaccessible in 1937.

The ore deposit is a typical disseminated deposit in a shear zone which strike's about N. 30° W. The mineralized zone is said to be 100 feet wide, and to have been traced for a distance of 4,200 feet along the shear zone. As seen in the crosscut, the ore body contains pyrite disseminated through silicified and somewhat brecciated quartz monzonite, with possibly also some quartzite. Locally, the pyrite occurs in small reticulating veinlets which cut the monzonite. The best ore is said to occur in those places where shearing has been most intense.

This property was under option to the Bunker Hill and Sullivan Company in 1937, and several men were employed in diamond drilling parts of the lode and in other development work.

Skylark claims

The Skylark group of claims lies at an altitude of 5,875 feet on the ridge between Hundred Dollar Gulch and Olive Gulch, one mile west of Dixie. A group of three claims, staked by Howard Powelson in 1897, is now owned by L. R. Powelson and Gusta Miller, who have leased it to W. B. Ackerman. The workings include about 500 feet of adits and crosscuts, now caved, and a 40-foot shaft. The vein could be seen only at the adit portals, but apparently it is the same type as the other veins of the district and cuts country rock of quartz monzonite. Pyrite is the only sulphide that was seen in the ore, but a small amount of copper is reported in assays. Twenty-five tons of picked ore were shipped to the smelter at Kellogg, Idaho, and yielded $28 in gold to the ton. The vein is said to carry ore which averages about $11 a ton.

Slip Easy mine

The Slip Easy group of 5 claims lies 1-3/4 miles northwest of Dixie on the ridge between Boulder Creek and Dixie Gulch. The property is now owned by Wm. Willies, and is under lease and bond to W. A. Hugo. Eight tons of ore shipped to the Kellogg smelter are said to have yielded $22 a ton. A steam-powered mill, with flotation cells and cyanide tanks, has been installed on the property and some ore has been treated in it. The workings, most of which are now caved and inaccessible, are said to total several hundred feet. Three veins have been opened, of which one about 4 feet wide is sparsely mineralized. A second, from which most of the ore so far recovered has been taken, is 12 to 16 inches wide, strikes N. 30° W. and dips steeply to the N.W. A third vein, said to carry the richest ore, is badly faulted and has yielded little. The property was not operated in 1937.
Sixty Four mine

This mine lies 2 miles north of Dixie, in Dixie Gulch. It was located by George Trader, who staked it to Joseph Morris in 1900. Morris sank a shaft 100 feet deep on the vein and produced some ore which was treated at Trader's mill on Olive Creek. In 1935, the property was leased to W. F. Robberson, who has carried on active development work. Six tons of ore shipped to the Kellogg smelter are said to have yielded an ounce of gold to the ton.

The vein lies in a shear zone in quartz monzonite, and varies in width from a knife edge to 3 feet. It is strongly sheared and is rudely banded by oxidized streaks and by lenticular inclinations of altered country rock. It strikes about N. 55° to 65° W. and dips 55° NE. About 200 feet from the portal it is cut by a wide lamprophyre dike, but not greatly displaced. The dike itself is shattered by later movements.

Swastika claims

The Swastika group, on the west fork of Rattles Creek south of Dixie, was staked by Edward Davis in the 1890's. It was later sold to the Majestic Mining Company which drove about 3,000 feet of adits and crosscuts. A steam-driven sawmill and compressor were installed, but no ore has been treated. The property is now owned by Vincent Modello. Livingston and Stewart describe this property as a disseminated deposit containing lens-shaped veinlets of quartz which carry molybdenite and pyrite.

Tsiwaka mine

The Tsiwaka mine, on Fourth of July Creek 1-1/4 miles northwest of Dixie, was located by Roy Burke and A. J. Taylor in 1896. Later, the ground was leased and some ore mined to a depth of 45 feet. The property was again leased in 1933 to W. L. Crow & Company. In 1935, it was subleased to Carl Klinkscale, H. C. Pownall, and Rodney Keating, and incorporated as "Loyalty Mines". The mine is equipped with a gas engine, hoist and skip, compressor, Straub jaw crusher, conveyor belt, McCormick-Deering Diesel engine driving 37.5 k.w. De Lavall generator, motor-driven, 15-ton Straub ball mill, cyanide tanks, and a half dozen new buildings, including shaft house and mill.

The inclined shaft, 150 feet deep, was partly filled with water in September, 1937, and the underground workings, said to be several hundred feet in length, could not be examined. The country rock is granite. Mr. J. L. Stanley, the manager of the property, estimates that so far about 550 tons of ore have been milled from this property.

Tonopah claims

The Tonopah group of 8 claims, located 2-1/2 miles by road west of Dixie, was originally staked in 1897 by Howard Powlison, but is now owned by L. R. Powlison and Gusta Miller. The vein, cutting granite, pegmatite, and quartzite, strikes N. 30° W. and varies from 2 to 8 feet in width. Developments on the ground include a 120-foot adit and two large open cuts excavated by a mechanical scraper. The vein is composed mainly of massive milky quartz through which run veinlets of glassy quartz which contain pyrite and possibly some galena. The vein is said to carry an average value of $7.50 to the ton, and the altered wall rock also contains some gold.


34.
The L. and L. mine, located 1-3/4 miles by road northeast of Dixie on the ridge between Boulder and Dixie gulches, was located in 1896 by Louis N. Larsen and James Lynch. In 1899, Larsen bought out his partner, and continued to develop the property. About 250 tons of ore were milled at the Pritchard arrastre on Fourth of July Creek, with a reported recovery of $6,000. Later, Larsen built an arrastre, run by water from a ditch from Nugget Gulch, at the mouth of Dixie Gulch. Before milling, the ore was roasted to oxidize the sulphides. It is stated that altogether about 1,100 tons of ore have been mined from six ore shoots above the adit level, and that the average recovery has been $35 to the ton. E. W. Wagner has recently bought the mine from Larsen, continued underground development, and installed a small flotation mill. It is said that underground workings include a 120-foot shaft and about 700 feet of tunnels, drifts, and crosscuts.

The vein ranges from 6 to 8 inches in width; strikes about west. The ore occurs in shoots, which vary from 20 to 80 feet long, along the strike in a shear zone. The vein is milky quartz with irregularly distributed sulphides, and locally contains lenses of the silicified granitic country rock.

American mine

The American mine is situated on the Elk City road about 1/2 mile north of Dixie. It was originally staked about 1897, and was worked intermittently until 1931. A 2-stamp, steam-driven mill has been installed on the property, and it is reported that about 1,000 tons of ore have been milled. In 1931, Conrad is said to have cyanided about 30 tons of tailings, with a recovery of nearly $25 a ton. The property was relocated in 1932 by Betty Wiles and leased in 1934 to Roberts and Hollingsworth, who built a new mill and treated a small amount of ore. In 1936, Edward Sans and F. F. Mguire sub-leased the mine and formed the American Gold Mining Company. This company operated for a few days in 1937, but mining ceased as the result of litigation.

The workings include a 250-foot adit, now partly caved, and a shallow shaft 600 feet west of the adit. The vein now exposed in the stope is about 2 feet wide, strikes N. 80° W., and dips 60° NE., and lies in a shear zone in granite. It is fractured and in places pinches out completely. In places, there are fragments of altered granite enclosed within the vein quartz. A shear zone, which trends N. 35° E., crosses the vein, but does not displace it.