STATE OF MONTANA
Forrest H. Anderson, *Governor*

BUREAU OF MINES AND GEOLOGY
S. L. Groff, *Acting Director*

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MINES AND MINERAL DEPOSITS OF THE SOUTHERN FLINT CREEK RANGE, MONTANA

by

F. N. Earll

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Montana College of Mineral Science and Technology

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CONTENTS

CONTENTS

ILLUSTRATIONS

ILLUSTRATIONS

TABLES

ABSTRACT

Mining in the southern part of the Flint Creek Range began in 1865 with discovery of the Georgetown placer deposit. Additional discoveries followed in quick succession so that by 1900 there were active mines in sixteen districts, and three more areas became active in the next 10 years.

Value of metal produced to 1968 is approximately $14 million, mostly for gold but including important amounts for silver, lead, copper, and tungsten. Most of the metallic ores occur as veins filling fissures in sedimentary rocks, carbonate rocks of Cambrian age being the most commonly selected host, but a few deposits occupy fissures in intrusive rock. One major ore body was contact metasomatic in origin. Non-metallic minerals produced from the area include several million tons of limestone and about a quarter million tons of silica (quartzite), most of which have been used by the copper smelter at Anaconda. These products probably would have brought at least $1 million on the open market.

The study area extends from the crest of the Flint Creek Range near Racetrack Peak southward to Georgetown Lake and the Warm Springs Creek valley. The northern quarter of this area is dominated by two large intrusive masses, the Philipsburg batholith on the west and the Mount Powell batholith on the east. They are separated by a thin screen of sedimentary rocks that is only 400 yards wide at its narrowest point. South of these major intrusive bodies the bedrock consists of folded and faulted sedimentary strata that have been penetrated in more than a dozen places by small intrusive masses. Most valleys and some upland areas are covered by a thin veneer of glacial debris.

Total thickness of sedimentary rocks exposed is approximately 20,000 feet. This includes 12,000 feet of Precambrian metasediments; most of the lower half is argillaceous limestone, and the upper half contains argillite, siltstone, and quartzite. Paleozoic strata total nearly 5,000 feet in thickness and are predominantly carbonate. Mesozoic strata total 2,000 feet in thickness and are predominantly clastic rocks. Tertiary beds consist of several hundred feet of gravel and conglomerate. Quaternary deposits include glacial moraine, terrace gravel, and valley-bottom alluvium.

Extrusive igneous rocks constitute the Lowland Creek volcanic sequence (Tertiary), comprising flows and ash-flow tuff as much as 3,000 feet thick overlain by breccia and agglomerate 500 to 600 feet thick; these rocks are approximately quartz latite in composition.

Seven intrusive rock types are recognized. The Philipsburg batholith is composed of granodiorite, and the Mount Powell batholith is quartz diorite. Stocks are composed of gabbro, granodiorite, hornblende quartz diorite, and biotite granite; dikes and sills are composed of gabbro, diorite, and dacite.

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INTRODUCTION

PURPOSE AND SCOPE

The publication of basic information on the mines and mining districts of Montana has long been one of the primary aims of the Montana Bureau of Mines and Geology. This has usually been accomplished through the use of two general types of publications; county reports, which describe all deposits within a given county, and mining-district studies, which are generally shorter but more detailed in regard to the specific mining district studied. The present effort lies somewhere between these two. The area covered, although large (more than 200 square miles), is smaller than the smallest county, but it includes parts of three counties; northern Deer Lodge, southeastern Granite, and southwestern Powell Counties. Furthermore, the area encompasses nineteen organized and unorganized mining districts and more-or-less informally recognized mineralized areas. Several of these districts have had sufficient production, either known or suspected, to warrant an individual report, but the almost universal lack of property access and of factual data makes this course of action impractical, hence the decision to group them into one regional study.

As the purpose of the study was to present data on the geology and the mineralization of the mines and prospects of the area, no effort was made to map the geology of the overall region in detail. Besides, the area had already been mapped, some parts of it two or three times, by different individuals. The author's task, then, was to map detailed geology in the vicinity of the mines and prospects studied, and to make certain that the regional geologic map was in general agreement with the picture developed locally. A geologic map of the entire area is presented as Plate 1, but this map is essentially a composite of the works of others, welded together by the author where they joined or overlapped. As it turned out, this required a surprising amount of welding, and more bending than one might expect.

Ideally, all mines and prospects in the area covered would be visited and described in a publication of this type. Actually, of course, this was impossible. There are literally hundreds of mines and prospects in the overall area, most of them inaccessible at the present time. An effort has been made to include discussion of all properties that have had a significant amount of production, plus most others that are reasonably accessible, particular emphasis being placed on those properties that have been brought to patent. Properties omitted include some for which permission to enter and study them was never received, some that were so remote as to make an actual visit impractical, and undoubtedly dozens, if not hundreds, that simply were not detected.

LOCATION AND ACCESSIBILITY

The area under consideration, referred to herein as the Southern Flint Creek Range, includes the mountainous terrain between the Clark Fork (Deer Lodge) valley on the east and the Flint Creek (Philipsburg) valley on the west. From U. S. Highway 10A, which follows Warm Springs Creek between Georgetown Lake and Anaconda along the south edge, the area extends northward for 12 to 15 miles to the center of T. 7 N. The northwest corner of this area, which would include the Philipsburg mining district and related deposits, has been omitted because that part of the area has already been covered adequately in other publications. The area remaining totals approximately 210 square miles, most of which lies within the Deer Lodge National Forest, and virtually all of which is mountainous terrain. Altitude ranges from 5,200 feet along Warm Springs Creek in the southeast corner of the area to 10,000 feet at Mount Powell near the northern boundary of the area. Other high points include Racetrack Peak, which is about 4 miles west of Mount Powell and has an altitude of 9,524 feet, and the westernmost of the "Twin Peaks", roughly 6 miles southwest of Racetrack Peak, at an altitude of 9,000 feet.

Although some parts of the study area are remote from ready access, overall there is surprisingly good access to most places. This is, of course, a function of the mining interest, and the innumerable roads that the miners and prospectors have constructed over the years. It would be pointless to attempt to list all roads entering the area, but principal access is provided, from north to south along the eastern side of the area, by roads following Granite Creek, Racetrack Creek, Modesty Creek, Antelope Creek, and Lost Creek. From east to west along the southern boundary, roads follow Olson Gulch, Foster Creek, Warm Springs Creek, Cable Creek, and Flint Creek. No roads enter the area from the west, however, and the only entry from the north is a road along Boulder Creek from Maxville; it ends at the Powell mines at the north end of the area. It should be noted that, excepting the Flint Creek road, none of these roads is satisfactory for passenger car travel for more than a few miles, and most of them require 4-wheel-drive equipment at some points.

PREVIOUS WORK AND ACKNOWLEDGMENTS

The first geologic work in the area, U. S. Geol. Survey Prof. Paper 78, The Geology of the Philipsburg Quadrangle, by W. H. Emmons and F. C. Calkins, was published in 1913. Today, almost 60 years later, it is still the classic reference for the area, and by far the most detailed and accurate description available of the largest part of the area under study. Although the work by Emmons and Calkins provided the basis for the geologic map of most of the area, and was the only published source of information for more than half of it, several later studies provide greater detail in some parts of the range (Csejtey, 1962; Mutch, 1961; Poulter, 1957; Wanek and Barclay, 1966). All these sources were used to a greater or lesser extent in the preparation of the composite geologic map presented herein. Figure 1 shows the outline of the area studied, and the portions of that area described by the various publications cited. Although none of the regional geology presented on the geologic map is original work by the author, he has exercised his prerogative to select and interpret the material used, and so must also accept full responsibility for the accuracy of the mapping as presented.

Many persons have provided useful information, property records, and just plain friendly encouragement that has been of inestimable help in bringing this study to fruition. This includes the great majority of mine owners in the area who took the trouble to reply to questionnaires that were sent to them; many volunteered useful information. Those whom I would single out for especial thanks include my two field assistants, Robert Reese (1965) and Jerry Harris (1966); Mr. Charles Goddard and Mr. Robert Ingersoll, Jr., The Anaconda Company, who provided a surface geologic map of the Southern Cross district and data on several other properties that are owned by that company; Mr. and Mrs. Clarence Bergloff, and Mr. and Mrs. Eugene Garrett.

SEDIMENTARY ROCKS

GENERAL STATEMENT

The following summary is not intended to be an exhaustive treatise on the stratigraphy of the sedimentary rocks to be found in the Southern Flint Creek Range, but rather a brief outline of the numerous formations present, giving their general distribution, thickness, and broad physical characteristics. The bibliography lists several references that may be consulted for additional details.

PRECAMBRIAN ROCKS

WALLACE FORMATION

The oldest rocks to be found in the study area are herein referred to the Wallace Formation of late Precambrian (Beltian) age. Emmons and Calkins (1913) correlated these rocks with the Newland Formation on the basis of lithologic similarity to the type Newland in the Little Belt Mountains and on their stratigraphic

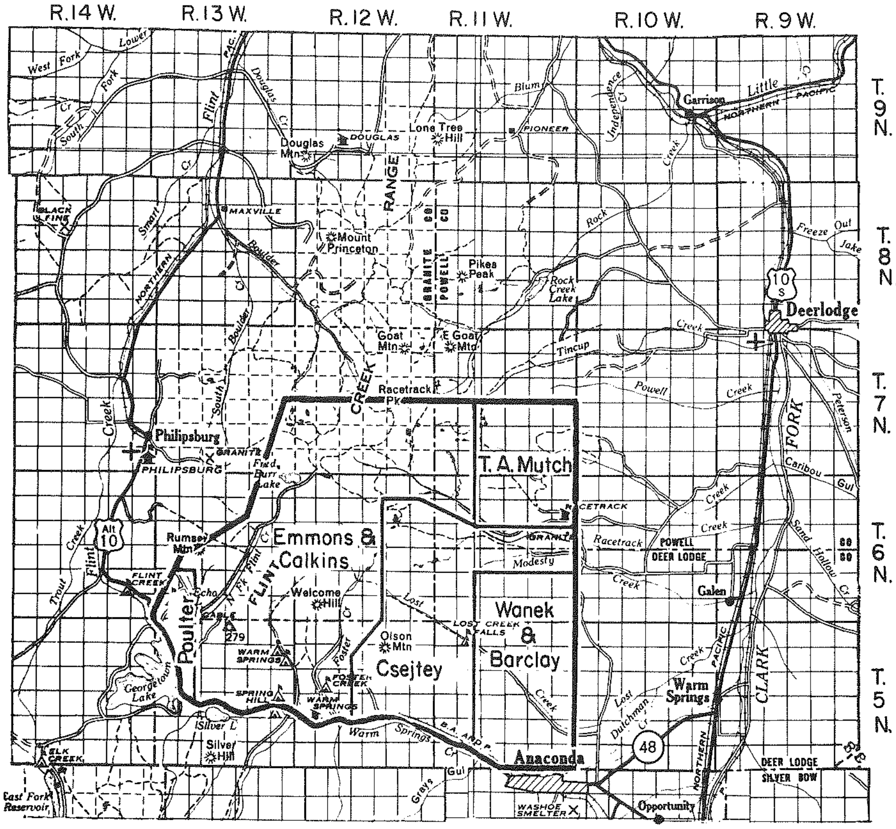


Figure 1.–Index map of the Southern Flint Creek Range area, showing sources of basic geologic mapping used

position below rocks that they thought to be Spokane Formation. It is now realized that the overlying beds are the lower part of the Missoula Group, including the Miller Peak and possibly the Bonner Formations, so the older rocks must be Wallace equivalents. Further confirmation of this correlation is to be had by tracing the exposures of the older Beltian rocks as they crop out, somewhat intermittently, around the north end of the Boulder batholith as far as Helena. It will be observed that east of the Continental Divide, along this belt of outcrop, the limestone underlying the Missoula Group has been referred to the Helena Formation (quite properly), but west of the divide it has erroneously been referred to as Newland. The Helena and Wallace Formations overlie the Spokane and its western Montana equivalent, whereas the type Newland lies stratigraphically below the Spokane.

The Wallace Formation contains about 7,000 feet of sedimentary rocks (Poulter, 1957), dominated by very thin-bedded siliceous to argillaceous limestone. Where fresh, the Wallace is dominantly a gray to dark-gray thin-bedded formation banded somewhat by layers of darker and lighter material. Weathered outcrops are commonly characterized by deep grooves that parallel the bedding; these are a result of differential weathering (Emmons and Calkins, 1913). Where altered at and near the contact with igneous rocks, the Wallace tends to be converted to a calc-silicate rock described as hornstone by Emmons and Calkins and as diopside-quartz-calcite-hornfels by Wanek and Barclay (1966).

The principal area of Wallace exposure is an elongate northeast-trending belt along the west side of Flint Creek. The exposures there are almost continuous for about 5 miles, from the north end of Georgetown Lake to within a mile of Red Lion, except where covered by glacial debris along the valley floor. There are also several widely separated and much smaller areas of Wallace outcrop to be found in the south-central and southeastern part of the study area. The largest and most easily accessible of these is just above the falls at Lost Creek campground.

MISSOULA GROUP

The younger Precambrian rocks in the area, referred to herein as Missoula Group, were identified as Spokane Formation by Emmons and Calkins (1913). Interestingly, the most recent publication on these rocks (Wanek and Barclay, 1966), also designates them as Spokane Formation, although none of the intervening investigators have. The present author has chosen to use the general designation "Missoula Group", although it is felt that most of the exposures could be correctly assigned to the Miller Peak Formation. The Bonner Quartzite, which overlies Miller Peak in the Missoula area, can be found cropping out along Flint Creek Canyon about half a mile west of the study area.

Missoula Group sediments are exposed continuously along the extreme western margin of the map area, from Georgetown Lake to the contact with batholithic rocks at Red Lion Peak 7 miles to the northeast. Another parallel belt, about a mile farther east, extends from the Cable mine to Twin Peaks. Again, there are other scattered and smaller areas of exposure in the south-central and southeastern part of the area. Although Poulter (1957) measured more than 10,000 feet of strata belonging to this group in Flint Creek Canyon, the unit thins rapidly eastward, owing to erosion, and probably does not exceed 5,000 feet anywhere in the study area. Thickness in the southeastern corner of the area is as little as 200 feet (Wanek and Barclay, 1966).

As observed along the western margin of the area and in Flint Creek Canyon, the Missoula Group rocks are medium-bedded, characteristically brick-red mud-cracked and ripple-marked argillite, siltstone, and some quartzite and conglomeritic layers. Farther east, where the rocks have been profoundly affected by adjacent and subjacent intrusive bodies, the dominant color is green, the metamorphism having produced impure quartzite, mica- and amphibole-rich schist, and hornfels.

CAMBRIAN ROCKS

FLATHEAD FORMATION

The lowermost Cambrian formation is the Flathead Quartzite (Middle Cambrian), which was deposited upon the eroded surface of the Missoula Group rocks at a marked angular unconformity. Emmons and Calkins (1913) noted an especially good exposure of this unconformity half a mile northeast of Olson Mountain.

The Flathead Formation, measuring as much as 200 feet in thickness (Emmons and Calkins, 1913), crops out principally in the south-central and southwestern part of the range as narrow, ribbonlike belts of resistant ridge- and cliff-forming quartzite. Most of the quartzite is white and vitreous, although locally it is light gray or even iron stained (Wanek and Barclay, 1966).

SILVER HILL FORMATION

The Silver Hill Formation, which conformably overlies the Flathead, was named by Emmons and Calkins (1913) for exposures south of the present study area. The formation contains 300 feet of shale and thin beds of siliceous limestone. At the type exposure on the south side of Silver Lake, Emmons and Calkins subdivided the formation into three members; the basal member, 120 feet thick, is composed of dark-green shale; the middle member, also 120 feet thick, is composed of thin siliceous limestone laminae; the upper member contains 90 feet of banded brown, white, and green calcareous shale.

The Silver Hill, unlike the erosion-resistant formations both above and below it, is soft, easily weathered, and only rarely provides prominent exposures.

HASMARK FORMATION

The Hasmark Formation, which overlies the Silver Hill conformably, was also named and described by Emmons and Calkins (1913). One of the type sections presented was measured " . . . on Warm Springs Creek 3 miles southeast of Cable", which places the section on the east side of the creek, near the south boundary of the study area. Total thickness of the formation at this location is 539 feet, but the base of the formation is covered. Another section, measured a short distance south of this, indicates an additional 450 feet of limestone in the lower member, making total thickness of the formation approximately 1,000 feet.

Emmons and Calkins subdivided the Hasmark into three members. These are, from the base upward, the lower magnesian limestone member, containing about 550 feet of strata that range from blue gray to white on fresh surfaces and are generally light blue gray in outcrop. The middle shale member, about 90 feet in thickness, is composed of thin- to medium-bedded chocolate-brown shale and subordinate thin limestone beds. The upper magnesian limestone member, approximately 350 feet thick, is dominantly white to cream color on fresh surfaces, and cream color to yellowish on weathered surfaces.

RED LION FORMATION

The Red Lion is the uppermost Cambrian formation in the area. This formation was named for the prominent exposures at the Red Lion mine on upper Flint Creek by Emmons and Calkins (1913).

The Red Lion Formation is composed of two fairly distinctive units. The lower or shaly member is composed of calcareous shale and thin magnesian limestone beds. Total thickness of the member is about 20 feet, most of which is limestone, but its distinctive feature is provided by two coal-black fine-grained brittle shale units, one at the base and the other at the top. This is overlain by the laminated limestone member, containing roughly 250 feet of distinctive, gray to blue-gray laminated limestone. The laminae are formed of siliceous layers that are narrow and closely spaced and which weather with pronounced relief, giving the member its distinctive appearance.

DEVONIAN ROCKS

MAYWOOD FORMATION

The lowermost Devonian rocks in the area belong to the Maywood Formation (Emmons and Calkins, 1913). Although Emmons and Calkins thought that the Maywood was probably Silurian, it is now generally recognized as being basal Devonian.

The Maywood overlies the Red Lion Limestone without apparent angular discordance, despite the fact that there was a depositional break that covered all of Ordovician and Silurian time at the very least.

Emmons and Calkins described the formation as 200 to 300 feet thick in the Southern Flint Creek Range area, and composed of generally thin bedded to flaggy reddish, gray, and olive-color magnesian limestone, calcareous shale, and yellowish limonite-stained sandstone. They further pointed out that sandstone is the lithology most commonly found in outcrop and that it is the most distinctive lithology in the formation.

JEFFERSON FORMATION

The sequence of beds mapped in the subject area by Emmons and Calkins (1913) as Jefferson Formation, and for that matter so mapped by all subsequent investigators including the present author, probably also includes the Three Forks Formation (Peale, 1893). The dividing point between these two formations is not clearly apparent in the Flint Creek Range, however, and seemingly little would be gained by trying to differentiate them here.

The formation, as exposed along Foster Creek and Cable Creek, is medium-bedded magnesian limestone that characteristically alternates between light-colored and dark beds (Emmons and Calkins, 1913). The very dark gray to black tone that is so common elsewhere in the Jefferson is uncommon here, probably because of bleaching by mild thermal metamorphism from nearby intrusives. Most exposures of the Jefferson Formation in the Southern Flint Creek Range are either cut off by intrusions or truncated or repeated by faulting, making a realistic estimate of thickness difficult. Emmons and Calkins (1913) reported a thickness of 1,000 feet in the neighborhood of Princeton, 6 or 8 miles north of the subject area, and Poulter (1957) measured 1,400 feet of combined Jefferson and Three Forks beds about 6 miles to the west.

MISSISSIPPIAN ROCKS

MADISON GROUP

The principal exposures of limestone of the Madison Group are to be found along upper Warm Springs Creek, in T. 6 N. Here, the formation crops out on both sides of the road; the bluffs on the east side of the road are most prominent. Scattered exposures of this formation can also be found in the southern and southeastern part of the map area.

The Madison Group, as exposed in the southern part of the Flint Creek Range, is approximately 1,200 feet thick (Wanek and Barclay, 1966), and probably contains the equivalents of both the Lodgepole Limestone and Mission Canyon Limestone as recognized elsewhere. No effort has been made to differentiate the group into its component formations here, however.

The lower part of the Madison, about 300 feet in thickness, is composed of thin- to medium-bedded dark gray limestone and calcareous shale. The upper part, about 900 feet in thickness, is composed of thick-bedded to massive lighter gray limestone. The upper part of the Madison is distinctive for two reasons, the abundance of chert and its abundant fossils. The chert, which tends to form layers, gives many exposures a banded appearance. Fossils characteristic of Madison outcrops are small crinoid stem segments and horn corals, but numerous other forms are present to tempt the collector.

PENNSYLVANIAN ROCKS

AMSDEN FORMATION

The Amsden Formation, here designated as Pennsylvanian, is generally regarded as transitional between Mississippian and Pennsylvanian. The Amsden is differentiated on the map (Pl. 1) in the southeast corner of the area where the geology is adapted from that of Csejtey (1962) and of Wanek and Barclay (1966), but not in the remaining area first mapped by Emmons and Calkins (1913), who regarded these beds as a lower member of the Quadrant Formation.

In the mapped area, the surface expression of the Amsden is an inconspicuous covered slope. Where exposed, the formation consists of 100 to 300 feet of soft red-brown shale and sandstone and some thin gray limestone beds. Although the formation is rarely exposed, it is indicated by reddish soil cover.

QUADRANT FORMATION

The Quadrant Formation, which overlies the Amsden with apparent conformity, has a thickness of 150 to 200 feet where measured in the Lost Creek-Timber Gulch area (Wanek and Barclay, 1966). Emmons and Calkins (1913) reported a thickness of 430 feet, but this figure includes not only the Amsden, as already mentioned, but also the overlying Phosphoria Formation, which amounts to roughly half of the measured thickness. The Quadrant Formation is found in isolated outcrops in the southeastern corner of the area and along a fairly continuous narrow belt that curves smoothly from the south-central to the north-central part of the map area.

The Quadrant is composed of thick-bedded white to light-gray quartzite, which characteristically forms bold outcrops.

PERMIAN ROCKS

PHOSPHORIA FORMATION

The Phosphoria Formation in the Southern Flint Creek Range is 150 to 200 feet thick (Emmons and Calkins, 1913, measured a section at Philipsburg that suggests a thickness of 210 feet for this unit). The upper half to two-thirds of the formation is composed of medium-bedded somewhat impure limonite-stained quartzite. The lower part, which is much less prominently exposed, is composed of mottled gray limestone and tan sandstone, and in a few locations a thin bed of black phosphate rock is present. The Phosphoria Formation is differentiated in the south-central part of the area where mapping is from Csejtey (1962), but is included with the Quadrant Formation in the north-central part of the area.

JURASSIC ROCKS

ELLIS FORMATION

The rocks overlying the Phosphoria in most places are Jurassic in age, and were referred to the Ellis Formation by Emmons and Calkins (1913), although more recent authors (Mutch, 1961; Csejtey, 1962; and Wanek and Barclay, 1966) have refrained from being so specific. Thickness is approximately 400 feet, and outcrops parallel those of the underlying Phosphoria Formation from Olson Gulch northward to the north boundary of the area.

The Ellis Formation is dominated by dark-gray to gray-green calcareous shale but it contains lesser amounts of yellow to brown thin-bedded sandstone. This generally nonresistant lithology leads to subdued outcrops.

CRETACEOUS ROCKS

KOOTENAI FORMATION

The basal Cretaceous deposits in the Southern Flint Creek Range area belong to the Kootenai Formation, which has a total thickness of 1,500 feet (Emmons and Calkins, 1913). The unit is considerably thinned by faulting in many of its exposures, however.

The basal unit of the Kootenai Formation here, as in most places, is a conglomerate layer a few feet to perhaps 20 feet thick. This conglomerate is composed principally of white quartzite pebbles in a sandstone matrix, which serves to distinguish it from a calcareous conglomerate in the upper part of the Ellis Formation, as Emmons and Calkins pointed out. The main body of the Kootenai is composed of red to gray-green sandstone and shale. About 300 feet below the top of the formation (where preserved) there is a series of gray limestone beds, some of which are very fossiliferous and are collectively referred to as the "Gastropod limestone". In the upper 200 to 300 feet, the Kootenai is composed of dark calcareous shale amid thin-bedded limestone layers.

Kootenai rocks are to be found in a few small exposures along the south boundary of the area just east of the "Lime Quarry". The main outcrop, however, parallels the northeast-trending belt of older Mesozoic and Carboniferous strata from Olson Gulch to Racetrack Peak.

COLORADO FORMATION

Exposures of the Colorado Formation (Upper Cretaceous) are restricted to the southeastern corner of the map area, completely isolated from exposures of the Kootenai. Wanek and Barclay (1966) reported that neither the base nor the top of the Colorado is observable at these exposures.

The formation, as exposed along Lost Creek, is composed of dark-gray calcareous shale, siltstone, and limestone in its lower part; several resistant chert-pebble conglomerate beds toward the middle; and thick-bedded coarse gray sandstone intercalated with thin gray shale in the upper part.

TERTIARY ROCKS

TERTIARY CONGLOMERATE

Southern Flint Creek Range sedimentary deposits of Tertiary age are dominated by conglomerate. Wanek and Barclay (1966) suggested a thickness of 400 feet for these deposits, and on the basis of fossils, assigned a Miocene age. The section includes conglomerate, siltstone, minor shale, and even a few thin beds of lignitic coal. The usual aspect of the deposit, however, is unconsolidated boulder conglomerate.

Distribution of Tertiary sediment is restricted to the southeastern corner of the range, on the lower slopes. The most extensive outcrops are to be found between Antelope Gulch and Modesty Creek, but the caps of some of the low hills north and northeast of Anaconda also provide good exposures.

QUATERNARY DEPOSITS

Surficial deposits of Quaternary age cover fairly large parts of the mapped area. These deposits have been subdivided, for purposes of mapping, into four broad categories; morainal deposits, terrace gravel, landslides, and alluvium.

Morainal deposits constitute by far the greatest part of the Quaternary cover. These glacial deposits occupy large areas along the valleys of the four major drainage courses in the area, Racetrack Creek, Lost Creek, Warm Springs Creek, and Flint Creek. In general, they are relatively thin, hummocky, conspicuously unsorted deposits covering the valley bottom and extending a considerable distance up the adjacent slopes. An especially large terminal moraine blocks the mouth of Racetrack Creek.

Quaternary terrace gravel deposits are found in only one location within the mapped area, capping low hills on the north side of Warm Springs Creek about 2 to 2½ miles west of Anaconda. Based upon evidence obtained elsewhere, Emmons and Calkins (1913) judged these gravels to be younger than Tertiary but older than much if not all of the glacial deposits.

The principal area occupied by Quaternary alluvium is along the southern boundary of the map area in the valley of Warm Springs Creek. Lesser accumulations are to be found along the other drainages, especially on lower Lost Creek, but areas large enough to constitute a good-sized pasture are distinctly rare. A few small areas of landslide material have been mapped in the southeast corner of the area (Wanek and Barclay, 1966).

IGNEOUS ROCKS

EXTRUSIVE ROCKS

LOWLAND CREEK VOLCANICS

Most recent investigators (Csejtey, 1962, and Wanek and Barclay, 1966) have included discussion of the Lowland Creek Volcanics with that of the sedimentary rocks, presumably because they were in fact deposited upon the land surface, and in most places display at least a crude banding or layering. The rocks are of unquestioned volcanic origin, however, and probably no more than 10 percent of the total accumulation exhibits characteristics imparted by generally recognized sedimentary processes. Therefore, the present author prefers to adhere to a perhaps older tradition, and discuss them under the heading of extrusive igenous rocks.

The Lowland Creek Volcanics have been subdivided into three members by Wanek and Barclay (1966), who related these units to the lower three members observed by Smedes (1960) farther east, north of Butte. The basal member, which is the only one that seems to be dominantly sedimentary (fluviatile) in origin, has a maximum thickness of 400 feet, and is exposed on the barren slopes of English Gulch and near the mouth of Lost Creek. These deposits, which unconformably overlie the Colorado Shale, are dominated by conglomerate but contain a lesser amount of arkose and minor siltstone and clay. The conglomerate is composed of cobbles of older rocks (especially quartzite), whereas the arkose is composed of quartz, feldspar, and hornblende grains of somewhat uncertain origin. Volcanic materials do occur in this member, in all facies, but they are decidely minor.

The middle member, referred to as the "Ash-Flow Tuff" member by Wanek and Barclay (1966), and as the "Welded Tuff" unit by Csejtey (1962) as well as by Smedes (1960), is separated from the lower member by an erosion surface, and Csejtey also noted a slight angular unconformity between the two. The member, which is as much as 3,000 feet thick, is composed of grayish ash-flow tuff, gray to grayish-red quartz latite flows, and gray lapilli tuff (Wanek and Barclay, 1966), and minor welded tuff and some conglomerate. Principal exposures are on both sides of lower Antelope Gulch, both sides of Lost Creek at the mouth, and in the gulch west of English Gulch, northwest of Anaconda.

The Ash-Flow Tuff member is overlain, with pronounced angular unconformity according to Csejtey (1962), by the upper or Volcanic Breccia and Red Bed member of Wanek and Barclay (1966), which would seem to be correlative with the third, or Breccia Unit member of Smedes (1960). This unit, as described by Wanek and Barclay (1966), is as much as 600 feet thick and is composed of quartz latite breccia and agglomerate, quartz latite flows, and lesser tuffaceous beds, sandstone, and siltstone. The great bulk of the member is gray to gray-brown and is clearly volcanic in origin. The upper part grades into a sedimentary facies, especially conglomerate, which may or may not be properly included within the Lowland Creek deposits. Wanek and Barclay (1966) noted an unconformity between these conglomerate beds and the Tertiary (Miocene) conglomerate south of the present map area, but the present author has not differentiated them in the Antelope-Modesty Creek area. Other exposures, still mapped as upper Lowland Creek, include the hillsides directly north of Anaconda, and two small areas along Antelope Creek.

INTRUSIVE ROCKS

Intrusive rocks are exposed at the surface over a fourth to a third of the mapped area, and they include a surprising variety of lithologic types. Depending upon the source consulted, there are 12 to 14 recognizable and mappable varieties of intrusive rock within the subject area. Without wishing to impugn the petrological accuracy of these distinctions, however, the present author suggests that several are facies variations of the same activity, and others, though they may be genetically distinct, are sufficiently alike petrologically to be classified the same. In support of this contention is the fact that the mineralizing solutions that have affected widely separated sections of the area also seem to find the various igneous facies about alike. Therefore, in the interest of greatly simplified discussion, the author has consolidated the intrusive igneous rocks under seven clearly separable headings.

BASIC SILLS

An extensive sill of hornblende-rich gabbro intrudes the upper part of the Missoula Group in the southeast part of the area. Exposed over a strike length of about

14 miles, the gabbro has a thickness ranging from 150 to 400 feet as measured by Csejtey (1962). Emmons and Calkins (1913), who referred to the rock as "diabase", gave its composition as being principally labradorite (An_{55}) and hornblende, lesser oligoclase (An_{22}), and some quartz. Although the rock texture is locally diabasic, modern practice calls for using the compositional name gabbro. In one exposure the gabbro is more stock-like than sill-like, but throughout most of its outcrop it is a remarkably constant sill. In one locality it intrudes the Wallace Formation.

Age of the gabbro sill cannot be determined accurately. The only definite statement that can be made is that it is pre-Laramide faulting. Although the youngest rocks intruded by the gabbro in the map area are Precambrian, somewhat similar sills intrude the Colorado Shale (Upper Cretaceous) about 30 miles to the north. On this basis the writer would tentatively suggest a latest Cretaceous age.

Also included under this heading is a large body of very similar rock exposed along the north side of Dempsey Creek, near the northeast corner of the area. Outcrops of gabbro here, which Mutch (1961) thought to be a sill, extend for about 3½ miles along the drainage and are as much as half a mile wide.

GABBRO

One of two gabbro stocks in the southern part of the area crosses upper Olson Gulch, and the other lies along upper Foster Creek. Although the gabbro bears a superficial resemblance to the basic sills, it can be readily distinguished by the presence of biotite as a major megascopic constituent.

Both gabbro stocks are coarse grained and composed of approximately equal amounts of hornblende and anorthite, but containing lesser augite, minor quartz, and of course biotite. Emmons and Calkins (1913) noted that the Foster Creek stock is somewhat less basic than the Olson Gulch one, having a bit more quartz and some microcline, but the plagioclase mineral in both is anorthite. Emmons and Calkins (1913) referred to these rocks as basic diorite; but the writer prefers to follow Wahlstrom's convention (1947), and refer to rocks whose plagioclase is more calcic than andesine as gabbro.

Age of the gabbro stocks is Tertiary, and they are clearly younger than the gabbro sills, because they cut across the same generation of Laramide folds and faults that offset the sills. The stocks are tentatively judged to be the oldest of the Tertiary intrusive bodies because they are the most basic, and because they are in turn intruded by granite.

HORNBLENDE QUARTZ DIORITE

A medium-size stock of hornblende-rich quartz diorite crops out over an area of 3 to 4 square miles along and south of upper Racetrack Creek. A few small outcrops of similar material are exposed south of Modesty Creek as well. Csejtey (1962) has referred to this body as the Racetrack Creek Pluton, a name that seems appropriate and will be retained here.

Some disagreement exists as to the correct terminology for this rock. Emmons and Calkins (1913) referred to it as diorite, whereas Allen (1961), Mutch (1961), and Csejtey (1962) all used the name granodiorite.

Because Allen's petrologic work is the most detailed, his average mode for the rock would seem to be the most reliable; average mineral composition is given as follows: Plagioclase (An_{34}), 41.7 percent; quartz, 21.9 percent; biotite and chlorite, 15.9 percent; potash feldspar, chiefly microcline, 10.5 percent; epidote, 5.2 percent; hornblende, 4.1 percent; and opaque minerals, 0.1 percent. Although the present writer will accept this mode, even though it seems unduly low in hornblende, he cannot agree with the nomenclature, preferring the designation quartz diorite for this composition.

The rock is medium to coarse grained, dark gray, and noticeably gneissose in most exposures. Its age relationship to other intrusive rocks in the area is uncertain. Csejtey (1962) thought it older than the porphyritic quartz diorite of the Mount Powell batholith to the north and west because of their contact relationships, and also because of its gneissocity. The granodiorite of the Philipsburg batholith might also be thought younger, tentatively, because it is somewhat more alkalic, but equally likely is the interpretation that the two rocks are essentially contemporaneous.

GRANODIORITE

A granodiorite body, commonly referred to as the Philipsburg batholith, occupies the northwest corner of the mapped area, and exposures of the batholith continue for several miles both north and west beyond the map boundary. Very similar granodiorite crops out in another, smaller area between Cable and Georgetown. This body, which is slightly more than 2 square miles in surface area, is herein referred to as the Cable stock.

Composition of the granodiorite of the Philipsburg batholith, as indicated by Emmons and Calkins (1913), is plagioclase (An_{40}), 30 percent; quartz, 30 percent; orthoclase, 25 percent; biotite, 10 percent; and hornblende, 5 percent. The Cable stock although very similar, contains more plagioclase and less quartz, the other constituents being about the same.

Age relationship to other intrusive rocks in the district can only be inferred. The batholith is in intrusive contact with Precambrian rocks of the Wallace Formation on the south and west and with Paleozoic sedimentary rocks on the east. It is separated from the neighboring and similar Mount Powell batholith on its eastern boundary by a thin screen of sedimentary rock that is less than a quarter of a mile wide in some places. Although the two bodies may be contemporaneous, differences in both texture and mineral composition suggest that they are not. The Philipsburg batholith, being very slightly more basic, is here tentatively judged to be the older.

PORPHYRITIC QUARTZ DIORITE

The large mass of porphyritic quartz diorite that occupies the northeastern corner of the mapped area was named the Mount Powell batholith by Emmons and Calkins (1913). Again, disagreement arises over terminology, a result of the profusion of classifications available. Although all investigators agree in general on the mineral composition of the rock, Emmons and Calkins (1913) and Mutch (1962) called it granite whereas Csejtey (1962) and Allen (1961) referred to it as granodiorite. The present author, however, will refer to it as porphyritic quartz diorite.

An average of seven modal analyses by Mutch (1961) gives a composition of 40 percent plagioclase (An_{20}), 34 percent quartz, 20 percent microcline, and 6 percent other, mostly biotite and muscovite. Allen (1961), averaging 32 analyses, reported 47 percent plagioclase (An_{27}), 29 percent quartz, 18 percent microcline, and 6 percent biotite and muscovite. The differences in the two modes do not seem significant, as they are no greater than those between successive samples.

The rock of the Mount Powell batholith is light gray and markedly porphyritic in most exposures. Phenocrysts are white microcline, and some are 1 to 3 inches in length. Groundmass is generally granitic and medium to coarse grained. The batholith is bordered by sedimentary rocks except where embayed by the Racetrack Creek Pluton on the southwest. Intruded strata range in age from Precambrian to Cretaceous. As discussed in the preceding section, the batholith is here thought to be slightly younger than the adjacent Philipsburg batholith to the west.

BIOTITE GRANITE

Several small stocks of biotite granite crop out near the southern margin of the area. The largest of these, roughly 2 square miles in surface area, has been called the Lost Creek stock by Csejtey (1962). Other, smaller exposures of very similar rock are to be found crossing upper Warm Springs Creek, along upper Foster Creek, and just north of the limestone quarry. There are several other, even smaller exposures as well.

Although no two of these intrusive bodies are exactly alike in all details, all have several features in common, and it seems likely that they are all genetically related, even if not strictly contemporaneous. All are light gray, all contain biotite mica as a prominent constituent, all are characterized by sodic plagioclase and microcline, and apatite and zircon are minor accessories in most if not all of them. Grain size decreases, generally, from east to west, being coarse in Lost Creek and medium fine on upper Warm Springs Creek. There also seems to be an increase in the calcium/sodium ratio in the plagioclase from east to west. The plagioclase of the Lost Creek stock is albite (An_5) according to Csejtey (1962), whereas that of the small body on upper Warm Springs Creek ranges from oligoclase to andesine (An_{15} to An_{40}). All these minor granite intrusive bodies postdate the Laramide fold and fault structures, and because of their alkaline composition, they are tentatively judged to be younger than the Mount Powell batholith.

DACITE AND DIORITE PORPHYRY

Twelve to fifteen small, generally lens- or dike-like intrusive bodies that range in composition from dacite to diorite have been mapped by Mutch (1961) and Csejtey (1962) in the northeastern quarter of the map area. Most of these small masses intrude the Mount Powell batholith, but a few have intruded adjacent sedimentary rocks. The generally north-northeast elongation of their outcrops led Csejtey (1962) to suggest that their intrusion was controlled by prominent subparallel joints of that orientation.

All of the included intrusive bodies are porphyritic, but there seems to be a general trend toward more basic composition and coarser texture from south to north. Thus those cropping out along and south of Dempsey Creek generally have an aphanitic groundmass and essentially dacitic composition, whereas those near Mount Powell have a fine-grained but phaneritic groundmass and dioritic composition. In all of them the rock is darker and finer grained than the enclosing Mount Powell granodiorite.

STRUCTURAL GEOLOGY

The structural development of the Southern Flint Creek Range is complex, as a glance at the geologic map (Pl. 1) will show. No effort will be made here to describe small individual structures, nor for that matter will the several episodes of deformation be discussed in great detail. Rather, a more general summary of regional and local structural trends would seem to be in order.

Two major structural elements bound the crustal block in which the subject area is located, and they seem to have exercised control over structures developed. The first of these, which passes about 20 miles north of the map area, has been called the Montana Lineament. The Montana Lineament extends as a nearly straight line in a west-northwesterly direction, from Helena to Spokane, Washington, or perhaps farther. The amount and precise location of its eastward extension is subject to some debate. Some authors feel that it cannot be traced continuously beyond Helena but others feel that it, or structures related to it, can be detected as far to the southeast as Billings.

The second of these major boundary elements has been named the Perry Line. This lineament follows an east-northeast path, and its location has been established mainly on the basis of the depositional belt of the LaHood Conglomerate (Precambrian) from Jefferson Canyon through the Bridger Range to the Crazy Mountains, about 30 miles north of Livingston. The westward extension of this lineament is somewhat in question. McMannis (1963) has traced the belt of LaHood deposition as far west as the south flank of the Highland Mountains, where it abuts against the north-trending Armstead-Melrose thrust zone. Gillette (1965) suggested that west of Jefferson Canyon the Perry Line may swing slightly more southward, passing approximately through the Mayflower, Silver Star, and Rochester mining districts, and terminating in the McCarthy Mountains. Whether this lineation of structural features can be carried even farther to the west is also subject to question. Certainly the coarse facies boundary provided by the LaHood Formation does not extend west of the Highland Mountains, but it is equally obvious that a series of structural dislocations continues along a near-linear path from the McCarthy Mountains along the south flank of the Pioneer Mountains roughly through the Argenta mining district, then just south of the Big Hole divide, and into Idaho via Lemhi Pass.

The precise origin and history of the Montana Lineament and Perry Line is hardly a subject for the present study, and in fact neither structure is entirely understood. Both structures, however, are extremely old, having been active at least as early as pre-Beltian (Precambrian) time, and both have remained active into the Tertiary if not even more recently. Both likewise seem to be primarily fault structures, the Montana Lineament being dominated by strike-slip movements, whereas the Perry Line has seen more of vertical displacement, although the sense of those movements cannot have been constant. The aspect of these two lineaments that concerns us with respect to the Southern Flint Creek Range, however, is the physical nature of the mobile block they outline. This is a wedge-shaped block 125 to 150 miles wide at its western base within Montana and 150 to 200 miles long, pointing eastward roughly toward the Crazy Mountains. The triangular block so defined includes structures that are the result of eastward-directed compression; it is characterized by several medium-size to large granite intrusions; and it contains within it and along its boundaries most of the metal-producing areas of Montana.

On a more local scale, one of the major structures of the range is the prominent thrust fault that extends from Georgetown Lake on the south, essentially along the upper Flint Creek valley until its exposure terminates against the intrusive rock of the Philipsburg batholith. The western block of the fault was the mobile one, and it moved eastward over the eastern block bringing Precambrian rocks predominantly of the Wallace Formation into contact with middle Cambrian strata. This thrust, referred to as the Georgetown thrust by Poulter (1957), cannot be traced definitely beyond its juncture with the Philipsburg batholith near Red Lion. Another thrust, however, mapped by Emmons and Calkins (1913) as emerging from the north side of the batholith near Princeton, is nearly on line with the Georgetown thrust and may well be its northward extension. Both of these thrust fault segments roughly parallel the major Philipsburg thrust, which lies 5 to 6 miles to the west. It seems reasonable to assume that these faults are related, both possibly being imbrications of the same eastward-moving block. For the map area under study, the principal importance of the thrust faulting is that it seems to have brought a barren block of rock from the west against the mineralized belt of Cambrian strata that borders it on the east. Because the thrust faulting clearly predates the igneous activity, which is believed to have fathered mineralization, this boundary would seem to be related to rock favorability rather than to the availability of mineralizing solutions.

Next in terms of structural prominence is a narrowly triangular, fault-bounded block extending roughly from Cable to Warm Springs Creek on the south, and narrowing northward until it crosses the northern map boundary about a mile west of Racetrack Peak. The block so defined contains three major faults in its southern portion and two in the north. The faults dip steeply eastward, and the eastern blocks are downthrown, forming a series of steps. The narrow stem at the north end of the fault block forms the thin screen or septum that separates the Philipsburg batholith on the west from the Mount Powell batholith on the east.

The southeast quarter of the map area is a veritable jigsaw puzzle of small fault blocks, including some thrust and reverse faults, but dominated by normal faults of relatively short strike extension. Faults of nearly any orientation are to be found in the group, but the overall trend forms an arc around the south end of the Mount Powell batholith. Although these minor faults serve to complicate the local geology to a marked degree, they do not seem to bear any consistent relationship to the numerous small igneous masses in the area, and they do not exercise any apparent direct control over mineralization.

Fold structures are less easily defined, in the Southern Flint Creek Range, in considerable part because of the numerous fault dislocations, which destroy their continuity. This is not meant to imply that fold structures are lacking, then, but that such folds as there are tend to be of small magnitude individually, and most of them cannot be traced for very great distances along their strikes.

There is some spatial evidence to suggest that folding has exercised some subtle control over mineralization, although localization is probably determined to at least as great a degree by favorable lithology. Probably the most continuous fold structure in the map area is one that Poulter (1957) has referred to as the Cable Mountain anticline. It will be noticed that the mines of the Georgetown, Southern Cross, and Red Lion districts, and even the Gold Bar Basin portion of the Twin Peaks district are located along the west flank of this generally anticlinal structure. Another fairly distinct trend begins roughly between the mouths of Foster Creek and Warm Springs Creek, and extends northward along complexly folded Paleozoic (mostly Mississippian) strata through the Johnson Basin, Welcome Hill, and Northern Cross districts, to the Powell mines. It does not seem reasonable to assume that this concentration of mineralization along belts of folded strata is entirely fortuitous.

Csejtey (1962), in analyzing the fold structures of the Flint Creek Range generally, noted that the pre-Middle Cambrian folding, which has affected the Missoula Group and older rocks of the region, and the Late Cretaceous-Early Tertiary Laramide folding have the same north-northeast trend. This bears out the contention that the triangular block lying between the Montana Lineament and Perry Line has been subjected to recurrent, eastward-directed stress for an extended time, and that this stress orientation, both in its active and its passive phases, has determined the structures of the Southern Flint Creek Range.

METALLIC DEPOSITS

HISTORY AND PRODUCTION

Although gold was first discovered in Montana at Gold Creek on the north end of the Flint Creek Range in 1852, it was thirteen years later before mining at the south end of the range began with the opening of the Georgetown placers in 1865. Placer mining, however, was never a major form of production in the Southern Flint Creek Range. The gravels were almost universally poor in gold, and the Georgetown and Flint Creek placers were also exceptionally deep. Probably the only placer in the south end of the range to return a profit to its operators was the Cable placer. This deposit is credited with production of "several" hundred thousand dollars in gold during the early years of operation at Cable (Emmons and Calkins, 1913). Total placer production from the Southern Flint Creek Range, however, probably did not exceed $575,000 (27,700 oz. Au), almost all of which was mined well before 1900.

Lode mining began with the discovery of the "Atlantic" Cable in 1866, followed by discoveries at Southern Cross and Georgetown shortly thereafter in the early seventies. Then prospecting carried eastward around the south end of the range, and northward toward its center. The Silver Lake and Blue Eyed Nellie districts were opened during the early eighties, the Red Lion mine was discovered in the late eighties, and properties on Lost Creek and Modesty Creek were first claimed during the middle nineties. Most of the other districts had gotten their start by the end of the year 1900.

Compiling accurate production statistics for individual mines in districts that were active as early as those in the Southern Flint Creek Range is a nearly impossible task, but district totals are presented here that are believed to be reasonably correct. Figures provided by Emmons and Calkins (1913) for the period prior to 1906 are virtually the only available record of that era but are thought to be accurate because they were derived in large part from people who had been there and had firsthand knowledge of what properties had been active and to what extent they had produced. Production data published by the United States Government have been used for the period 1906-68, and these data are reasonably complete, although not specific as to production of individual mines. Then too, for a few properties it has been possible to check published data against estimates by property owners, and for some others, to roughly check the volume of stopes mined against supposed production tonnage.

Overall mine production of the mining districts of the Southern Flint Creek Range is estimated to have yielded gross receipts of just under $14 million (Table 1). Of this total, about 83 percent was the product of only four districts; the very closely associated Southern Cross, Cable, Gold Coin, and Georgetown districts. Roughly 40 percent of the total production was obtained prior to 1906, the period covered by Emmons and Calkins (1913). The principal producing district during those early years was Cable, much smaller contributions coming mostly from the Southern Cross, Georgetown, and Blue Eyed Nellie districts. The period since 1906 has been dominated by the Southern Cross district, which added $6 million to the total, plus major contributions by the Gold

Table 1.—Metal production, by districts, Southern Flint Creek Range, 1865-1968

District	Au, oz.	Ag, oz.	Cu, lb.	Pb, lb.	Zn, lb.	WO_4, lb.	Value	Principal producing mines
Southern Cross	271,922	316,529	1,042,623				$ 6,568,838	Southern Cross, Hold Fast, Oro Fino, Short Shift, Golden Wedge
Cable	165,127	134,904					3,535,820	Cable, Cable placer
Gold Coin	34,854	132,904					1,073,685	Gold Coin, Hub
Blue Eyed Nellie		600,000		9,000,000			1,000,000	Blue Eyed Nellie
Hidden Lake	18,896	1,125					644,000	Hidden Lake
Georgetown	21,397	8,317					452,253	Pyrenees, Luxemborg, Ontario, Reliance, Georgetown placer
Johnson Basin		15,000				77,000	240,000	New Year, Tip Top
Red Lion	5,733	11,046	1,489				137,944	Red Lion, Hannah, Mickey Glittering Hill
Olson Gulch	2,177	38,411	4,000				83,587	Cameron, Silver Chain, Antelope
Silver Lake	125	50,000	2,500	95,000	55,000		82,000	Silver Reef, Hidden Treasure
Lost Creek	1,987	8,930	500	2,000			47,100	Silver King, George, Silver Queen
Others	1,316	15,465	20,000			1,200	54,374	Welcome Hill, St. Thomas, Nineteen Hundred, Amazon, Dark Horse, Powell
Totals	523,534	732,310	1,071,112	9,097,000	55,000	78,200	$13,919,501	

Coin and Hidden Lake mines. Other districts, although adding considerable production in the aggregate, were relatively minor producers individually.

That the amount of time and money spent on exploration and development in the Southern Flint Creek Range is out of proportion to the return is obvious. Comments on this by Emmons and Calkins (1913) are revealing. They remarked with reference to the Powell mine that "More than 2,500 feet of drifts and crosscuts have been run . . . . Some ore has been shipped from the mine, but though great expenditure has been made for prospecting no profitable deposit has yet (1907) been discovered." That the mine in later years managed a few more small shipments of ore is beside the point, it has never even begun to repay the investment made in it. Although the comment applied to one specific property, the same could be said with equal justice of numerous others whose owners were noteworthy more for their optimism than for their prudence. Looking briefly to the future, any remaining potential as metal producers that the Southern Flint Creek Range districts may have rests in the store of relatively low-grade primary ore that may be present at depths not yet explored in the mines. If these possibilities are to be explored at all, it will have to be done with more forethought than has been exercised to date.

ORE OCCURRENCE

This section will be concerned with the general character of the mineralization and such regional controls of that mineralization as have been recognized. For observations on specific deposits, the reader is referred to the sections that follow, in which the several districts and their individual mines are discussed.

The deposits of the Southern Flint Creek Range have produced significant amounts of gold, silver, copper, lead, zinc, and tungsten, but gold has been by far the most important product of the region, total value of the gold produced being almost nine times the total for all other metals. Future production can probably be expected to continue this dominance of gold, but possibly an increasing role may be played by some of the other metals, especially copper. The deposits that have produced these metals are of three types, although it must be noted that some individual properties contain more than one of the types of ore. These types, to be discussed separately in the following paragraphs, include fissure veins in intrusive rocks, veins and replacement lodes in sedimentary rocks, and contact metasomatic replacement deposits.

Fissure-filling veins in intrusive rocks, which have had such importance in the nearby Granite mining district, have to date been of very small import in the southern part of the range. The only significant production from veins of this type has come from the Luxemborg and Pyrenees mines in the Georgetown district. Although other structures of this type have been prospected at other properties, such as the Amazon mine in the Racetrack district, production has ranged from disappointing to nonexistent. In describing the Pyrenees and Luxemborg veins, Emmons and Calkins (1913) noted their mineralogical simplicity—quartz and auriferous pyrite and a lesser amount of calcite, the whole forming fissure fillings and sheeted zones in the granodiorite of the Cable stock. Oxidation in the upper portions of the veins, of course, altered the pyrite to limonite, leached away most of the calcite, and left the gold as free-milling metal.

Nearly all of the mines in the subject area explore mineralized structures in sedimentary rocks, and more than half of the total metal produced has been derived from deposits of this type. Emmons and Calkins (1913), in their exhaustive treatment of the deposits developed to that time, noted that mineralization was known in almost every pre-Tertiary sedimentary unit. Economically important mineralization has been a great deal more selective, however, being almost restricted to carbonate and quartzite, and of these, favoring those of Cambrian age. More will be said of this relationship later. All deposits of this group seem to be controlled by fault fissures, but replacement has been important in the formation of virtually all of those that are enclosed in carbonate rocks. Thus although veins in quartzite will simply fill the fissure or breccia zone available, those in limestone will almost invariably display replacement of the adjacent wall rock to a greater or lesser degree. Veins may either parallel or cross the bedding. Those that cross the bedding tend to exhibit swells or shoots where they cross favorable beds.

Mineralization in these veins is of two types, those containing gold almost to the exclusion of other metals, and those notable for their contained silver, lead, and zinc. Those of the first type are to be found in the Southern Cross and Gold Coin districts, among others, and those of the second in the Silver Lake, Olson Gulch, and Blue Eyed Nellie districts.

Gold veins are similar to those in intrusive rock except for their copper content. Minerals include quartz, pyrite, lesser calcite and chalcopyrite, and minor amounts of pyrrhotite and magnetite. Gold occurs as finely divided particles in pyrite. Silver content ranges from roughly equal to that of gold, to as little as one-tenth that of gold, but in all deposits its value is much less. Oxidation produces a characteristic red limonite, containing fine free gold and in some places copper carbonates.

Silver vein gangues are similar to those of the gold veins, being dominated by quartz and containing much less calcite. The sulfides, in general order of abundance, are galena, sphalerite, and tetrahedrite. Pyrite is generally not conspicuous. Most of the silver is in argentite, although some is doubtless included in both galena and tennantite as well. Oxidation produces minor limonite and carbonates of copper and lead.

There is only one contact metasomatic replacement deposit of any importance in the area, but that one is the Cable mine, and it is the second largest metal producer. Thus this deposit "group" assumes an importance somewhat out of proportion to the number of known deposits. The Cable mine is in what is essentially a roof pendant of Hasmark Limestone (Cambrian), which penetrates the roof of the Cable stock. At the contact with intrusive rock, the limestone has been strongly metamorphosed to form garnet-epidote skarn. Remaining limestone has been extensively marbleized, the effect being to lighten its color and increase its grain size notably.

Deposits formed are of two types, large irregular masses of magnetite, which are of no present economic importance, and the tremendously productive calcite-quartz-pyrite-gold lodes. Because the property has not produced much since 1910, Emmons and Calkins' (1913) description of the ore will be repeated here; "The Cable ore bodies are replacement deposits of contact-metamorphic (metasomatic) origin. The primary ore is coarse calcite carrying a variable amount of quartz, pyrite, chalcopyrite, pyrrhotite, arsenopyrite, magnetite, and gold so intimately associated as to indicate that they must have been deposited at the same time." Surface oxidation produced an accumulation of limonite, quartz, and gold, and some copper carbonates.

Several factors seem to control the location of valuable deposits in the Southern Flint Creek Range, some of them quite obvious but others less clearly apparent. First, of course, there is the spatial relation to intrusive igneous rock; the eastern part of the Georgetown district is within the Cable stock, and Cable is in a pendant of sedimentary rocks in its roof. The rich deposits at Southern Cross are adjacent to the Cable stock, those at Red Lion are almost as close to the Philipsburg batholith, and the lodes of Olson Gulch and Blue Eyed Nellie bear a similar relation to other, smaller intrusive bodies. The only major producer in apparent defiance of this "rule" is found at Hidden Lake, but the relationship is otherwise so consistent that one is tempted to suggest the presence of an intrusive body at no great depth below the deposit, even though no direct evidence of its presence can be offered.

Another ore control is suggested by the alignment of districts along northeastward-trending belts. These belts, one along the east side of the Georgetown thrust from Georgetown Lake to Red Lion and the other extending along the wedge of Paleozoic strata from Olson Gulch to Racetrack Peak, are characterized both by northeast-trending folds and by subparallel faults. This prominent concentration of deposits along geographically restricted belts simply cannot be fortuitous, but the degree to which structure has been effective, as opposed to favorable lithology, cannot readily be determined. As mentioned earlier (Structural Geology), the Georgetown thrust seems to mark the western boundary of important mineralization in that area. This may mean that the Wallace Formation lying to the west of the fault was chemically unfavorable to replacement or lacked open fractures suitable for fissure filling. Another, perhaps more likely possibility, inasmuch as the Wallace contains ore elsewhere, is that the fault itself has acted as a barrier to mineralizing solutions, and therefore opportunities for ore formation west of it were few. Conversely, at Hidden Lake the major Cable Mountain fault passing to the west of the mines may well have been the agency whereby the source of mineralizing solutions was tapped at depth. The relationship of ore to folds is even less clear cut, but the recurrence of replacement lenses in minor flutes in the strata leads this investigator to suspect a subtle control.

The other ore control is lithologic. As mentioned earlier, although mineralization is known in all of the pre-Tertiary strata, important concentrations have been very selective in their choice of a host. Of the several favorable hosts, the dolomitic limestone in the upper and lower parts of the Hasmark Formation is by far the most favored. Although one cannot ordinarily prospect for ore satisfactorily with a pencil, in this case a little figuring discloses that roughly 91 percent of all the ore ever found in the Southern Flint Creek Range has come from veins and lodes within these two favorable zones, which aggregate about 900 feet in thickness. A correlation between host lithology and ore as consistent as this can hardly be ignored, yet there are prospects where reasonable projections of vein structure to intersect one or both of these zones have seemingly not been tested. Other, somewhat less favorable zones that have nevertheless been found to contain important ore bodies include the Madison, Jefferson, and Red Lion Limestones, and the limestone of the Wallace Formation, listed in order of their apparent favorability to mineralizing solutions. Very little mineable ore has been found in rocks of other lithology.

MINING DISTRICTS

Before the descriptions of individual mines and mining districts are presented, a few words of explanation of the basis on which individual properties have been assigned to districts would seem to be in order. To begin with, the "Mining District" is a phenomenon that has been with us since the earliest days of mine development in the western United States. It served an important social-political purpose at a time when there were no well-developed communities nearby, and the "law" was all too frequently determined by who had the necessary force to impose his views on others. The mining district, then, was the community that the miner could call home; it was the social center, and the "Miner's Courts" that were formed established the law locally and enforced it whenever necessary. Early mining districts, because they almost invariably began with placer mining activity, usually served only those prospects along a single drainage, or perhaps a series of stream forks that were close together. When lode mining entered the picture and claims extended up the slopes away from the placers and even crossed the divide into another drainage and "district", the confusion began.

Today, the original purpose of the mining district is gone. All mining must comply with uniform state and federal laws, and the miners tend to live in nearby urban centers, commuting considerable distances to work each day. The districts still serve a useful purpose in studies such as the one being presented here, however, in that they allow discussion of mining properties in groups of manageable size, and in which the several prospects or mines are likely to have a good deal of geological similarity.

The criteria used in assigning properties to districts herein are three; first, to adhere to tradition and include only those properties within a given drainage wherever possible; second, to retain the historically interesting names used by the miners who developed them; and third, to assign properties to the district indicated in the original location notice if at all possible. This last criterion is the one most frequently violated, owing in part to the multiplicity of names that vied for acceptance in the early days of some districts and in part to an unfortunate tendency of prospectors to assign their claims to whatever district had the largest production at the moment.

DEER LODGE COUNTY

BLUE EYED NELLIE DISTRICT

Much of the story of the Blue Eyed Nellie mining district has been lost with the passing years. Discovered about 1880, the Blue Eyed Nellie mine, which was the only property in the district to achieve significant production, was operated for 8 or 10 years until closed about 1890. Legend has it that the ore body had pinched out, and the owner, a Mr. Brown, then left Montana and went to Alaska. Sometime between 1890 and 1906 when Emmons and Calkins visited the district, there was a fire which burned in the mine shaft among other places. The stark dead trees that cover much of the surface of the district, now whitened by long exposure to the elements, are probably a legacy of that fire. Emmons and Calkins (1913) reported that the mine was inaccessible at the time of their visit, and it is inaccessible today, although it seems to have been reopened briefly between then and now.

District production, virtually all of which came from the Blue Eyed Nellie mine, probably included about 600,000 ounces of silver and 9 million pounds of lead, estimated to have been worth $1 million.

Blue Eyed Nellie mine.–The mine is located on exposures of the Hasmark Limestone, which locally strikes slightly west of north, roughly parallel to the long dimension of the claims (Fig. 2), and dips moderately westward. Mineralization consisted of siliceous replacement of limestone along generally west-striking fractures. The ore was found in three shoots that dip steeply south and are arranged in an en echelon pattern. Thus one shoot extended from the surface north of the main shaft to the 120-foot level about 80 feet south of the shaft. The second ore shoot extended from just above the 120-foot level about 200 feet southeast of the main shaft to a point 30 or 40 feet below the 300-foot level about 250 feet southeast of the main shaft and 180 feet northwest of the McCarty shaft. A third, much smaller, ore shoot found on the 350-foot level extended 30 to 40 feet above that level and 10 to 15 feet below it. This shoot was about 50 feet southeast of the second one (Fig. 3).

Primary mineralization was dominated by galena, but tetrahedrite (presumably argentiferous) was also contained in quartz gangue. Secondary minerals observed included the ever-present limonite, plus malachite and cerussite. Native silver would be expected under these conditions, but none was observed in any of the specimens examined.

An effort at deeper development of the mine was made at a later date. At that time an access tunnel 1,800 feet in length was driven from the Mohawk lode to intersect the presumed extension of the Blue Eyed Nellie structure on about the 700-foot level. Maps show some crosscutting from these workings, as well as a long sinuous raise to the 350-foot level, but no stopes. There is no record that any ore was produced from these deeper workings.

Other mines and prospects.–Although all of the known production of the district came from the Blue Eyed Nellie lode, there are other patented claims and a large number of unpatented claims in the district. As a matter of fact, about 140 lode claims have been recorded from the district over the years, although many of them are actually in other districts. Among properties visited by the writer were the Homestake, Surprise, and Mohawk. Workings on the Homestake lode were confined to a shaft about 40 feet deep in strongly marble-

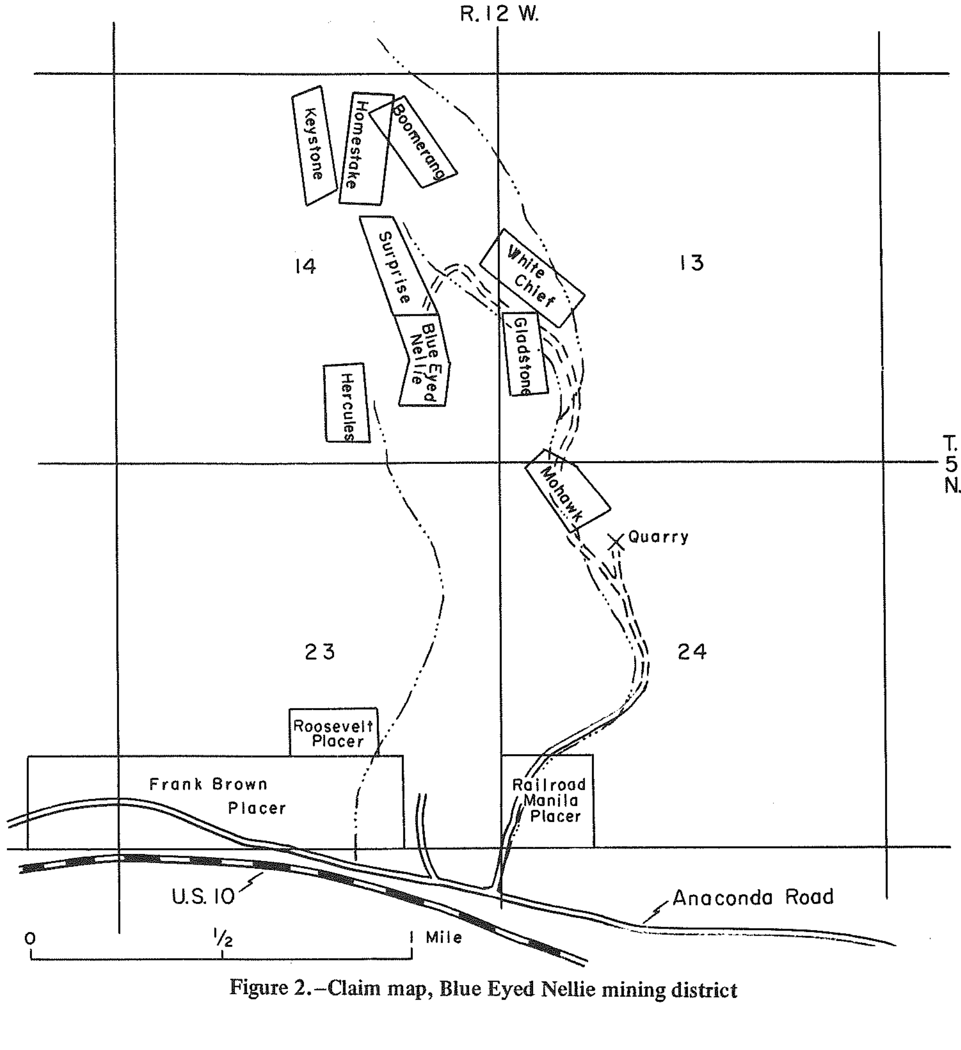


Figure 2.–Claim map, Blue Eyed Nellie mining district

ized Hasmark Limestone. Very little mineralization was noted, and there seems to have been no production. The three excavations on the Surprise lode are a vertical shaft or pit about 10 feet deep and two shallow inclines, 30 and 50 feet long. Observed mineralization was restricted to copper carbonate stains on quartz replacement of limestone. Again, there seems to have been no production. No indication of mineralization was observed on the Mohawk lode, and the large dump is the product of the long access tunnel driven to the Blue Eyed Nellie mine.

CABLE DISTRICT

The Cable mine, which with the adjacent Cable placer was the only producer of any consequence in the district, was the first property discovered in the Southern Flint Creek Range area. Located in 1866, the property went into operation almost immediately, producing $172,000, mostly in gold, in 1867 (Emmons, 1907).

Several other claims were located during the early years of development, but by and large they served as protective acreage surrounding the Cable lode; none shared the peculiarly favorable geological setting of the Cable, and as a consequence, none achieved production of record. In addition to the twenty patented properties shown on the district map (Fig. 4), about fifty other lode locations have been made over the years. None of these produced ore of record.

Total district production, including some from the Cable placer, is estimated at $3,535,820 from 165,127 ounces of gold and 134,583 ounces of silver. Although some copper is present in the ore, little or none of it was recovered. About 90 percent of the total production was realized prior to the beginning of the present century.

Cable mine.—The Cable mine is located on a narrow northwest-trending septum or pendant of limestone within the granodiorite Cable stock (Pl. 2). Most of the pendant is composed of strongly metamorphosed Hasmark Limestone, but some altered calcareous shale of the Silver Hill Formation is explored toward the southeast part of the mine.

The mine was developed by a series of levels, two of which are shown on Plate 2. In addition, reports indicate that there were three more levels below the tunnel level, which were serviced through winzes, and two levels above the tunnel level besides the one shown. Total depth of development below surface would be approximately 500 feet. The principal operating level can be seen to be almost a maze of branching tunnels, indicative of the complexity of the mineralized structure. Emmons (1907) noted that there seemed to be no consistent relation between the location of ore and the proximity of either igneous contact, nor for that matter were the stopes noticeably aligned at any particular elevation. Also,

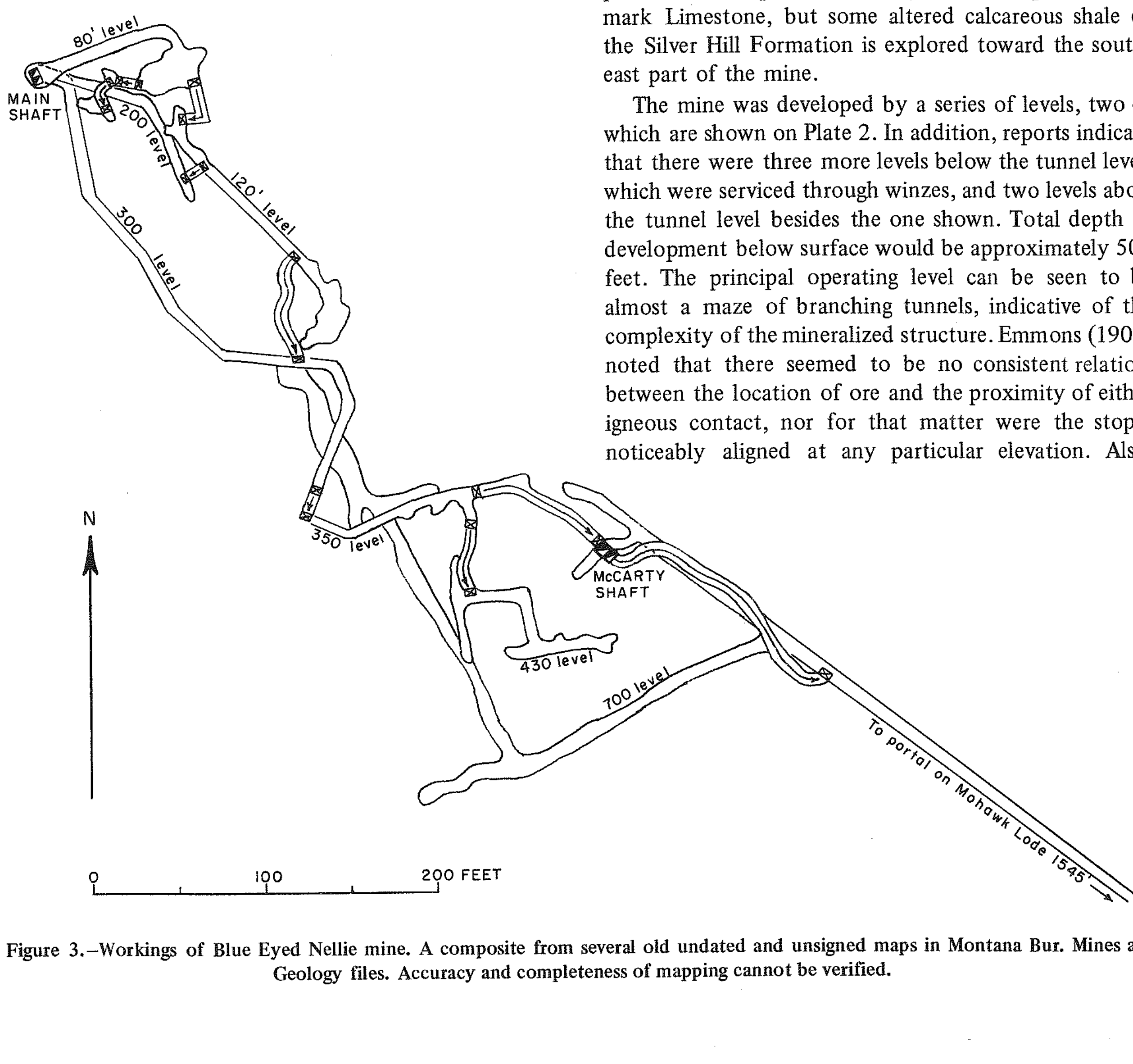


Figure 3.—Workings of Blue Eyed Nellie mine. A composite from several old undated and unsigned maps in Montana Bur. Mines and Geology files. Accuracy and completeness of mapping cannot be verified.

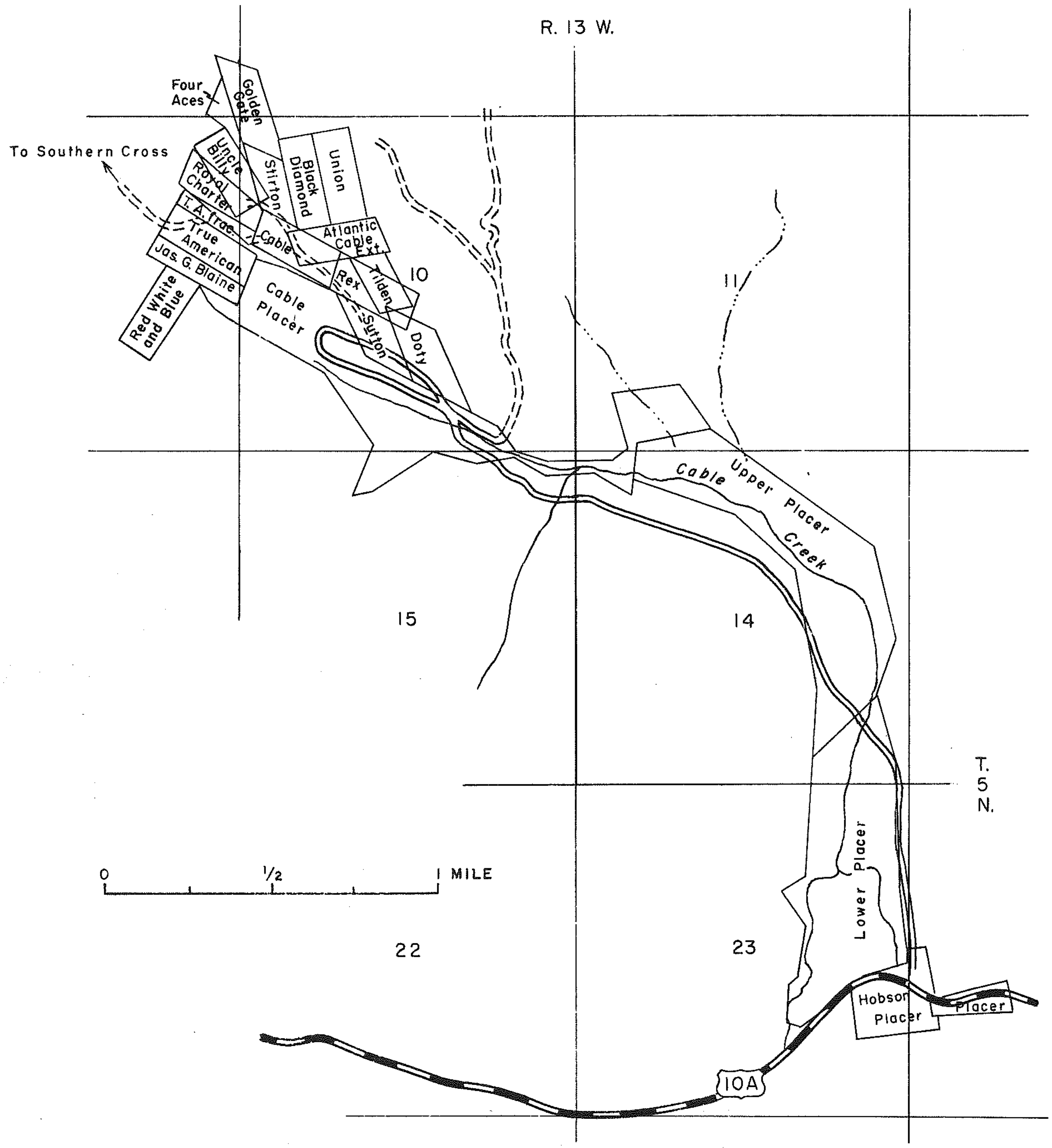


Figure 4.–Claim map, Cable mining district

although the large Lake stope was almost horizontal and parallel to the bedding of the enclosing limestone, other stopes were more steeply inclined and less clearly related to bedding.

The primary ore included quartz, introduced into the coarse-grained calcite of the host limestone, plus sulfides and oxides of iron and copper. The principal primary minerals, according to Emmons (1907), were quartz, pyrite, and chalcopyrite, with lesser magnetite and pyrrhotite. Gold was found disseminated in the quartz, calcite, and primary sulfides, and as larger nuggets and plates. Less prominent minerals that are also primary include galena, sphalerite, arsenopyrite, and marcasite. Minerals regarded as secondary by Emmons include limonite, hematite, chalcocite, bornite, malachite, azurite, chrysocolla, some manganese oxides, some native copper, and possibly argentite. Gangue minerals, besides quartz, include calcite, dolomite, siderite, and the usual contact silicates, garnet, epidote, wallastonite, actinolite, and mica.

In addition to the gold ore for which the mine is justly famous, there are numerous lenticular bodies of magnetite, some of which are indicated on the map (Pl. 2). Magnetite bodies, although interesting, have not been of any great economic importance to date. Emmons noted their large size and irregular shape and that they do not seem to bear any consistent relation to the limestone bedding. Thus ore controls at the Cable mine have been well concealed by the combination of metamorphism and mineralization. One might surmize, however, that permeability provided by intersecting shears may have been of importance here, as they have been in many other deposits in the nearby area where the evidence is more readily visible. An excellent discussion of the metamorphism in and near the Cable mine is provided by Holser (1950), particular emphasis being placed on the formation of the magnetite ore bodies.

GEORGETOWN DISTRICT

The Georgetown mining district was established prior to 1870 upon discovery of the Georgetown placer, followed by the initial lode discovery, the Pyrenees lode, in 1870. The most active period came during the 1880's and 1890's, but the district remained fairly active through the early years of the present century. There was intermittent small-scale activity until as recently as 1951.

Some confusion exists as to just what should be included within the Georgetown district. Although initially the several mining districts clustered around the settlement at Georgetown maintained their separate identities, in more recent years there has been a tendency to combine reports from all of these districts under the single heading of Georgetown District. Thus, Bureau of Mines production statistics report production from Cable, Gold Coin, and Southern Cross, as well as that from Georgetown proper, as coming from the Georgetown district. Although there may be some justification for this practice, in the interest of simplicity, much of the historical significance is lost. Therefore, only those properties within the drainage of Georgetown Creek are included in the district (Fig. 5). The Cable, Gold Coin, and Southern Cross districts are treated elsewhere in the report.

As noted previously, the first lode discovery in the district was made in 1870, and the other properties that have contributed more than token amounts to total district production were all known by the late eighties. Nevertheless, claim location continued at a rapid pace for some time afterward. After deletion of those locations known to be in other districts, there were still more than fifty claims filed in the district between 1900 and 1905, and more than forty more were filed by 1910. Sporadic location has continued into the 1960's, but few of the claims are actually very near the district.

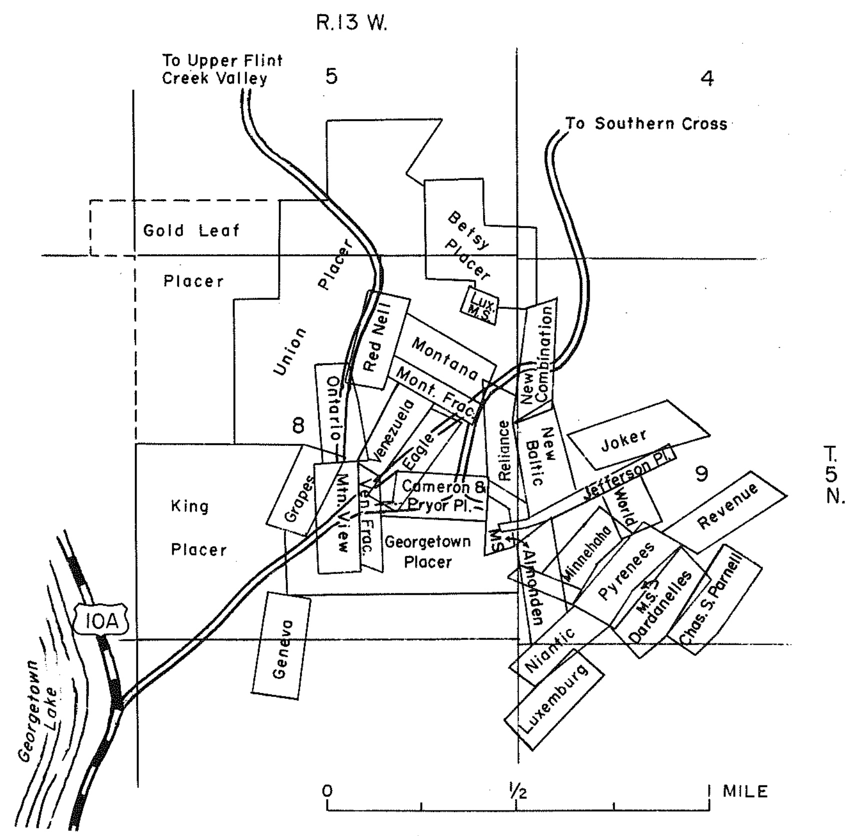


Figure 5.–Claim map, Georgetown mining district

Total production of the district is estimated to have had a value of slightly more than $450,000, from about 21,000 ounces of gold and 8,000 ounces of silver. Of this total, nearly 85 percent came from the Pyrenees mine and roughly half of the rest from the Georgetown placer. Other properties that have recorded production include the Luxemborg, Montana, Ontario, and Revenue mines.

Luxemborg mine.–Located southeast of Georgetown at the southern edge of the district, the Luxemborg mine was discovered in 1875 by Salton Cameron, one of the most active early developers and operators in the area. The mine was developed on a series of northeast-striking northwest-dipping fissures in granodiorite of the Cable stock (Emmons and Calkins, 1913). Access was provided by an adit and two shafts. Minerals reported include quartz, calcite, pyrite, limonite, and gold. Production to the time of Emmons and Calkins' visit in 1906 was estimated at $20,000 (1,000 oz. Au). There is no record of production since that time.

Montana mine.–About a quarter of a mile north of Georgetown, the Montana lode was located in 1902, and when visited by Emmons and Calkins in 1906 it had been developed by a shaft 104 feet deep. They noted that the ore occupied a northwest-striking crushed zone dipping 45° NE in Jefferson Limestone. Minerals reported were quartz, pyrite, and a massive gray copper mineral, which was probably tetrahedrite, and some malachite, azurite, iron oxides, and calcite (Emmons and Calkins, 1913). The mine was inaccessible when visited in 1968, but a sample of quartz-limonite ore taken from the dump assayed more than an ounce of gold per ton. The property produced a minor amount of ore during initial development, and it is mentioned again, briefly, as an "other producer" in 1935.

Ontario mine.–The Ontario lode is located about a quarter of a mile northwest of Georgetown, and the property was inaccessible at the time of Emmons and Calkins' visit in 1906. There has been no further development since that time, and no clue to the nature of the ore body remains in view except an abundance of barite on the dump. The property is reported to have produced "several" thousand dollars worth of silver, presumably during the late eighties (Emmons and Calkins, 1913).

Pyrenees mine.–The Pyrenees mine, which has been the principal producer of the Georgetown district, is located about half a mile south of town, within the Cable granodiorite stock. The property was discovered in 1870, and by 1906 had produced about one-quarter million dollars in gold (Emmons and Calkins, 1913). When visited in 1906 by Emmons and Calkins, the mine had been closed for some time, and all workings were inaccessible. The property was reopened in about 1918, and it has produced sporadically since then, the most recent production being from the period 1949-51.

The principal mine access was a vertical shaft to a depth of 266 feet (Fig. 6) and two or more adits. The principal adit enters at about the same altitude as the shaft collar and follows the vein structure to the northeast for about 400 feet. Another adit has its portal west of the claim and intersects the vein on the 77-foot level. Additional working levels were driven from the shaft at 168 and 266 feet. The vein has an average strike of N. 25° E., and dips 70° to 77° W. Vein width as great as 12 feet is reported. Primary mineralization is auriferous pyrite, and chalcopyrite in a quartz gangue.

Revenue mine.–The Revenue lode is located on the Cable granodiorite nearly three-fourths of a mile east of Georgetown. The principal mine access was a southeast-trending adit, which followed a zone of narrow quartz-limonite veins. Numerous old pits and trenches (Fig. 7) attest to early prospecting efforts on the property. In addition, several bulldozer cuts made in 1967 expose the vein structures explored at greater depth by the adit.

The property is equipped with a small mill, currently in disrepair, which was probably installed about 1938. Government statistics indicate minor production of gold in 1939 and 1940.

Placer deposits.–Several placer locations have been made in the district including the Betsy, Cameron and Pryor, Georgetown, Gold Leaf, Jefferson, King, and Union placers, but almost all of the district placer production was derived from just one of these properties, the Georgetown. Production of the Georgetown placer to 1870 was estimated at $40,000 (Emmons and Calkins, 1913), and no significant production from it has been recorded since that time.

Nearly all of the placer ground in the district, including the Georgetown placer and placers extending up Flint Creek into the Red Lion district, were acquired by the Butte and Georgetown Mining and Milling Company in 1910. After formation of this company, a French engineer (Perrier de la Bathie) was commissioned to make an extensive study of the deposits. His examination, completed in 1913, confirmed the presence of vast reserves of placer gravel but indicated that average value was on the order of .01 ounce of gold per cubic yard. Although Monsieur de la Bathie predicted handsome profits at an estimated mining cost of 5 cents per yard, the company directors presumably took a less optimistic view of the situation, as the proposed large-scale dredging operations never began.

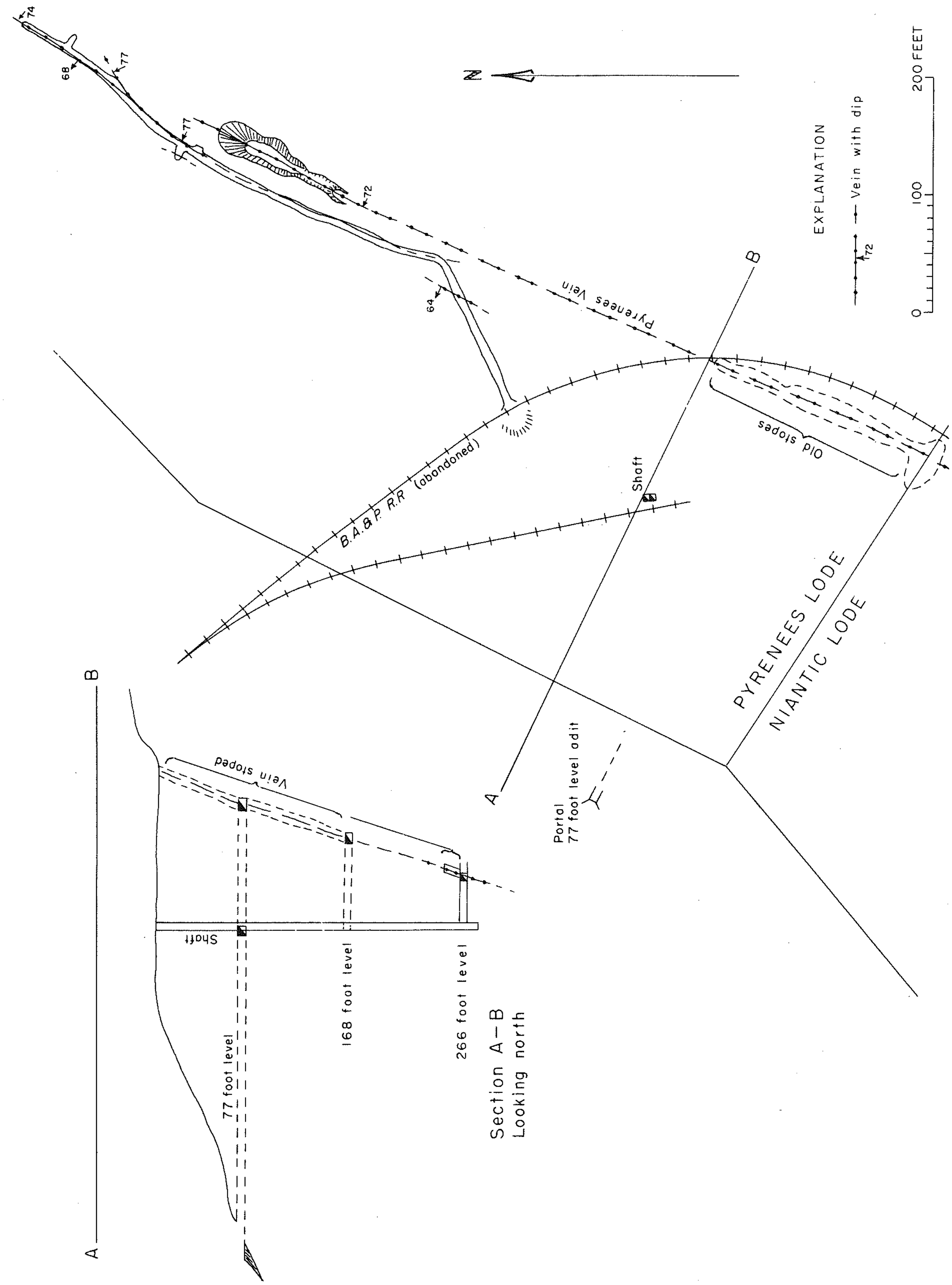


Figure 6.–Map and cross section, Pyrenees mine, Georgetown district (map courtesy of The Anaconda Company)

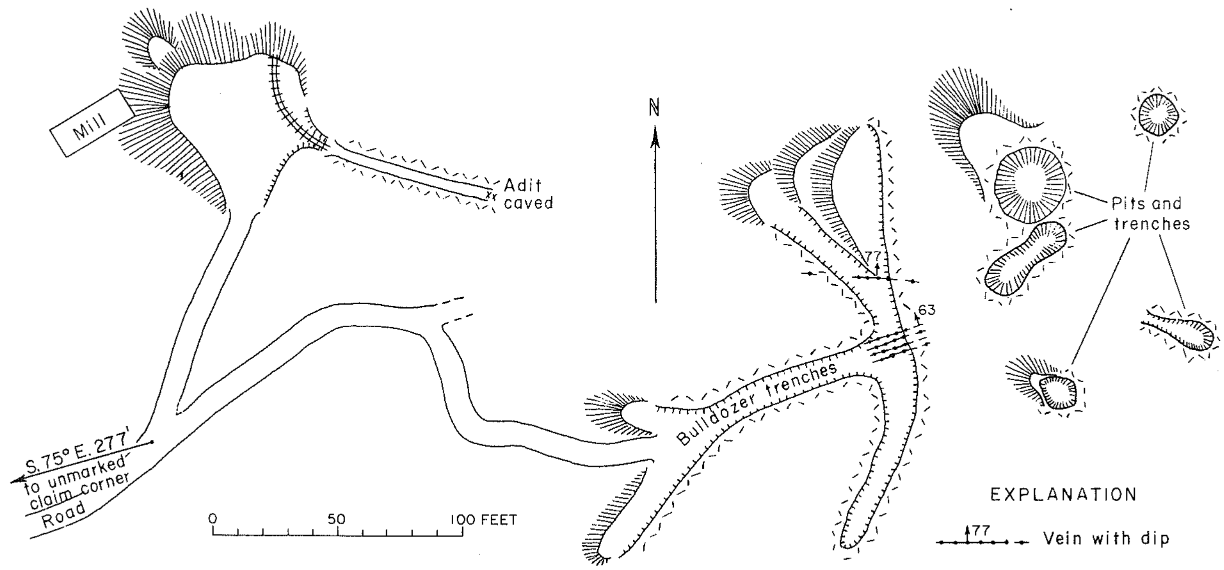


Figure 7.–Revenue lode, Georgetown mining district. Tape and compass survey by F. N. Earll and J. N. Earll, September 1969.

GOLD COIN DISTRICT

The story of the Gold Coin district is essentially the history of one mine, the Gold Coin mine. Gold was discovered in the district in 1898, and there followed the usual rash of claim filings. Although 28 of those claims were eventually taken to patent, only 6 have had any significant share in the production.

By 1906 the Gold Coin mine was in full production, a 30-stamp mill was in use to pulverize the ore, and gold was recovered by pan amalgamation. Mill recovery was said to be about 85 percent, and according to Mine Superintendent L. E. Ireland, production was valued at about $200,000 (Emmons and Calkins, 1913). Operations continued for several years, but by the end of 1912 the district was dormant.

The depression in the 1930's brought reopening at Gold Coin, and the mine operated continuously from 1930 to 1940. During this period a cyanidation circuit was added to the mill, and in addition to considerable tonnage of mine ore, all precyanidation mill tailings were reprocessed during this period. Gold production for the 10 years nearly doubled the mine's previous total.

Mining was renewed for two brief periods, one by leasers during the early 1950's, and again by the mine owner during the early 1960's. Neither of these periods of operation added significantly to total mine production.

The only placer mining in the district was prior to 1906, when some hydraulic mining on the Daly Gulch placer was reported. No direct record of placer production is available, but it is thought to have been small. Total district production is estimated to include nearly 35,000 ounces of gold and 133,000 ounces of silver, valued at the time of sale at slightly more than $1 million.

Gold Coin mine.–The Gold Coin mine is located on a low hill that separates Daly Gulch from the Flint Creek drainage and the Georgetown mining district. The mine is only about 300 yards north of U. S. Highway 10A, and the mill buildings and many of the dumps are clearly visible from the road.

The country rock is dolomitic limestone of the Hasmark Formation, which strikes northeast and dips almost uniformly 30° to 40° NW. The principal vein structure, nearly at right angles to the bedding, strikes N. 50° W. and dips 65° to 70° NE. Primary vein filling is reported to be composed of quartz, pyrite, pyrrhotite, and chalcopyrite. Oxidized ore available for examination at the surface is quartz and limonite, which contain gold and silver and occasional patches of malachite.

The mill and principal mine workings are all on the Red Fir claim, and the extension of the vein continues westward along the length of the Little Josie lode; minor development appears on the Sunnyside and Center claims. All these claims are property of the Gold Coin Mining and Milling Company. Some development work, chiefly shallow pits and adits, is visible on other properties to the north, but there is no record that any of these properties produced appreciable ore.

The mine has been developed by a series of adit levels; drifts followed the mineralized vein structure, and both open and square-set stopes were raised from the drift levels. Several of the stopes were mined to within 20 feet of the surface, and then the weakened, weathered cap of rock either fell or was caused to cave into the mined-out stope below. Today these stopes remain as steep-sided pits at surface, some of the old supporting timber still in place and visible for five or six floors down. Seemingly

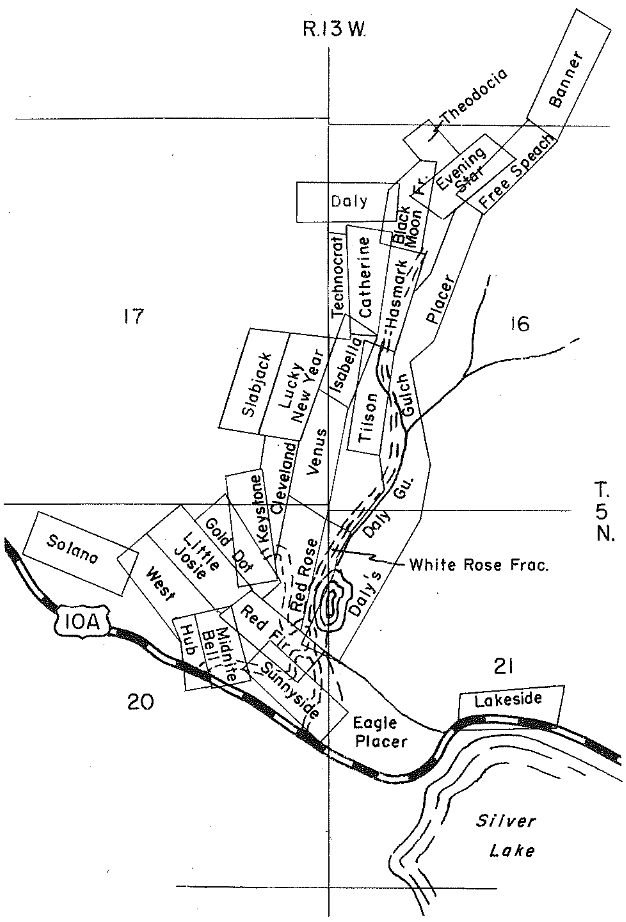


Figure 8.–Claim map, Gold Coin (Daly Gulch) mining district

no effort has been made to exploit the primary ore of the deposit, although such reports as there are (all hearsay) suggest that there might be some. If primary ore does exist at depth at Gold Coin, however, it should be expected to be relatively low grade, and it probably would require more sophisticated treatment than the existing mill can provide.

JOHNSON BASIN DISTRICT

The name Johnson Basin district is herein proposed for the mining area on the broad divide between Foster and upper Warm Springs Creeks, which is partly breached by the secondary drainage that is referred to as Johnson Basin (Fig. 10).

Mines in the area are characterized by replacement veins along fissures in limestone host rock. Early development of all these properties was aimed at exploitation of high-grade silver ore. In more recent times, however, tungsten has been recognized at several places in the district, and one of the properties produced a moderate tonnage of tungsten ore just before the end of the government stockpiling program in the middle 1950's.

Known production in the district can be ascribed to two separate periods; an early period, prior to 1906, in which the principal product was silver, and a later period, 1954 through 1956, when tungsten ore was produced. Total district production to date is estimated to have returned approximately $240,000 from about 15,000 ounces of silver and 77,000 pounds of tungsten trioxide.

Mike Hannon mine.–The Mike Hannon mine may well be the oldest mine in the district (Fig. 11). The name is the designation used by local residents, and refers to the fact that much of the later development of the mine was accomplished by a man of that name. The earliest, and probably the only productive work at the mine, however, was a steeply inclined shaft at the uppermost level of the workings. This shaft is reported to have been sunk by a man named McMasters. The McMasters shaft seems to be very old, not only because of the condition of shaft timber, which has almost completely rotted away, but because of the very crude handmade horse- or mule-powered whim used to hoist material from the shaft. Although either item could have been constructed after 1900, it seems more likely that they predate that time.

At the upper level the vein strikes N. 40° W. and dips 70° NE, and where exposed in a surface cut it is about 3 feet wide. A second level, 100 feet below the shaft collar, consists of about 500 feet of adit that was intended to intersect the bottom of the shaft. The writer's tape-and-compass survey suggests that this effort missed its target by a short distance. The third and lower level workings have not been extensive and did not encounter any mineralization of interest.

No record of production from this property has been found, but it seems likely that some ore was produced from the shaft many years ago.

New Year-Tip Top mine.–The New Year and Tip Top lodes are located along a ridge near the center of the district. Early production, reported by Emmons and Calkins (1913) is credited to the New Year mine, whereas more recent production is reported from the Tip Top. Most of the development seems to be confined to one location, which probably lies near the boundary between the two claims (Fig. 12).

The vein strikes N. 40° to 60° W. and dips 50° to 60° NE, almost parallel to the bedding of the enclosing Hasmark Limestone. Mineralization is dominantly replacement by quartz, which contains pyrite, galena, chalcopyrite, and scheelite. Secondary minerals include limonite, malachite, and calcite(?).

Early mine development was by means of a shaft inclined 65° NE. The shaft can be seen to extend 100 feet or possibly more in depth, but only the upper two levels were examined by the writer, as shaft timber was

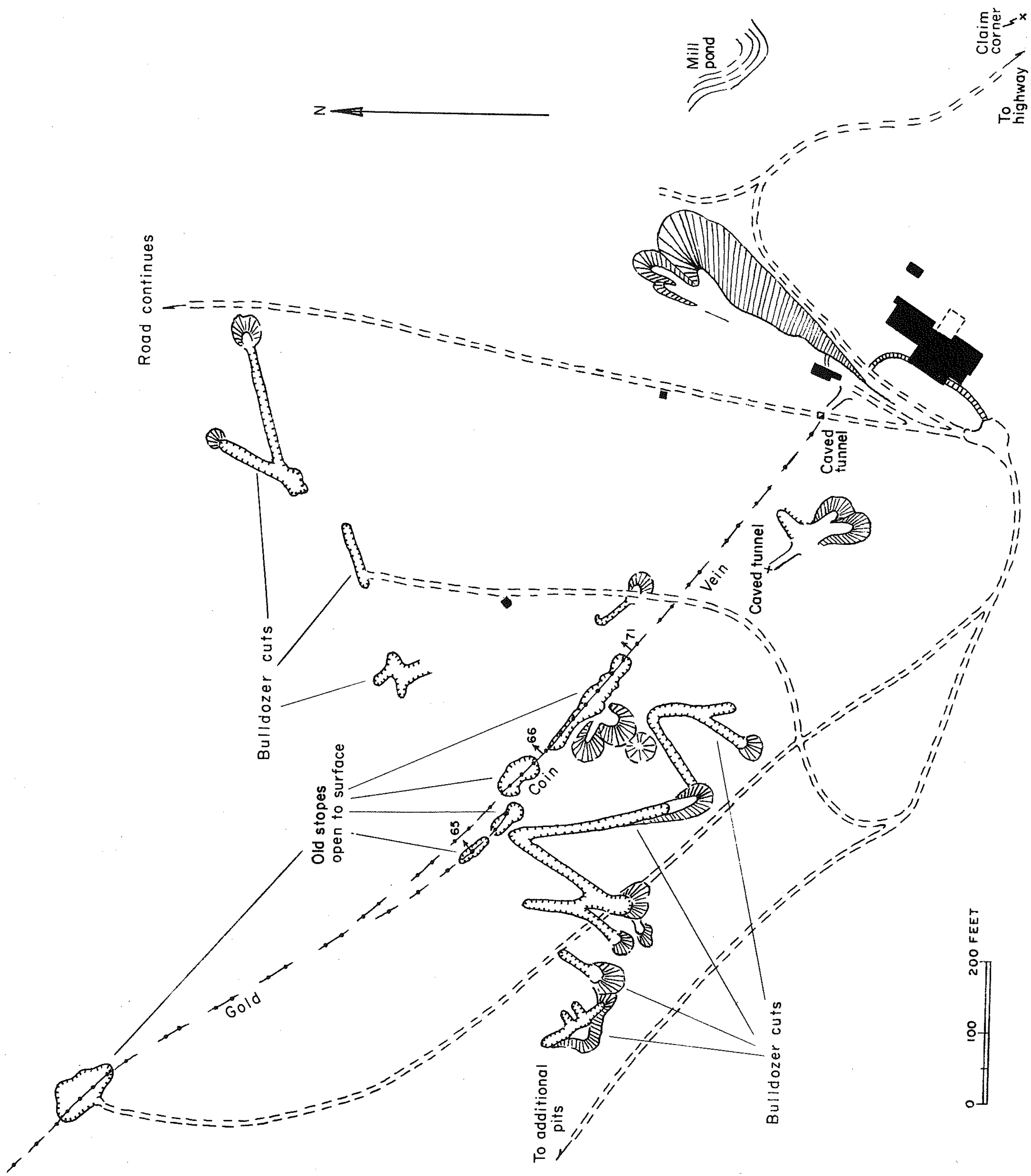


Figure 9.–Surface workings, Gold Coin mine (F. N. Earll and J. N. Earll, June 1969)

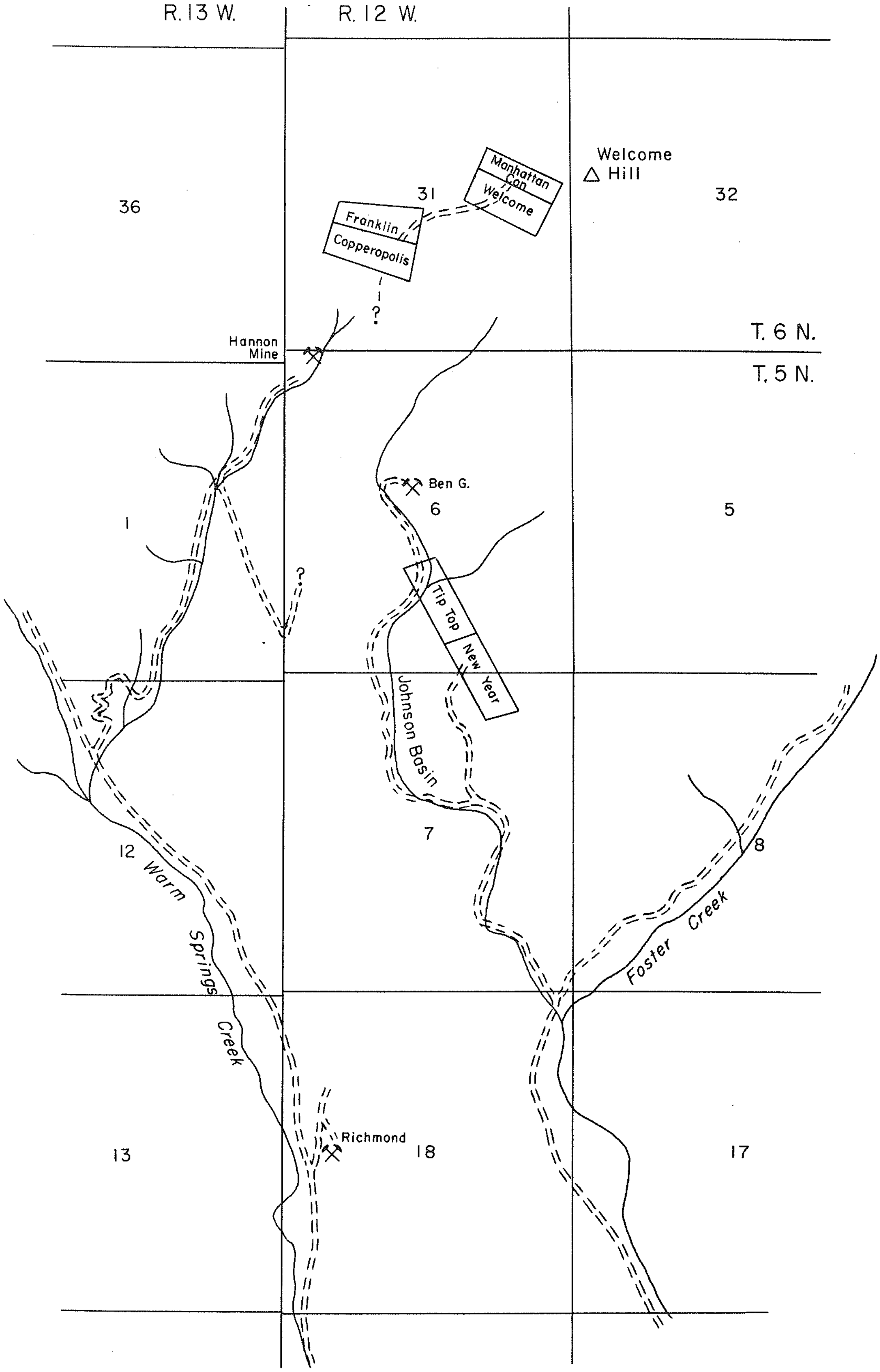


Figure 10.–Claim map, Johnson Basin mining district

Figure 11.—Mike Hannon mine, Johnson Basin district (F. N. Earll and T. F. Harriss, June 1966)

in poor condition. Considerable ore was stoped from levels driven from the shaft, and this is presumably the work referred to by Emmons and Calkins (1913) as having been done about 1895 to 1905.

More recent work includes an open cut about 75 feet long and 35 feet wide, two short drifts driven from it (Fig. 12), and several cuts and bulldozer trenches. This later work accounts for most or all of the tungsten production from the district.

Richmond (Ontario) mine.—The Richmond mine is located on the slope east of Warm Springs Creek near the south end of the area included in the district. This property may also have been called the Ontario mine, but it should not be confused with the more widely known mine of that name in the Georgetown district.

The mine explores a northeast-striking vein in Madison Limestone (Fig. 13). The principal mine working is a shaft, which is inclined 22° near the surface but steepens to 65° after about the first 100 feet. The steeper part of the shaft continues for an additional 45 or 50 feet but was not entered for inspection. A small tonnage of silver ore has been stoped from these workings. A lower adit level, approximately 300 feet below the shaft collar, was presumably driven with the intent of intersecting the extension of ore below the shaft, but if so, this adit has yet to reach its target.

Welcome mine.—The Welcome mine is located high on the west flank of Welcome Hill, north of the head of Johnson Basin. The mine was developed early and is reported by Emmons and Calkins (1913) to have had a 500-foot adit level from which short raises and winzes had been driven. They reported the workings to be unsafe in 1907, and none of the workings were accessible in 1966. Even the access road had nearly vanished under second-growth timber.

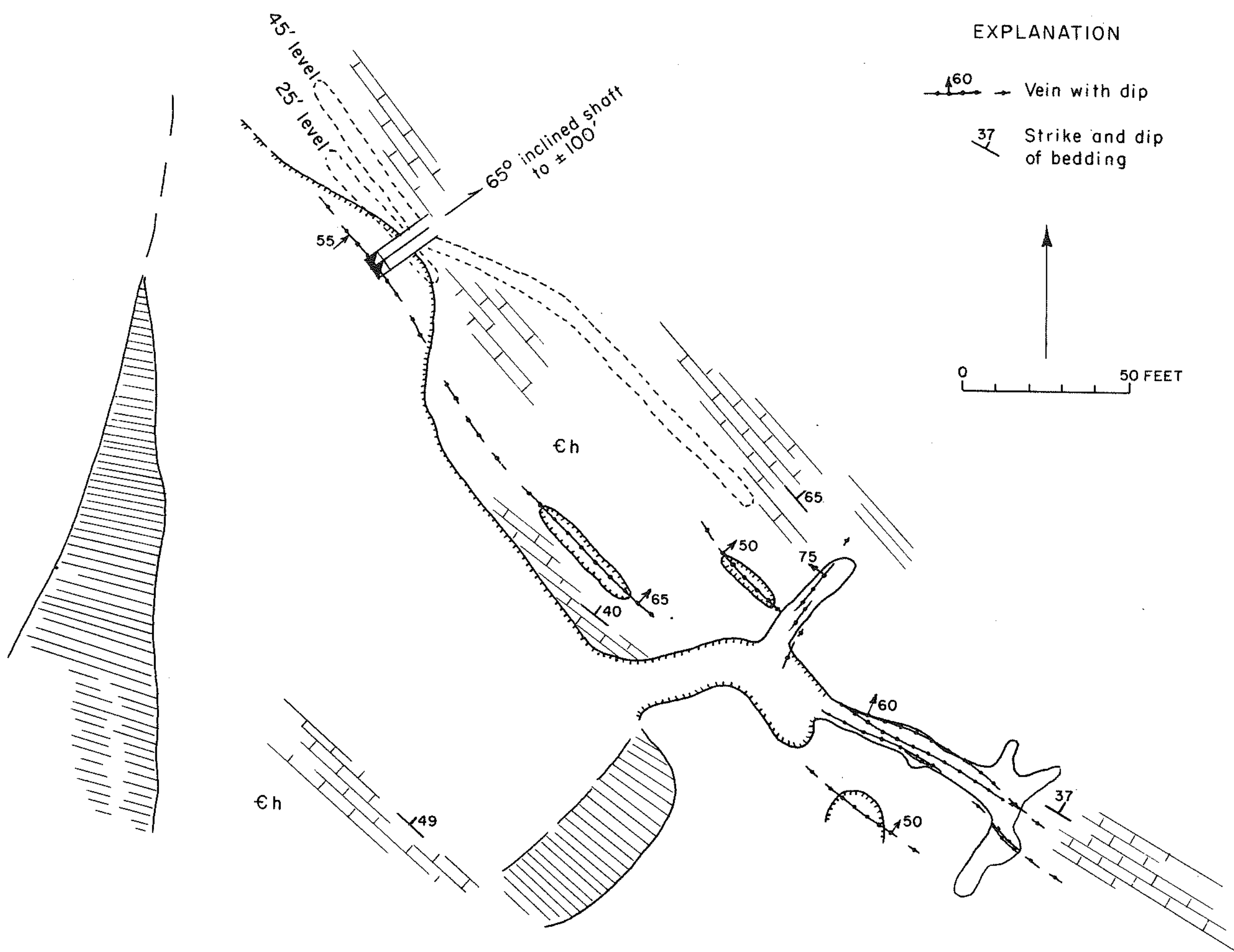


Figure 12.–New Year mine, Johnson Basin district (F. N. Earll and T. F. Harriss, June 1966)

Host rock is Jefferson Limestone, which locally dips northward at a slight angle. Pockets in the limestone contain quartz, sphalerite, tetrahedrite, and argentiferous galena (Emmons and Calkins, 1913).

Copperopolis prospect.–Workings on the Copperopolis lode are near the crest of a north-facing ridge, which lies between the Mike Hannon and Welcome mines. Workings include a 10-foot discovery shaft, an adit about 25 feet long, and several shallow pits. Ore seems to occupy northwest-striking shears in Jefferson Limestone. Observed minerals include silver-rich galena, limonite, and malachite. Of interest is a small deposit of travertine near the workings, which indicates the former existence of a mineral spring there.

LOST CREEK DISTRICT

Placer activity in Lost Creek Canyon began in the early nineties with filing of the Fire placer in 1892, the Astoria in 1893, and the Diamond in 1894. Although the Astoria was intended to be a gold producer, the Fire placer seems to have been a clay pit, and the Diamond was located on limestone outcrops for the purpose of producing lime. The exact date of the earliest lode-mining activity cannot be determined accurately. Emmons and Calkins (1913) recorded production from both the George and the Silver King mines prior to 1906, but the writer has not found original claim filings on either property. The claims may have been located under some name other than the one by which the resulting mine came to be known, or quite possibly the claims were not formally located at all. The first recorded lode claim in the district was the Republic claim (exact location unknown) in 1903; four more claims followed in 1907, and by 1910 a total of 59 lode and 15 placer claims had been located.

Lost Creek valley is an exceptionally straight, possibly fault-controlled valley, which has been strongly modified by glacial scouring upstream from the Lost Creek falls. Rocks exposed along the steep valley slopes range in age from Precambrian to Cretaceous. Mineralization is fairly consistent in its distribution, nearly all of the known deposits being replacement lodes in limestone host rock and all at or fairly near the contact with small intrusive igneous masses.

District production has been far from spectacular. The Silver King mine had produced "a small amount of rich ore" prior to 1906, and the George mine had had considerable development and presumably some production also. Since that time the Silver King property has apparently been dormant, but the George mine produced a bit more, and small ore bodies were mined at the Silver Queen and Diamond placer (Contact Lode). The numerous other prospects within the district show no indication of having produced any ore at all. Total value of production can only be broadly approximated, this writer's estimate being $47,100 including nearly 2,000 ounces of gold, 9,000 ounces of silver, and the rest in copper and lead.

George mine.—The George mine is located high on the slope south of Lost Creek valley, in the SE¼ sec. 35. The only road access to the property is from Olson Gulch, but because the mine itself is on the Lost Creek side of the divide, it is included in this district.

The mine was developed by two shallow inclined shafts and several adits on the outcrop of the lower part of the Hasmark Formation. All mine workings were caved and inaccessible in 1966. Samples of the oxidized ore showed limonite, malachite, azurite, and fair values in silver (to 15 ounces) in quartz gangue, but no samples of the primary ore could be found. Emmons and Calkins (1913) indicated that some of the ore contained lead, presumably as galena. Other nearby mines contain primary tetrahedrite, which would account for the copper content of the ore, and possibly some of the silver.

Silver King mine.—The Silver King mine was not visited by the writer. It is located near the head of Lost Creek, on the north side of the valley, almost straight across from the George mine. There is no record of production subsequent to Emmons and Calkins' study, published in 1913. At that time they described the property as being located on dolomite of the Hasmark Formation and developed by two inclines that were connected by a level only a few feet below surface. Ore was described as quartz that contained galena, tetrahedrite, and possibly stromeyerite ("a sooty black sulfide which carries silver and copper").

Silver Queen mine.—The Silver Queen mine is located on exposures of the Wallace Formation on the north side of Lost Creek, near the eastern edge of sec. 6. Small, very irregular masses of igneous rock, presumably offshoots from the Lost Creek stock, occur within and adjacent to the mine workings.

The mine has been developed by a series of short adits along the splitting vein structure. The ruins of a large water wheel are to be found at the creek below the mine workings. This wheel once powered a small mill (rumored to be the same mill now at the Dark Horse

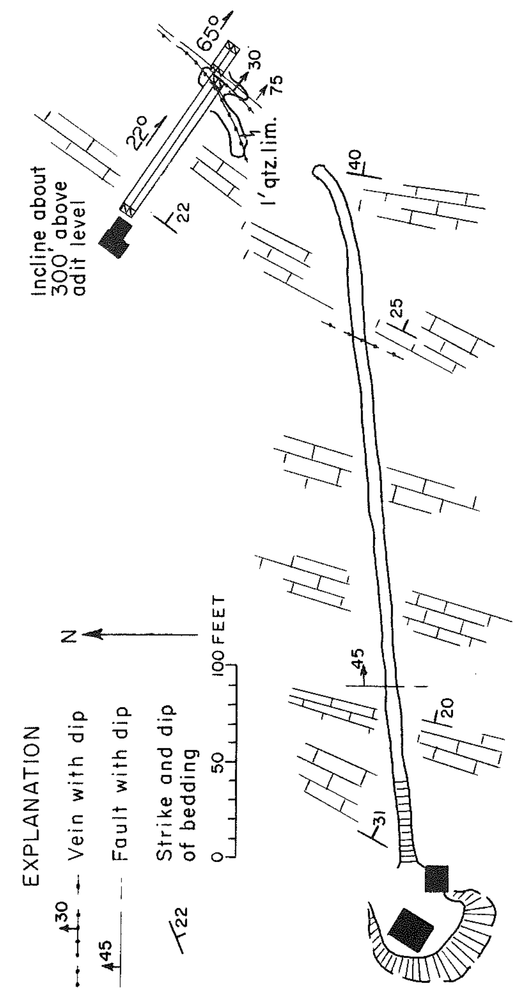


Figure 13.—Richmond mine, Johnson Basin district (F. N. Earll and T. F. Harriss, June 1966)

mine in the Racetrack district). Ore was brought to the mill by a tramway down the steep valley slope. The tramway cable and some of its supports are still in place; in fact, the cable provides almost the sole means of scaling the extremely steep slopes between adit levels.

Ore, as judged from samples of the noncommercial material left behind, was quartz and limonite, presumably of value almost entirely for its gold content. One lens of ore extending roughly from the 54-foot level to the bottom of a winze at about the 165-foot level has been mined (Fig. 15). A rough estimate indicates that it contained about 200 tons of ore. Examination of dump material at the lowest (280-foot) level provides no indication that that work encountered ore.

Diamond placer (Contact Lode)-Great Eastern mine.—The mine situated on the Diamond placer and Great Eastern lode claims (and which may at one time have been referred to as the Contact Lode), is located on the north side of Lost Creek, in the SE¼ sec. 9, on the out-

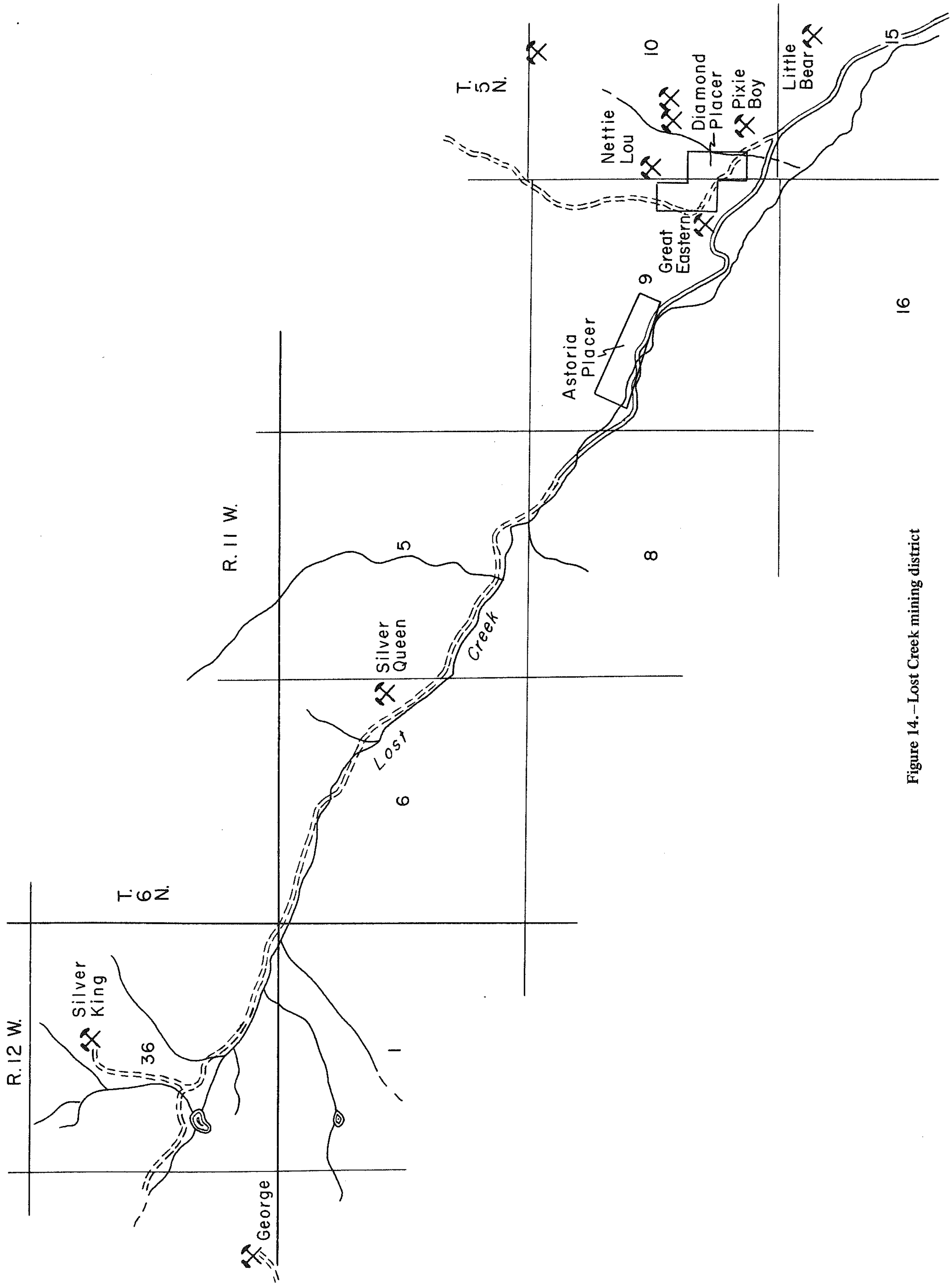


Figure 14.–Lost Creek mining district

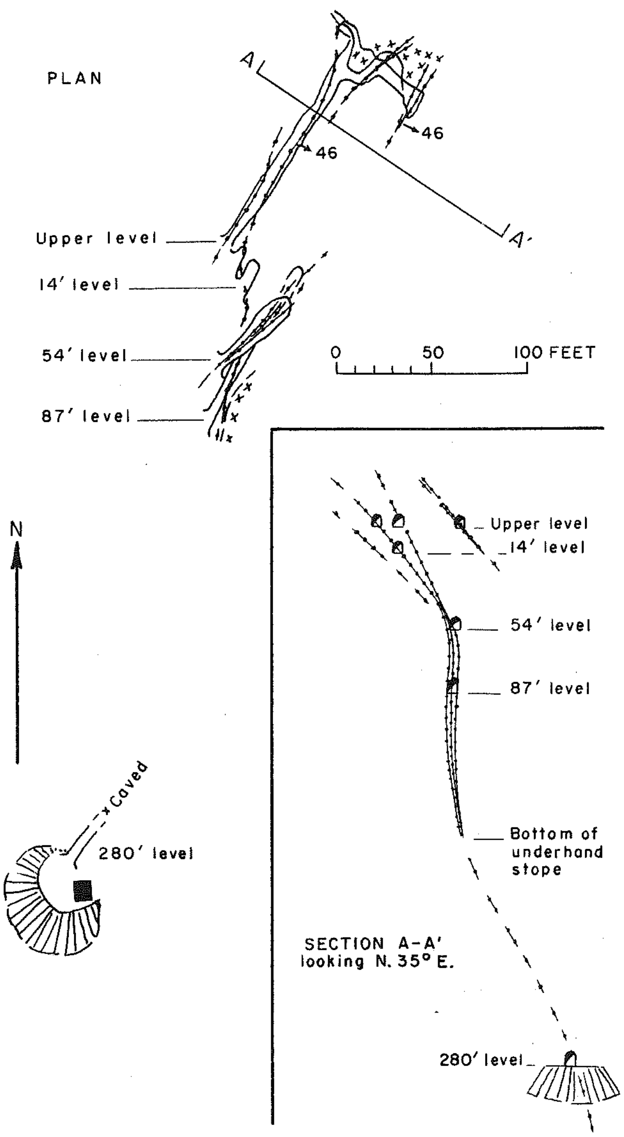


Figure 15.–Map and section, Silver Queen mine, Lost Creek district (F. N. Earll and Robert Reese, 1965)

crop of the Madison Limestone near its contact with the Lost Creek granite stock. The principal workings consist of three short adits, a shallow shaft (or raise), and a short inclined winze. Also several small pits and trenches are scattered here and there on the property (Fig. 16).

The workings explore several small vein lenses in the limestone. Oxide-zone ore is composed almost entirely of quartz, limonite, and very minor malachite, containing low values in gold and silver. It seems probable that two small pods of ore were mined, although there is no direct record of shipments from the property. Production of nonmetallic minerals from this property is discussed elsewhere in the report.

Other mines and prospects.–In the several other prospects in the district, perhaps the most extensive development is to be found on the claim currently (1965) called the Pixie Boy (Fig. 17). The Pixie Boy adit is on the north side of Lost Creek valley, just east of the Timber Gulch road. Workings consist of a 285-foot adit driven to prospect the contact between Madison Limestone and a small granite dike. No indication of significant mineralization was noted in the workings.

Another prospect, now called the Nettie Lou (Fig. 18), is located on the east side of Timber Gulch, about half a mile north of the Pixie Boy. Here three short adits explore narrow veinlets in limestone host rock. Quartz and limonite contain small amounts of gold, silver, and lead. A few tiny green crystals were observed that were tentatively identified as pyromorphite.

About half a mile below the Pixie Boy, in sec. 15, three small adits (now caved) on the hillside explored a fault contact. Seemingly no ore was encountered there.

MODESTY CREEK DISTRICT

Claiming activity on Modesty Creek began in 1892 with the filing of one placer claim, named simply "Placer". This was followed by the Modesty placer in 1895 and the Daisy in 1898. The next half-dozen years saw the staking of four more placers and three lode claims, but mining activity seems to have been restricted to a few test pits and trenches. There is no record of production, nor is there any reason to believe that there was any production that went unrecorded. The district remained virtually dormant until the 1920's.

Mining activity along Modesty Creek presumably began in 1920 or 1921, and the district was officially credited with "a little" production in 1922. Judging by what the district produced during its "good" years, "a little" production can probably be translated to mean one or two ounces. In almost every year from 1922 through 1946, the placers of the Modesty Creek district produced, but the average annual production was almost unbelievably low. The year 1935 might be taken as typical; three placer properties reported total production of 9 ounces of gold for the year. Granted that some of the recovered gold may not have reached the operators during cleanup, the amount that went astray is not likely to have been large.

The cause of the poor placer showing is not hard to find. A search of the source area upstream and on the slopes adjacent to the placer workings discloses many minor prospects, but no significant deposits capable of producing a major placer accumulation of metals. Only one lode mine in the district shows any significant amount of development, and this property is on the north or wet fork of Modesty Creek and could not have supplied metals to the placers. This lode could have supplied gold to placers on lower Modesty Creek, but there is no evidence to indicate that it actually did so. Total production to date from the district is estimated to be 200 to 250 ounces of gold and a few ounces of silver.

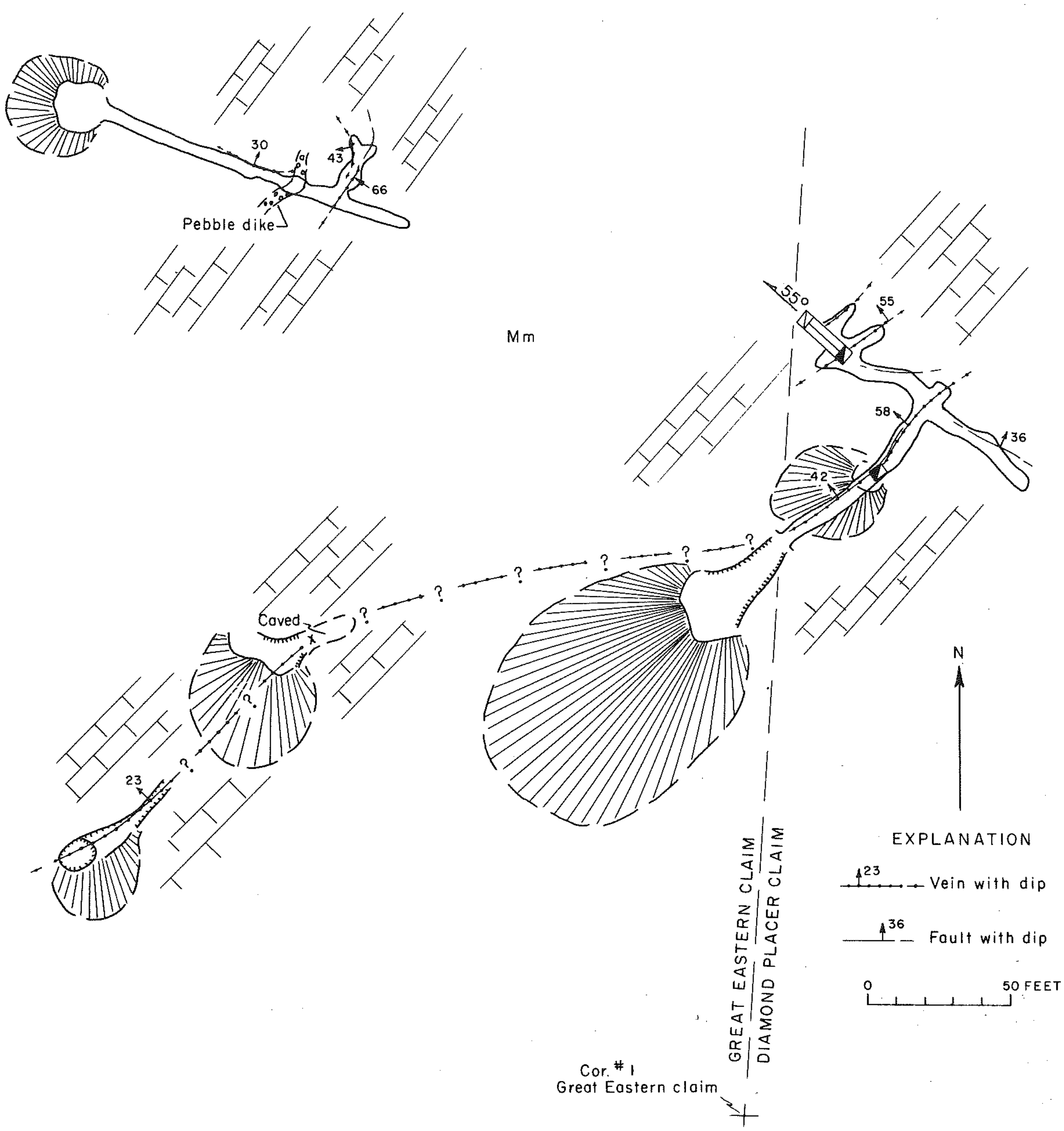


Figure 16.–Principal workings, Diamond placer and Great Eastern claims, Lost Creek district (F. N. Earll and Robert Reese, 1965)

Dry Creek placer.–Almost all of the placer activity in the Modesty Creek district has taken place along the south or dry fork of Modesty Creek. Although production has always been reported as though it came from one source, the record shows that as many as sixteen placers were in operation during the peak production year, which was 1934. This suggests that the various claims were operated as separate units.

Placer diggings begin a short distance south of the confluence of the north and south forks, and continue without interruption up the south fork for more than a mile. Bedrock exposed west of the creek bed is predominantly Missoula Group (Precambrian), but there are minor exposures of the Wallace. East of the dry fork the surface is covered by Tertiary gravels. Limestone, tentatively identified as Madison, is to be found on both sides of the south fork just upstream from its confluence with the north fork.

A rough estimate of the extent of the Dry Creek placer operation indicates that during the 24 years of operation the amount of gravel processed was approximately 70,000 yards. Even allowing for considerable misplaced production, it seems unlikely that the gravel could have averaged more than 10c a yard, certainly not a very attractive prospect.

Water for placer operations was provided by an intricate system of irrigation ditches that lace the adjacent slopes, especially those to the west, which probably saved

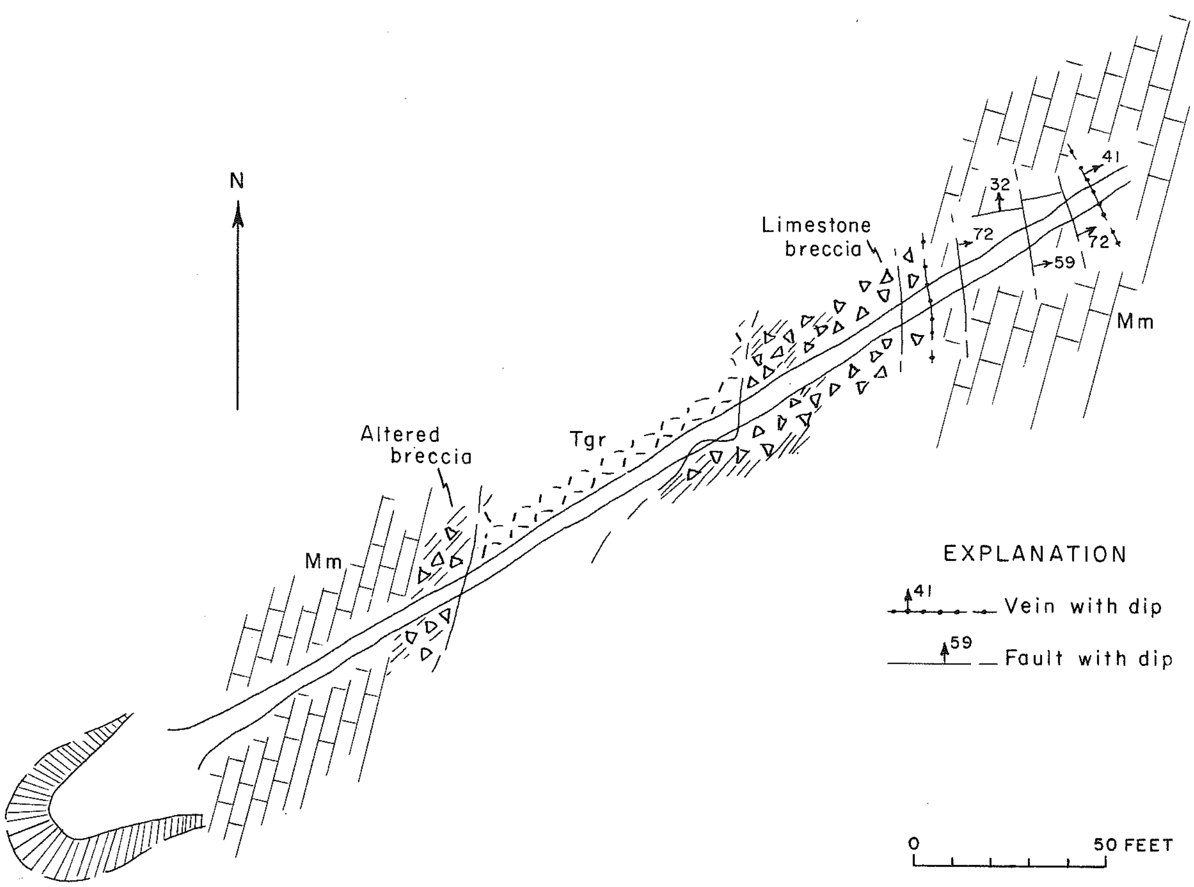


Figure 17.–Geologic map, Pixie Boy prospect, Lost Creek district (F. N. Earll and Robert Reese, 1965)

nearly all of the spring runoff for placer operations. This suggests that actual operation was probably restricted to a short period in the spring of the year when sufficient water was available.

Annie Jane prospect.–The only lode mine that has had more than token development was held under the Annie Jane lode claim when visited in 1965. Because some of the development is obviously very old, the property may well have been claimed under one or more other names in times past, but the writer has not been able to determine what other names it has had.

The Annie Jane prospect is located on the south side of the north fork of Modesty Creek about three-tenths of a mile above its confluence with the south fork. The property is developed by a series of shallow adits driven to prospect narrow discontinuous crosscutting vein structures (Fig. 20). No mineralized structures of mineable size were observed, and samples of the "ore" showed only small amounts of gold, silver, and copper. All observed vein material was completely oxidized and consisted of quartz, limonite, and malachite. No lode production is recorded from the district.

OLSON GULCH DISTRICT

Mining activity along Olson Gulch began early, the Silver Chain and Cameron lodes having been located and active during the early eighties. At least five claims had been filed by 1900, and two of them were already patented. There is some confusion as to how many claims were actually located, however, as several are known to have been recorded as being in the Blue Eyed Nellie district, which lies to the east, whereas one was recorded as being on Foster Creek to the west. Twenty or so were correctly designated as being on Olson Gulch.

The principal product of the Olson Gulch mines was silver, and most of it was produced during the late eighties and early nineties while silver prices were still somewhat attractive. Most of the mines had closed by the late nineties as the price of silver continued to drop, and by the time the district was examined by Emmons and Calkins in 1906 many of the tunnels and shafts had already caved and were no longer accessible.

Resurgence of activity in the district during the early 1960's in response to increases in the price of silver, which finally managed to regain the level of 100 years

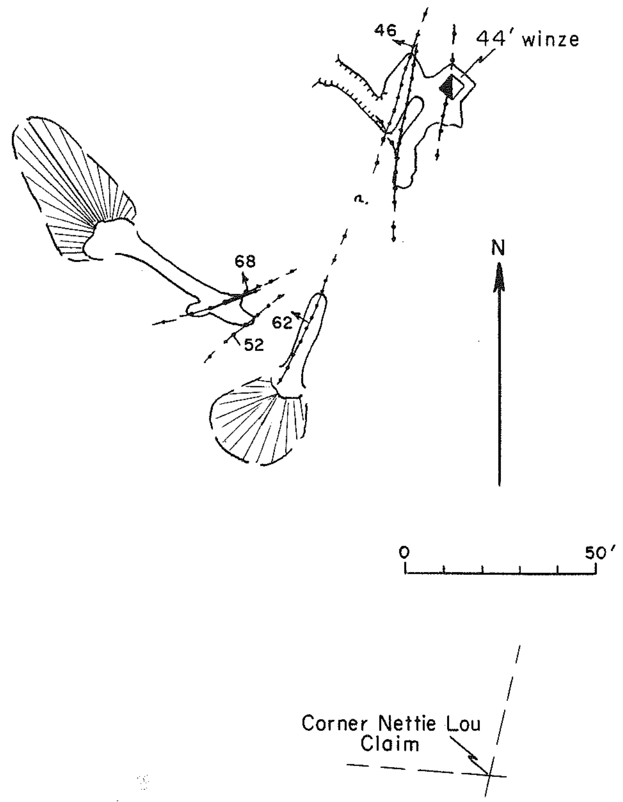


Figure 18.–Nettie Lou prospect, Lost Creek district (F. N. Earll and Robert Reese, 1965)

earlier, was short-lived, adding perhaps 25 percent to the total production of the district. The writer's estimate of total production from the Olson Gulch district includes nearly 2,200 ounces of gold, 38,000 ounces of silver, and 4,000 pounds of copper, having a combined value of $83,600. Of this total, nearly one-quarter came from the Cameron mine, and almost all of the rest from the Silver Chain and Antelope.

Cameron mine.–The Cameron mine is located just above a steep escarpment of limestone on the low divide between Olson Gulch and Foster Creek, about a quarter of a mile north of the highway in the southern part of the district (Fig. 21). The claim covers a strongly silicified area within the Hasmark Limestone, and mineralization seems to be directly related to this silicification, which presumably derives from emanations from the granodiorite stock that crops out about half a mile to the north.

All production has come from a series of shallow pits and trenches within the silicified limestone zone. The positions of the pits seem to define a zone of fracturing trending roughly north, which may have provided a control over mineralization. Ore discovered so far has been restricted to small pods or lenses within the sheared and silicified limestone. Mineralization has resulted in the replacement of 40 to 80 percent of the limestone host rock by silica and the deposition of sulfides of lead, silver, and copper.

Silver Chain-Antelope mine.–The Silver Chain and Antelope lodes are located at the extreme north end of the district, at the head of Olson Gulch. Early reports consistently link the two properties, suggesting that they were operated together. Examination shows that most of the development work was performed on the Silver Chain, however, and presumably most of the combined production came from it.

The Silver Chain lode is on exposures of the Hasmark Limestone. A small granite stock intrudes the limestone a few hundred feet north of the claim, and a gabbro intrusive body is exposed over a considerable area an equal distance to the south. The distribution of workings suggests a north-striking vein structure, but bulldozer work, presumably done in the early 1960's, has virtually obliterated the surface expression of the deposit.

Early development of the property is reported to have included two shafts to a depth of about 200 feet, plus drifts along the vein. The ore contained argentiferous tetrahedrite in a quartz gangue (personal communication, George Henderson).

The adjacent Antelope lode, although continuing along the same northward trend, is on exposures that are predominantly Madison Limestone. Dumps at the adits are small, and exploration was obviously not extensive.

Stormway-Morgan Evans mine.–The Stormway and Morgan Evans lodes are located along a generally west-striking fissure vein within the gabbro stock that occupies the north-central part of the district. The property has been prospected by means of a series of four adits along the vein structure, the lower two of which probably were the most extensive. Emmons and Calkins (1913), who were able to observe the vein in one of the adits that was still open at that time, reported it as striking N. 73° W. and dipping 80° N. They stated that the vein was 3 feet wide, and was composed of quartz containing pyrite, chalcopyrite, and bornite. All mine workings were inaccessible in 1966, and there is no record of ore shipments from the mine.

Other mines and prospects.–Of the many other prospects in the district, two perhaps deserve mention. Among those where a considerable amount of development work has been done is the Gold Crown lode. From the location and description, this property would seem to be the same one described as the Mayflower claim by Emmons and Calkins (1913). The workings explore quartz-pyrite mineralized shear zones in a granodiorite stock in the southwestern part of the district. Early prospecting was by means of adits, and toward the north end of the claim there is some more recent bulldozer work.

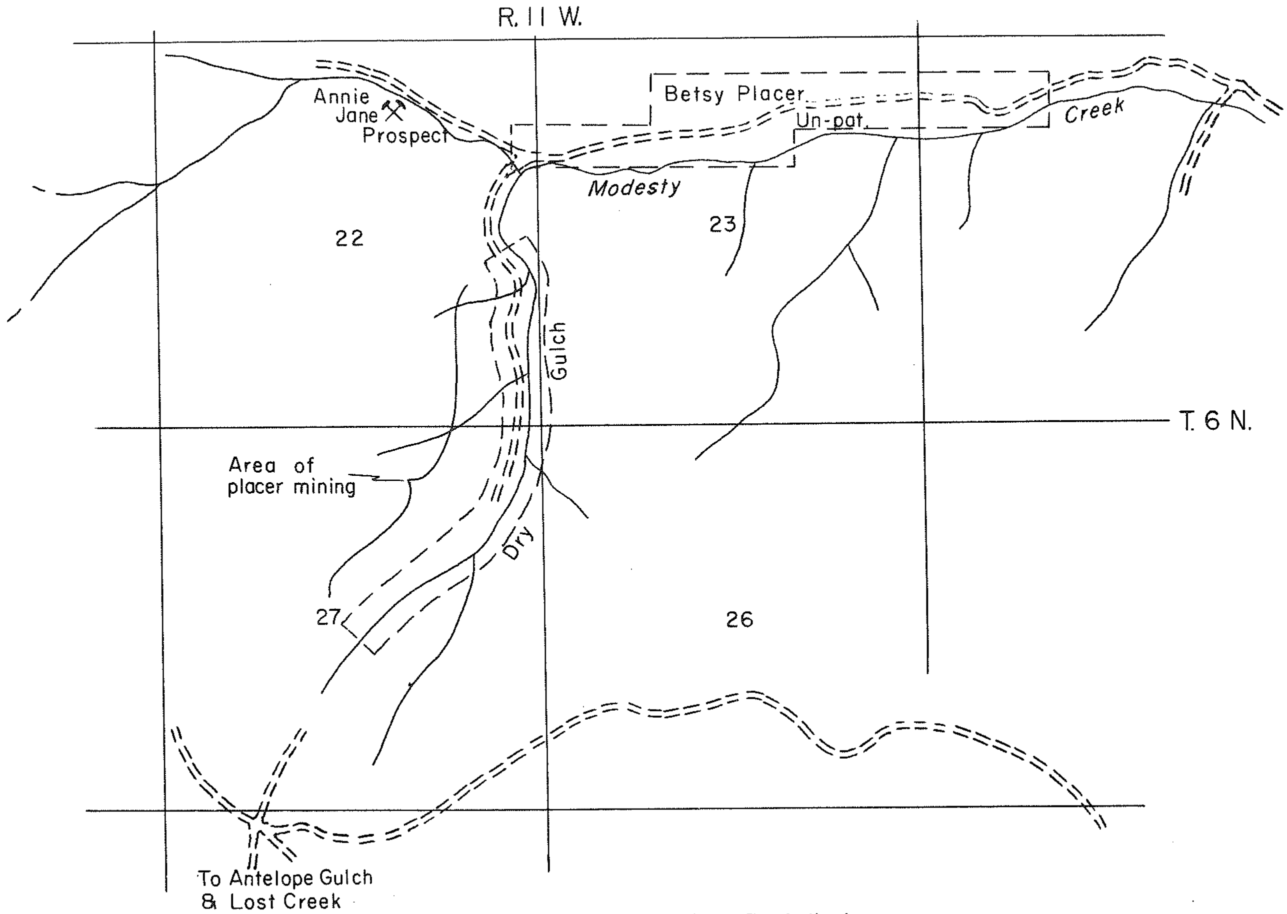


Figure 19.–Claim map, Modesty Creek district

North of the Gold Crown is the Bung Your Eye lode. This property too seems to have been described by Emmons and Calkins, but as the Grey Rock claim. In any event, as on the Grey Rock, there is a northeast-trending adit on the Bung Your Eye lode. It was started in the granodiorite stock and continued to or beyond the contact with the Madison Limestone that lies to the north. The adit is no longer accessible, but examination of the material on the dump indicates that although the contact was reached, no encouraging evidence of mineralization was found there. A small excavation farther up the hillside to the north at the outcrop of the contact also failed to uncover indications of mineralization.

SILVER LAKE DISTRICT

A small group of mines and mining claims north and south of Silver Lake constitute the Silver Lake mining district. Only those properties lying north of the lake are within the boundaries of the present study area and are discussed below. These include three patented claims that have been developed as a unit and several unpatented lode locations (Fig. 22).

The district was discovered in 1884 and the Silver Reef lode claim was located. Production prior to 1906 totaled about 14,000 ounces of silver and 50 ounces of gold, seemingly all from the Silver Reef mine (Emmons and Calkins, 1913). More recent production has boosted total value to approximately $82,000, including 50,000 ounces of silver, 125 ounces of gold, 95,000 pounds of lead, 55,000 pounds of zinc, and 2,500 pounds of copper. Again, although some production has been credited to the Hidden Treasure property, the largest part can be attributed to the Silver Reef. No production is known to have originated on any of the unpatented properties.

Silver Reef mine.–The Silver Reef mine is on exposures of the Red Lion Limestone, which locally strikes N. 80° W. and dips 15° to 20° S. Early mine development was by means of two shallow shafts and a northeast-trending adit (Emmons and Calkins, 1913). When visited by the writer in 1969 the adit was inaccessible, and although the shafts were open at surface, neither of them extended to the adit-level workings. Recent development has been by means of a series of open cuts on the outcrop of the ore-bearing zone (Fig. 23).

The primary ore is reported to consist of galena, tetrahedrite, and some argentite in a quartz gangue.

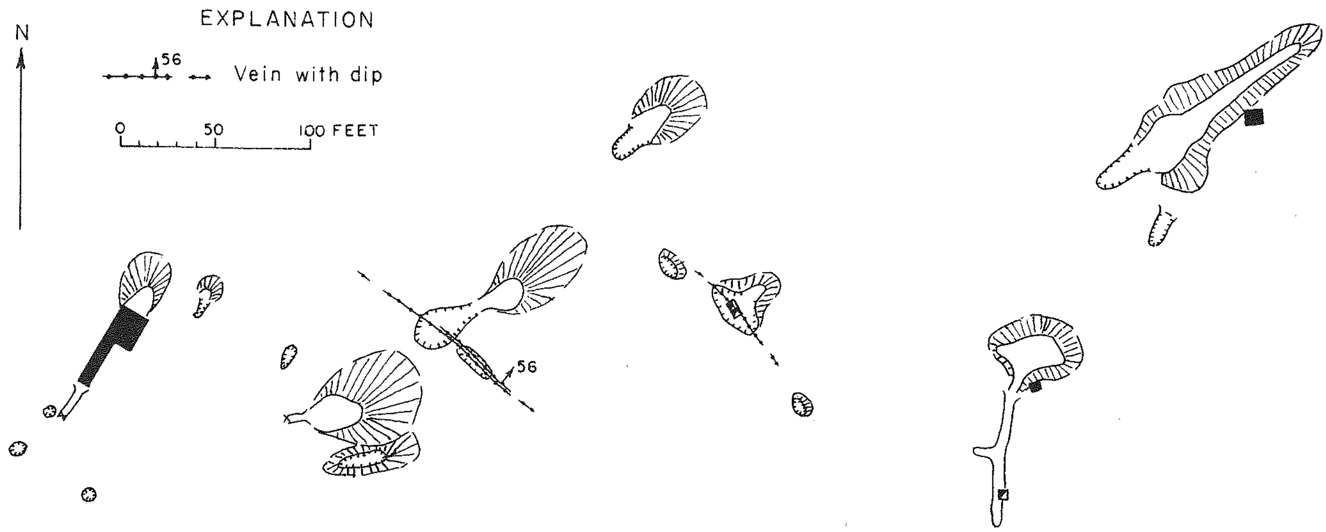


Figure 20.–Annie Jane prospect, Modesty Creek district (F. N. Earll and Robert Reese, 1965)

Oxidized ore, observed at the surface, is a quartz filling and replacement of fractured limestone, containing relict tetrahedrite plus malachite and azurite as principal minerals, and several ounces of silver. The ore is poorly exposed but seems to have been localized along a gently dipping shear plane parallel or nearly parallel to the bedding.

SOUTHERN CROSS DISTRICT

The Southern Cross mine, which was destined to become the premier gold producer of the Southern Flint Creek Range, got off to a most unpretentious start. A claim was located on the outcropping vein in 1866, but the outcrop could not have been very inspiring, as the claim was allowed to lapse and it was not relocated for 5 or 6 years.

The second owner, Salton Cameron, did some development work and is credited with producing "some" gold between the early seventies and 1884. He also built a 10-stamp mill for the mine, but mill recovery was so poor that operation was discontinued almost immediately.

The next owner was the Southern Cross Gold Mining Company, which kept the mine in sporadic operation, in part through leasers, until 1904, when one of the leasers, Lucien Eaves, discovered an important ore shoot. Eaves' ore shoot yielded an estimated $318,000 worth of ore that averaged about $25 per ton in the first year of operation. He estimated total production to 1906 at approximately $600,000, of which the greatest part was in gold (Emmons and Calkins, 1913). In the years to follow until the mine closed in 1920, the Southern Cross mine went on to produce approximately $5 million in gold, silver, and copper, which is more than 75 percent of the total production of the district to which it gave its name.

Other major producing mines of the district include the adjacent Holdfast, Short Shift, Oro Fino, Orphan Boy, and Golden Wedge mines, the Short Shift and Golden Wedge being operated from underground access in the Holdfast mine. Most of the ore from these latter mines was produced during the period 1920-42, after closure of the Southern Cross. Minor production is recorded from the Twilight, and several other properties may have yielded test lots of ore. None, however, managed any sustained production. Total district production is estimated to have brought nearly $6.5 million, from approximately 272,000 ounces of gold, 316,000 ounces of silver, and 1,000,000 pounds of copper.

Holdfast-Short Shift-Golden Wedge mines.–The Holdfast and the adjacent Short Shift and Golden Wedge properties are located on the southeastward extension of the Southern Cross vein structure. Country rock is northwest-striking west-dipping Hasmark Formation.

Early mine development was from a couple of shallow shafts and an adit toward the eastern end of the Holdfast lode. The later, more extensive development proceeded from a tunnel level whose portal was near the west end of the claim, just above the BA & P Railway tracks. This tunnel intersected the old workings at approximately the 100-foot level, and from it the mine was developed to the 400-foot level through the use of internal inclined shafts. The major part of the workings, which total about 8,000 feet of drifts and crosscuts, aimed at exploring the extensions of ore from the Southern Cross mine where it crosses the Golden Wedge and Short Shift claims and passes across the northeast corner of the Holdfast lode (Pl. 3).

The ore, like that of the Southern Cross mine, is a replacement of the limestone host rock along north- to northwest-trending fissures. Oxidation of the ore is nearly complete so that it is composed essentially of quartz and limonite and contains gold and silver in roughly equal amounts, plus minor copper. Primary ore is reported to contain quartz, pyrite, pyrrhotite, magnetite, and chalcopyrite, the free gold occurring as tiny grains within the pyrite.

Oro Fino mine.–The Oro Fino mine is located just north of the Holdfast along what might be called the Oro Fino-Orphan Boy vein (Pl. 3). The vein, which is in Hasmark Limestone, strikes just slightly west of north and dips 55° to 60° W. Ore, as in the other mines of the district, is composed of auriferous limonite in a quartz gangue.

Orphan Boy mine.–The Orphan Boy mine is located along the Oro Fino-Orphan Boy vein, approximately 1,000 feet north of the principal Oro Fino workings and 2,400 feet due east of the Southern Cross shaft. The ore body is a north-striking replacement lode that dips 60° to 70° W. (Pl. 3).

Southern Cross mine.–The Southern Cross lode claim is a northwest-trending parallelogram along the extension of the Southern Cross fissure. At surface the southeastern half of the claim covers exposures of the upper dolomitic member of the Hasmark Formation, whereas the northwestern half is underlain by the Red Lion and Maywood Formations. All of these strata strike nearly north, and dip 40° to 50° W. (Pl. 3).

Early development of the mine was through a series of shallow shafts on the east vein, and a principal inclined shaft (the Eaves Incline) on the west vein. Later development was around a central three-compartment vertical shaft. Development includes several miles of drifts and crosscuts that explore the very complicated vein structures. The deepest workings are on the 600-foot level, which is only partly developed, workings being restricted to the west vein zone, which was reached by a winze from the 500-foot level. The shaft, which extends slightly below the 600-operating level, bottoms at an altitude of 6,315 feet, which is roughly 50 feet below the level of Georgetown Lake, which is about 2½ miles to the south. It has been reliably reported that an increasing problem with water influx was a major factor contributing to closure of the mine.

As has been implied above, the ore deposit at Southern Cross is extremely complex when viewed in detail. The general pattern of ore distribution, however, consists of two groups of north-striking structures, which can be referred to as the east and west veins, which branch from or cross the northwest-striking Southern Cross fissure. Mineralization resulted in extensive replacement of the dolomitic limestone host rock parallel to the bedding, which strikes north and dips about 50° W. Fissuring of

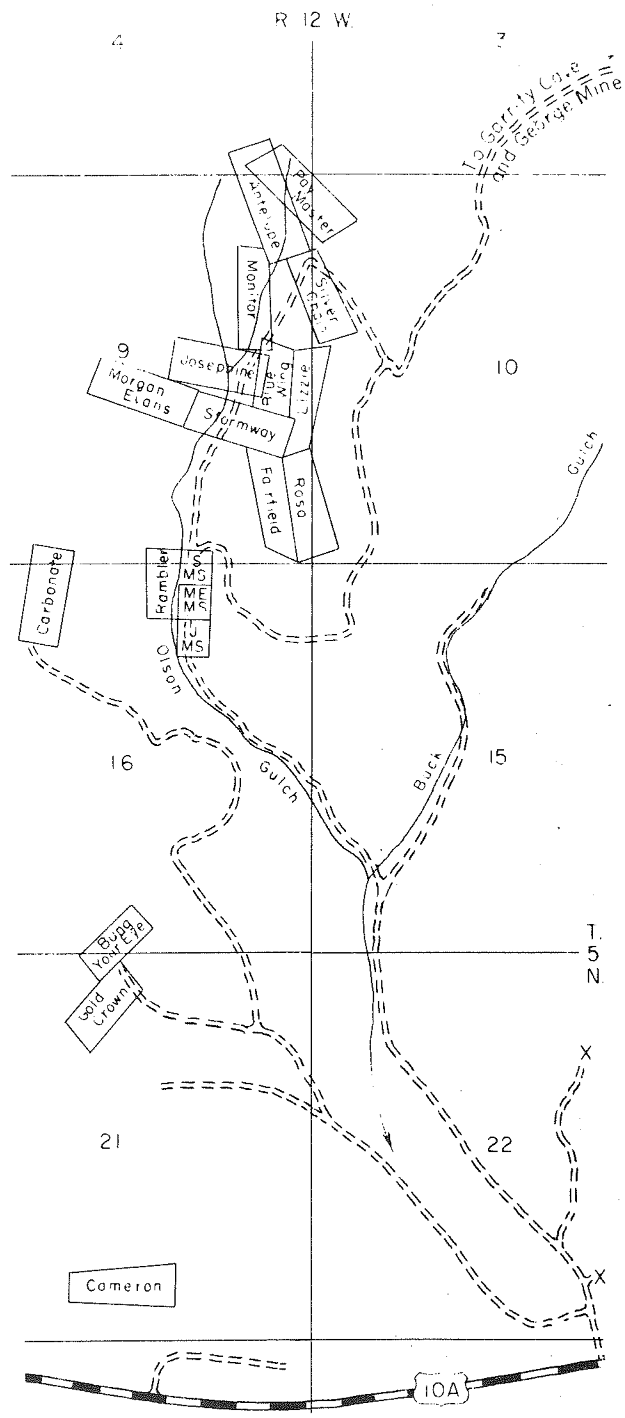


Figure 21.–Claim map, Olson Gulch district

the limestone has also been observed, which although of similar strike and dip, is not entirely parallel to the bedding. As with several other ore bodies in the range, the principal concentration of mineralization at Southern Cross seems to be localized by the intersection of favorable structural elements. In this case, the loci are favorable zones in the Hasmark Formation where intersected by the northwest-striking Southern Cross fissure and related parallel structures.

Primary ore is dominated by quartz and auriferous pyrite, accompanied by minor pyrrhotite, magnetite, and chalcopyrite. Nearly all of the ore mined, however, had been oxidized, and was composed of limonite and quartz, minor copper oxides and, of course, gold. The gold occurs as very fine grained free flakes in pyrite (Emmons and Calkins, 1913). As deeper levels of the mine were developed, primary ore became more prevalent, and copper became a significant byproduct.

GRANITE COUNTY

FRED BURR LAKE CLAIMS

The only reason that discussion of the Fred Burr Lake area is included here is that it is the eighth largest concentration of patented lode mining claims in the study area, and this fact demands some explanation. It is not necessary to examine the claim map (Fig. 25) carefully to realize that the search for mineral wealth was of little concern to the claimants. Even some of the claim names, such as the Trout, Duck, Island, and Champlain lodes, suggest this. The High Ore lode on the other hand, suggests a sense of humor in the claimant, or perhaps this was to make the mineral lands surveyor, who had to certify the claims, feel better about the whole thing.

Today all claims in the group are the property of the county, and they serve admirably to protect the water supply of the town of Philipsburg. The fact that the claims are an obvious violation of the mining laws is perhaps beside the point.

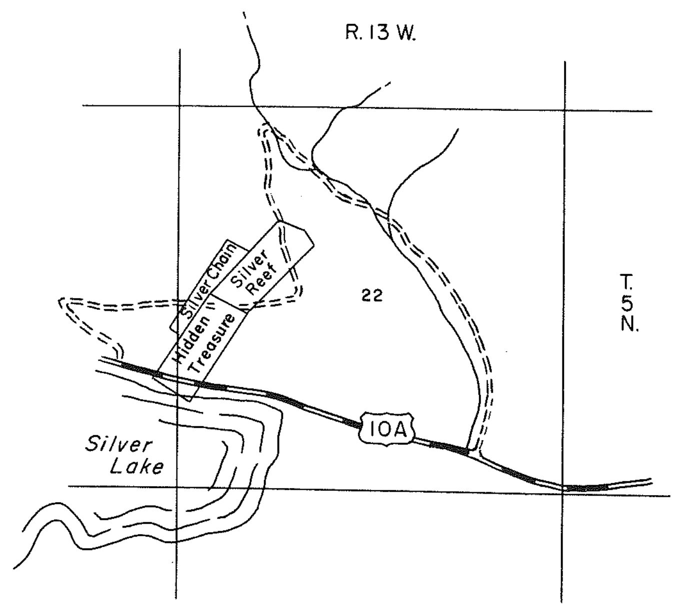


Figure 22.–Claim map, Silver Lake district

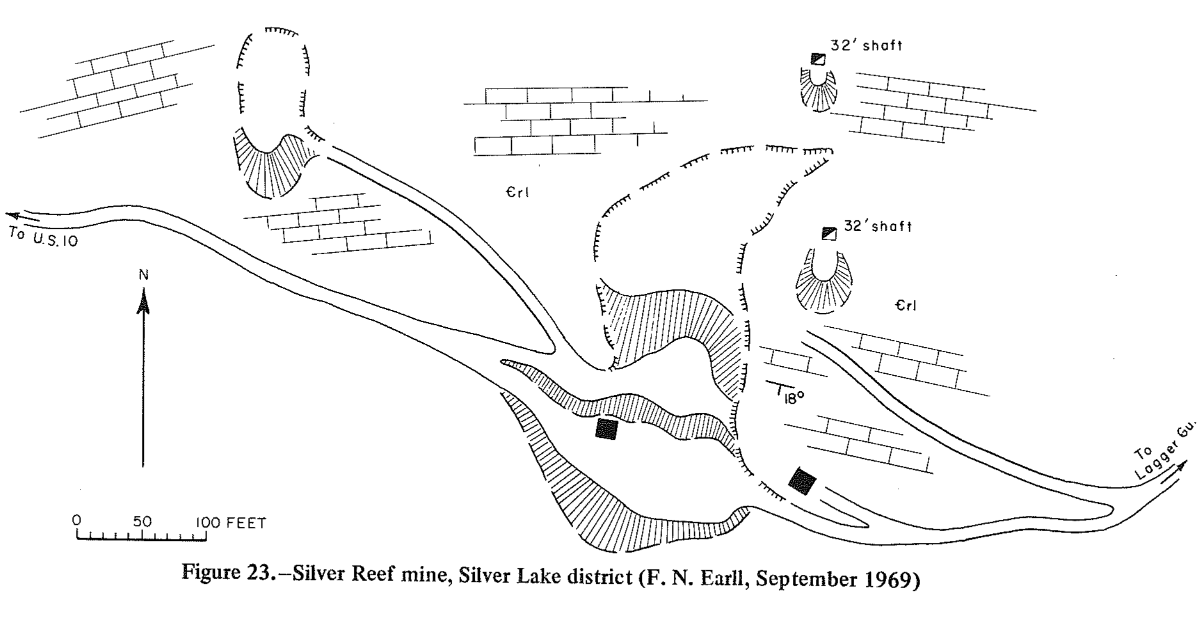


Figure 23.–Silver Reef mine, Silver Lake district (F. N. Earll, September 1969)

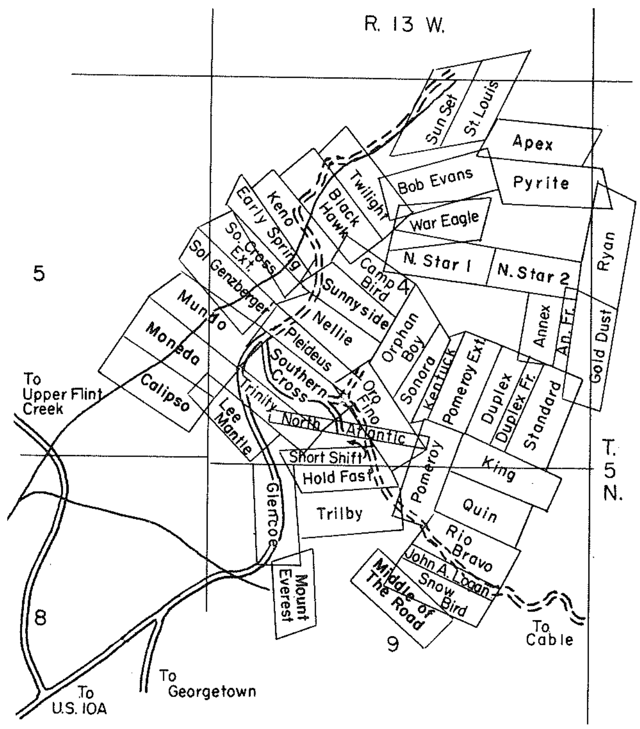


Figure 24, Claim map, Southern Cross district

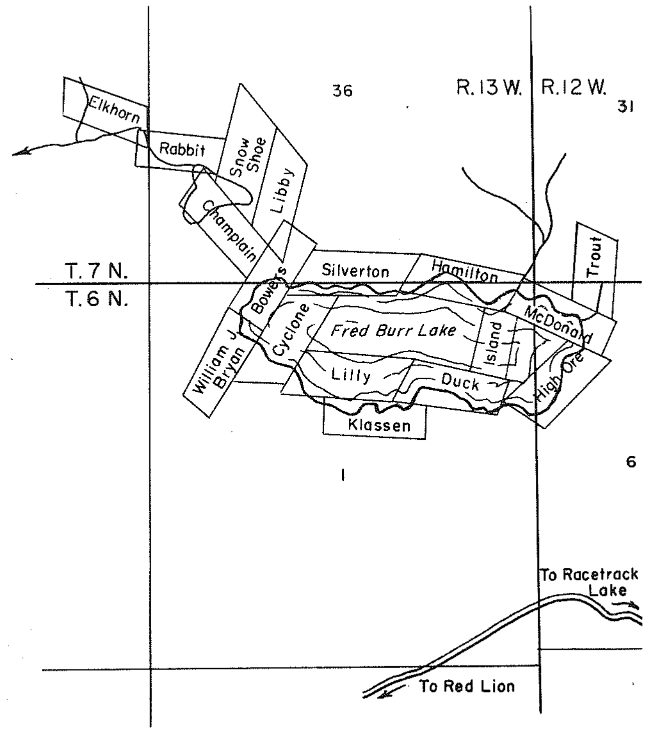


Figure 25.–Claim map, Fred Burr Lake claims

HIDDEN LAKE DISTRICT

The first reported mining activity in the Hidden Lake district was at the Robinson mine. Presumably this was shortly before the mine was visited by Emmons and Calkins in 1906. There is no record of a Robinson claim, but the first lode claim filed in the district was the Blue Eyed Annie, located in the year 1900. One of the three locators of this claim was named Robinson, and it seems likely that the claim subsequently became known as the Robinson mine. Another early claim in the district was the Venture, first located in 1905, which later, under another name, was to become the center of the district production. Placer mining activity in the district has not been significant. A few placer claims were filed on Warm Springs Creek, downstream from Hidden Lake, but no production has been recorded, nor is there physical evidence of more than testing-scale activity.

Robinson mine.–The Robinson mine is approximately half a mile north of Hidden Lake, along the road from Diaperville (the settlement at Hidden Lake) to Red Lion. None of the mine workings were accessible at the time of this writer's visit. Emmons and Calkins (1913) described the mine as being developed by an 80-foot inclined shaft, a 150-foot tunnel, and "several" hundred feet of drifts and crosscuts. Ore is said to have been composed of quartz and pyrite containing values in gold and silver in a sheeted vein zone striking S. 40° E. and dipping 60° NW (this is an obvious misprint, the vein presumably dipping southwest parallel to other local vein structures). Country rock is pink quartzite of the Missoula Group.

Emmons and Calkins (1913) further stated that a small lot of ore from the property had been sent to the Dougherty mill, which was about a quarter of a mile north of the mine along the road to Red Lion. There is no subsequent record of production from this property, and although it is possible that other small lots may have found their way to one mill or another, it seems unlikely that any significant production was ever realized. Little remains of the Dougherty mill; parts of its log walls still stand, a bit of flume, but that is about all. An almost complete lack of tailings indicates that very little ore was ever treated there. In 1906 the log structure housed a 3-stamp mill and amalgamation plates, adequate to handle a small tonnage of free-milling gold ore (Emmons and Calkins, 1913).

Hidden Lake mine.–The Hidden Lake mine is on the south slope of a low hill, about half a mile southwest of Hidden Lake. On the north side of the hill there is a small community, built to house the miners and their families, which became affectionately known as Diaperville.

When visited in 1966, none of the mine workings were accessible. The principal mine access was a vertical shaft, now caved at the surface, extending to a depth of 400 or

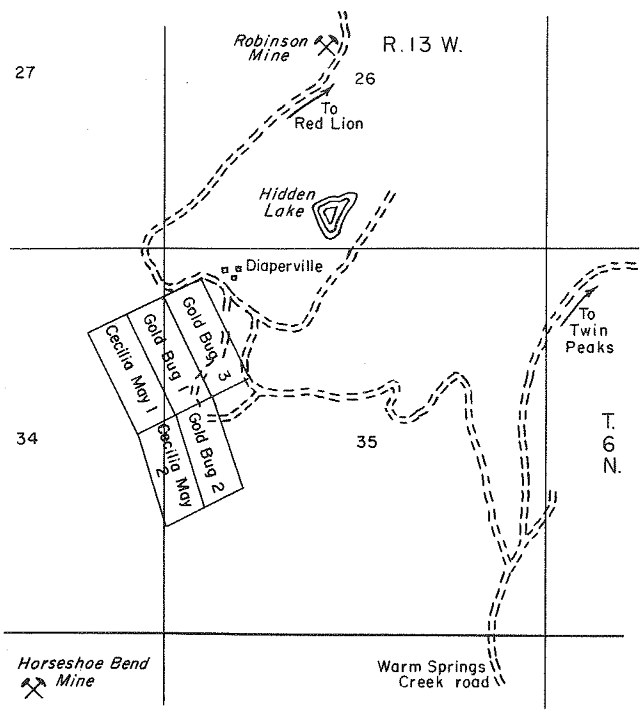


Figure 26.–Claim map, Hidden Lake district

500 feet. The mill building was still standing but in poor condition, and all salable equipment had been removed.

The mine exploited a northeast-striking steeply dipping vein of predominantly pyritic quartz in quartzite of the Missoula Group (Fig. 27). From 1933 through 1942 the property produced slightly more than 100,000 tons of ore that averaged just over 0.2 ounce in gold and a bare trace of silver. Profitable operation from such low-grade ore was facilitated by the soft vein material, which made both extraction and milling relatively easy. With increased depth, the ore became more consolidated and less profitable to mine (personal communication, N. F. Simon).

MOUNT POWELL MINES (RACETRACK PEAK) AREA

A group of five claims, high on the west flank of Racetrack Peak at an altitude of 8,000 to 8,500 feet (Fig. 28), is known collectively as the Mount Powell mines. The property is generally reported as being in the South Boulder mining district, as it is near the head of one of the tributary drainages of that creek. The major production of the South Boulder district centers around the small settlement of Princeton, about 8 miles northwest of the Mount Powell mine, and outside the area mapped for the present study.

Development of the mine undoubtedly began somewhat prior to 1900, and when visited by Emmons and Calkins (1913) in 1907, there had already been more than 2,500 feet of drifts and crosscuts driven. The map (Fig. 29), although undated, was probably drawn at about this same time. It shows approximately the amount of development work reported by Emmons and Calkins, and its author, Thomas T. Baker, was deputy mineral lands surveyor in the area during the 1890-1910 era.

The mine is in a wedge of upper Paleozoic and lower Mesozoic strata that lies between the Mount Powell batholith on the east and the Philipsburg batholith on the west. Mineralization followed a northwest-striking fissure vein that dips steeply south and crosses the Madison Limestone at the western end of the lower two levels and progressively younger formations as it continues eastward. Vein filling, as reported by Emmons and Calkins (1913), is quartz that contains tetrahedrite, pyrite, and copper carbonates. The most common mineral found at surface on the dumps, however, is chrysocolla. Although the underground workings were almost inaccessible when visited in 1969, such evidence as was available indicated that the best ore was found where the vein crossed the Quadrant Quartzite.

When reported upon in 1907 by Emmons and Calkins, most of the mine development was confined to the lowest two levels shown on Baker's map. There is little to indicate that any major development has taken place since that time. The 425-foot level has been almost obliterated by a rockslide, and a short entry has been made at about the 315-foot level. Some bulldozer work is of much younger vintage. An effort was made to reopen the lower levels, probably during the late 1950's or early 1960's, but the work was abandoned without achieving that purpose. Emmons and Calkins reported a small production from the property prior to their visit, and it is listed among "other producers" of the South Boulder district in 1914, 1916, 1918, and 1919. Total production almost certainly does not exceed 500 tons of ore, having a value of $16,000, small return for the amount of development.

RED LION DISTRICT

Mining activity in the Red Lion district began in the late eighties with discovery of the Red Lion mine. A 10-stamp mill was constructed on the original Red Lion millsite bordering on Flint Creek, and claim-filing activity, which had been slow, accelerated. By 1900 about fifty lode claims had been filed, but all or nearly all of the ore produced came from the Red Lion and Hannah mines (Emmons and Calkins, 1913). In 1901 the Milwaukee Gold Extraction Company was formed and purchased the operating properties of the district for a reported $60,000. The company then set out upon an ambitious program to expand and develop the district. Included in the development plans were a new 100-ton amalgamation and cyanidation mill and townsite on the east side of the road, about a quarter of a mile closer to the mines than the old mill had been, and a 3,800-foot aerial tramway to carry ore from the Hannah mine to the new mill.

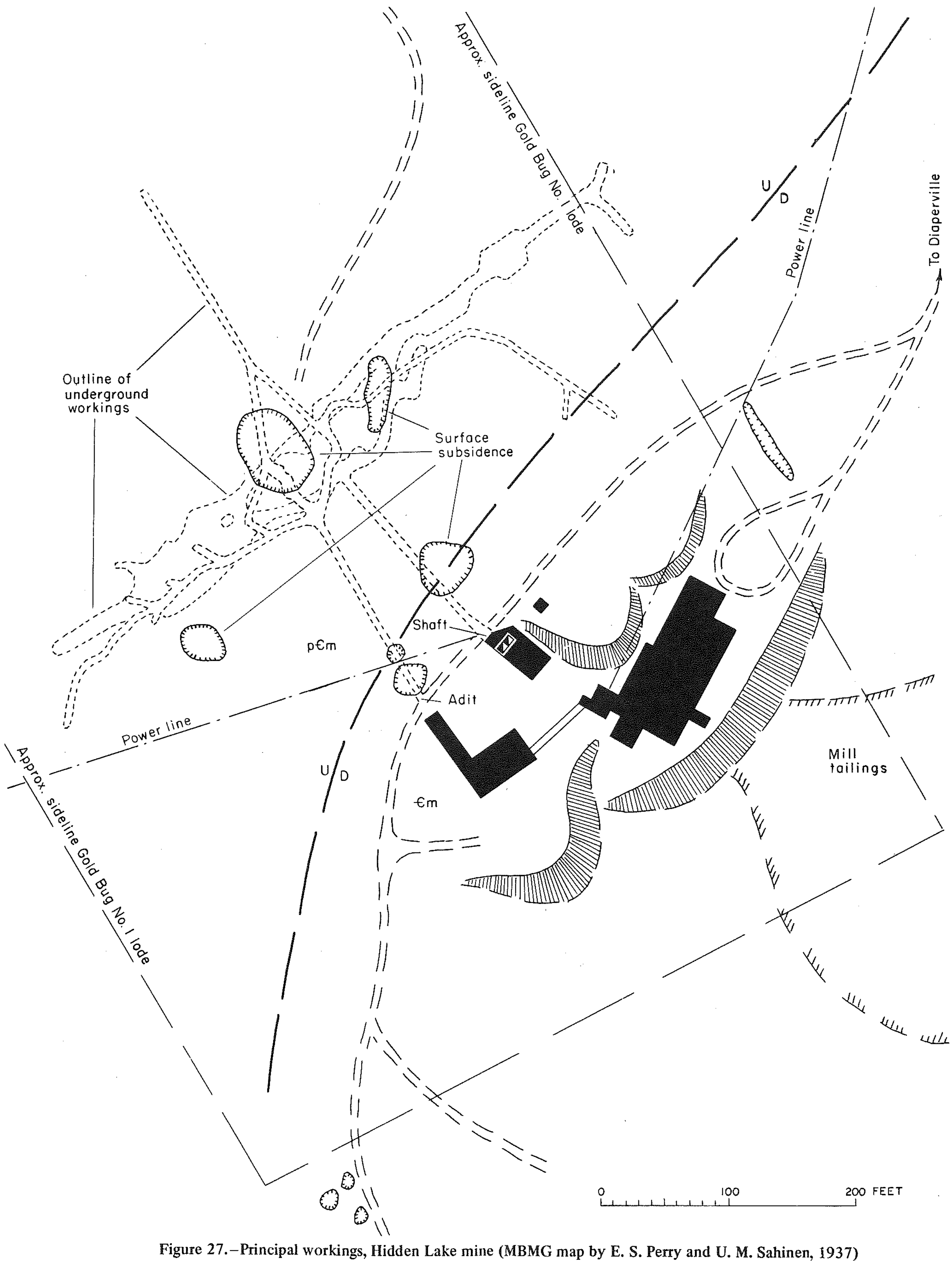


Figure 27.–Principal workings, Hidden Lake mine (MBMG map by E. S. Perry and U. M. Sahinen, 1937)

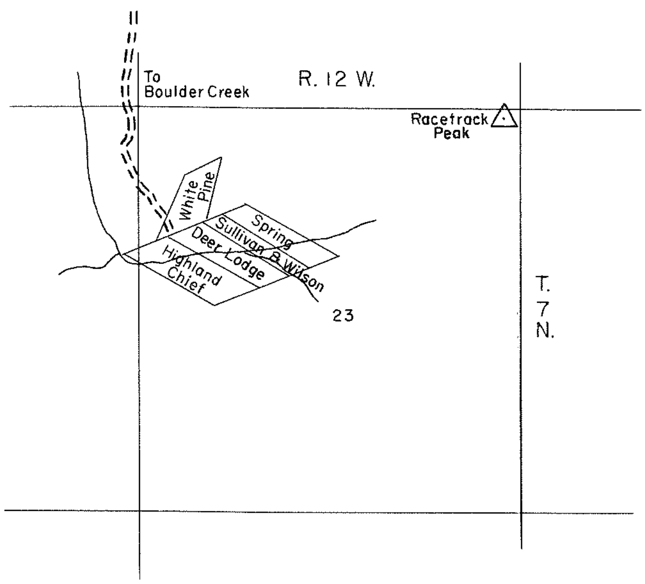


Figure 28.—Claim map, Mount Powell mines (Racetrack Peak) area

What the Milwaukee Gold Extraction Company properties lacked in ore, they made up for with an active press agent. The Anaconda Standard, in April 1905, and even the Mining World carried glowing accounts of developments at Red Lion. These accounts described a rich vein, 5 feet wide and averaging $20 per ton, at the Red Lion mine, and an "immense" vein, 76 feet wide at surface and still 60 feet wide where intersected in a tunnel at a depth of 125 feet, which averaged $15 per ton in gold, at the Hannah mine. Claim-filing activity was revitalized, the operating company filing 27 more claims, while others brought the total of claims filed in the district to more than 150 by 1910.

When Emmons and Calkins made their study of the district, in 1906, the bubble was already breaking. The immense ore body at the Hannah mine was reported by them to be a lens-shaped lode 30 by 40 feet in plan; the Red Lion vein was described as 2 to 4 feet wide, carrying $5 to $20 in gold per ton. Presumably there was a good deal more $5 ore than of any richer kind, for very little ore ever reached the new mill that waited at the bottom of the tramway; there are no tailings below the mill, and the tramway cables, although rusted by more than 60 years of exposure to the elements, show no wear. The Milwaukee Gold Extraction Company's operations were brought to a close through foreclosure about 1914, and a new company, the Badger Montana Company, took over efforts to put the district into production. Their efforts resulted in the driving of a tunnel on the Thurston lode and a shaft on the Surprise, but little or no ore was found (personal communication, W. F. Flynn).

Meanwhile, claim-filing activity toward the south end of the district had been progressing. Although the Senator and Union lodes had been filed in 1898, most of the claims appear between 1910 and 1920. Although several of these more southerly properties have provided sporadic small shipments of ore, none have managed any steady production.

Estimated value of total production from the Red Lion district is $137,944, from 5,700 ounces of gold, 11,000 ounces of silver, and 1,400 pounds of copper. Nearly half of this total had been produced prior to 1906!

American Flag lode.—Development on the American Flag lode consists of a series of shallow shafts and pits along a northeast-striking vein structure (Fig. 31), most if not all of which date from the pre-1906 period. The ore is composed of gold-bearing limonite in a quartz vein, which strikes about N. 60° E. Country rock is dolomitic Hasmark Limestone. Emmons and Calkins (1913) stated that some ore had been sent to a mill on Warm Springs Creek. There is no record of production since that time, and no major development has been attempted on the claim.

Flint No. 2 placer.—The Flint No. 2 placer was located by the Butte and Georgetown Mining and Milling Company. Most of their properties are in the Georgetown district and are described under that heading. A company report by Perrier de la Bathie, dated July 18, 1913, noted that some development work on the Flint No. 2 placer in 1910 yielded sufficient gold to pay wages. The value of the gravels or the quantity was not encouraging, as no further development is recorded. The other placers in the district, the Moonlight and the Castle, have no recorded production.

Golden Eagle and Flint Creek mines.—The Golden Eagle mine, in the southwest part of the district, and the adjacent Flint Creek mine, which is seemingly on the Alliance lode claim, were described by Emmons and Calkins (1913). All of the development on these properties must have been done prior to their visit, as there is no later record of production. Emmons and Calkins described the veins as being in Flathead Quartzite and roughly parallel to the bedding, which strikes northeast and dips southeast. The ore occurs in sheeted quartz fissure veins containing auriferous limonite, pyrite, and some tellurium and bismuth. Several thousand dollars worth of this ore is reported to have been shipped to the Gold Coin mill.

Hannah mine.—Development at the Hannah mine, one of the first properties in the district to be developed, began about 1890, but principal work was between 1901 and 1910, by the Milwaukee Gold Extraction Company. Although none of the underground workings are accessible, the tall tower at the top of the aerial tramway that connects the mine with the mill at Red Lion was still

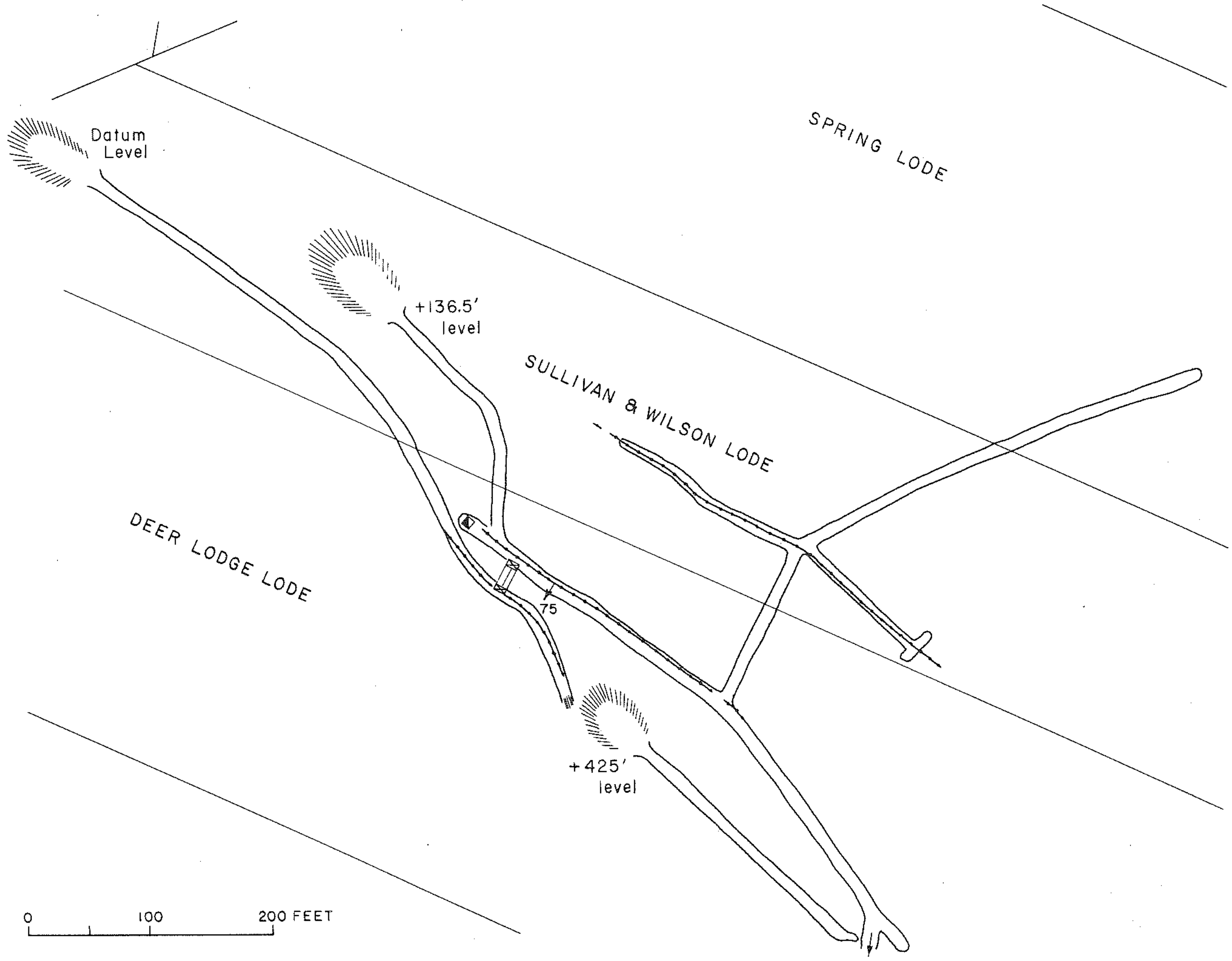


Figure 29.–Mount Powell mine (MBMG map by T. T. Baker, undated)

standing when visited in 1966, but the trestle from mine to tramway tower was far too weakened by the ravages of time to be traversed.

The productive ore lens in the Hasmark Limestone seems to be an extension of the vein found at the Red Lion mine (Fig. 31). Emmons and Calkins (1913) described the ore body as being elliptical and about 30 by 40 feet in plan on the 120-foot level. The ore is quartz-limonite replacement of Hasmark Limestone, as is most of the ore in the district. Emmons and Calkins explained the pronounced widening of the ore body at the Hannah property by the presence of four narrow northwest-striking fissures, which intersect the northeast-striking vein at this point.

Lila Dixon lode.–The Lila Dixon lode, near the northeastern corner of the district, crosses a narrow ridge to extend slightly onto the eastern side of the Cable Mountain divide. Workings consist of short adits and shallow pits and trenches along the extension of the northeast-striking vein structure encountered on the American Flag lode (Fig. 31). Host rock is again the Hasmark Limestone, and ore consists of gold-bearing quartz-limonite veinlets and replacements. The Lila Dixon is one of the more recently operated properties in the district, having produced 110 tons of ore averaging 0.3 ounce of gold per ton in 1941-42.

Mickey mine.–The Mickey mine is the youngest producing property in the district, having been located in 1946 by Eugene Garrett. The mine is developing a fissure vein that strikes N. 40° W. and dips 65° to 85° S. in Hasmark Limestone. Development to 1968 consisted of a 145-foot adit along the vein structure (Fig. 32).

The property also boasts a small water-turbine-powered mill, which Mr. Garrett built between 1940 and 1956. The mill has been used to process ores from the Mickey mine and other properties in the district in which Mr. Garrett holds interest, notably the Detroit, Iron Chancelor, and several others. Minor production is noted from the Mickey mine in 1960, 1962, and 1963, but the amount is not recorded.

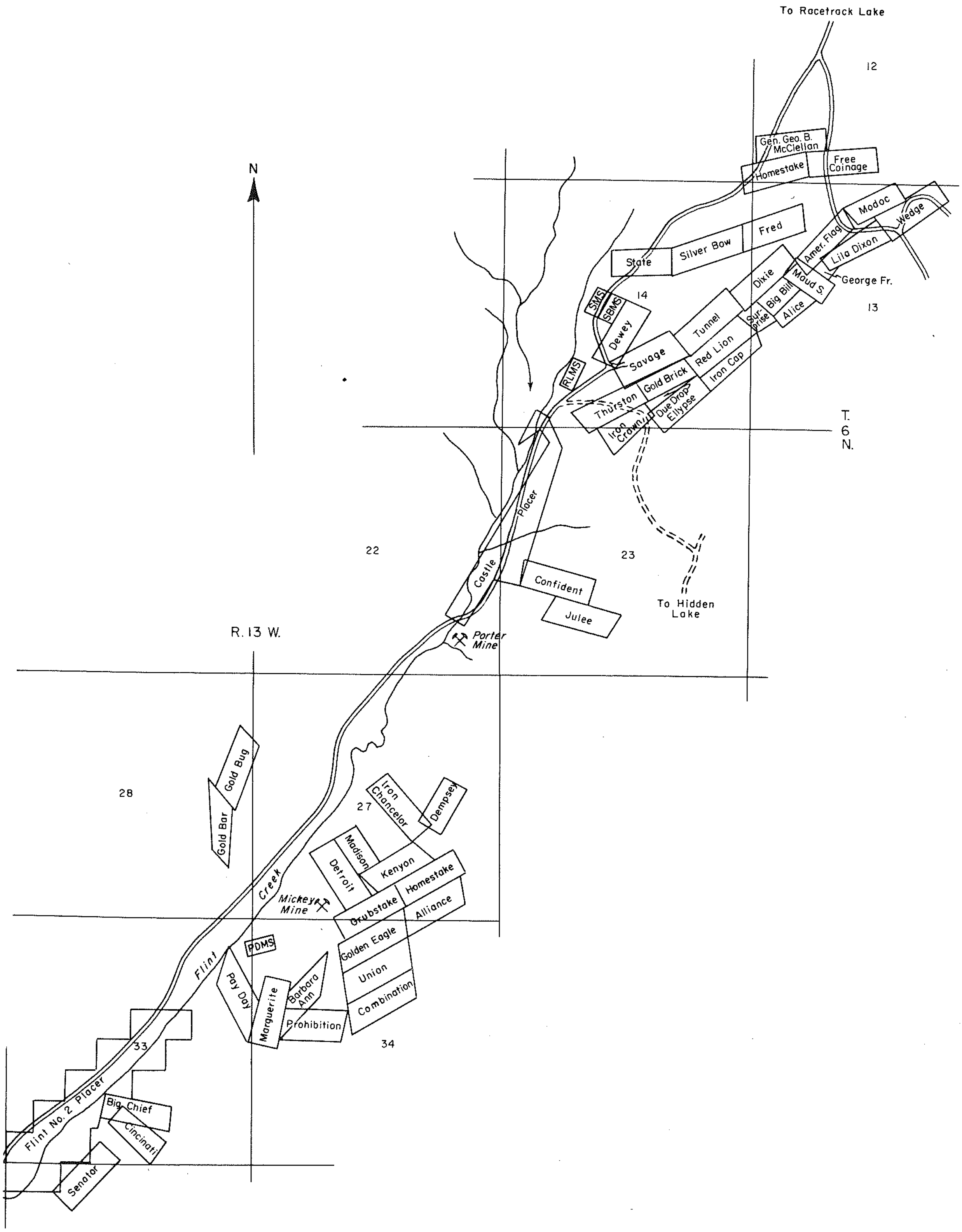


Figure 30.—Claim map, Red Lion district

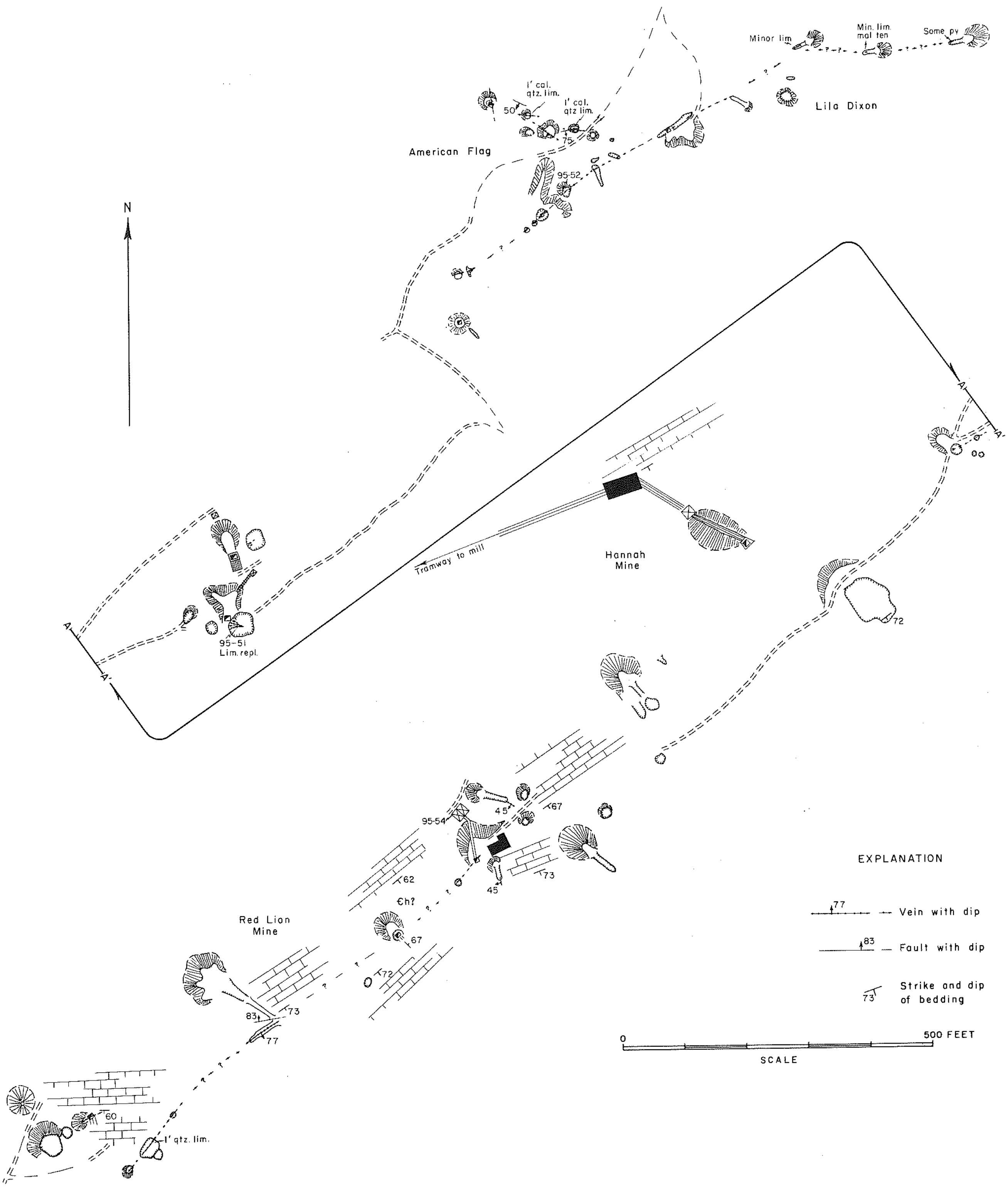


Figure 31.–Mine workings on Red Lion, Surprise, Big Bill, Lila Dixon, and American Flag claims (F. N. Earll, July 1966)

Modoc lode.—The Modoc lode is at the extreme northeast end of the district where coarse granodiorite of the Philipsburg batholith is in contact with strongly altered limestone (Fig. 31). Minerals include the usual iron oxide accumulations at the contact, plus disseminated pyrite, chalcopyrite, and bornite in the granodiorite near the contact.

Porter mine.—The Porter mine is low on the west slope of Cable Mountain, near the center of the Red Lion district. The mine is developed by two inclines and a short adit along a generally west-striking south-dipping vein structure in Hasmark Limestone. One small stope produced a few tons of oxide gold ore (Fig. 33).

Red Lion mine.—The Red Lion was the first discovery in the district, and the one from which the district takes its name. Located in the late eighties, the mine was developed through two shafts along a northeast-striking vein that dips steeply southeast (Fig. 31). Production to 1905 is reported to have had a value of $38,000, mostly in gold. The mine workings were inaccessible in 1906 when visited by Emmons and Calkins (1913), and seemingly there has been no further development on the property, all subsequent work having been restricted to the adjacent Hannah mine.

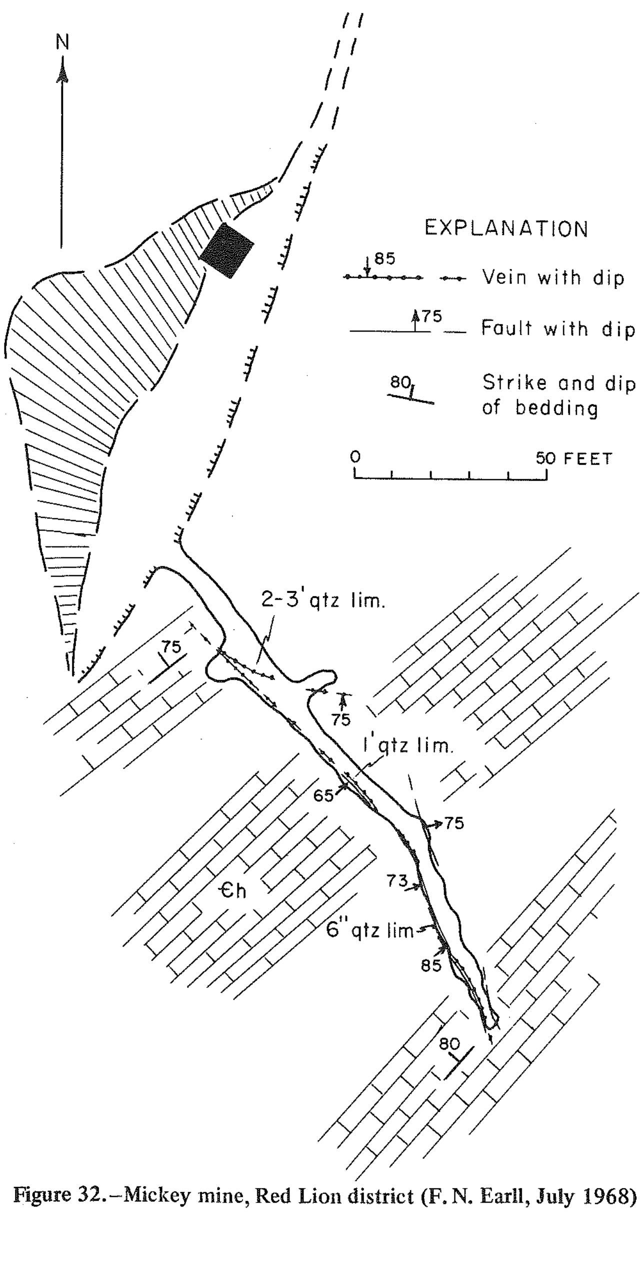


Figure 32.—Mickey mine, Red Lion district (F. N. Earll, July 1968)

The vein, which ranges from 2 to 4 feet in width, roughly parallels the bedding of the host Hasmark Limestone, but in detail the vein structure crosses the bedding of the host strata both along the strike and the dip. Strike of the vein at the Red Lion shaft is N. 50° E. and dip is 77° SE. Ore observed at surface is quartz and limonite that carries some low value in gold. Primary ore is reported to include pyrite, specular hematite, and magnetite, as well as gold (Emmons and Calkins, 1913).

Other mines and prospects.—There are many other properties in the district, more than 200 claims having been filed to date. On most of these claims, little or no work has been performed. Among those showing more than token development are the Cincinnati, where an adit about 360 feet in length was driven on a bearing S. 53° E., but no ore is known to have been encountered. The Julie lode has an adit 140 feet in length in Hasmark Limestone to prospect a narrow northeast-striking lead (Fig. 34). Again, no ore seems to have been found. The Montana mine was on the ridge between Flint Creek and Warm Springs Creek. A 100-foot shaft is reported to have explored a vein 1 to 2 feet wide in steeply dipping quartzite of the Missoula Group. A small amount of hand-sorted ore containing quartz, pyrite, and gold is said to have been sent to the Dougherty mill in the Hidden Lake district sometime during the early years of district development (Emmons and Calkins, 1913).

TWIN PEAKS DISTRICT

The mining area here referred to as the Twin Peaks district includes the several minor drainages tributary to the head of Warm Springs Creek, and two recognized mining areas; Gold Bar Basin on the west, and Northern Cross on the east (Fig. 35).

Mining activity began in the Twin Peaks area about 1890, most of the properties being reported as active at the time of Emmons and Calkins visit about 1905. Patents were issued on several of the claims in 1896 and 1897. Although a fair amount of development work has been accomplished at the several properties of the district, none of the mines has ever achieved steady production. Emmons and Calkins (1913) credited the St. Thomas mine with "several" thousand dollars worth of gold production as of 1906, and the Nineteen Hundred with about $3,000 worth. Although the Northern Cross

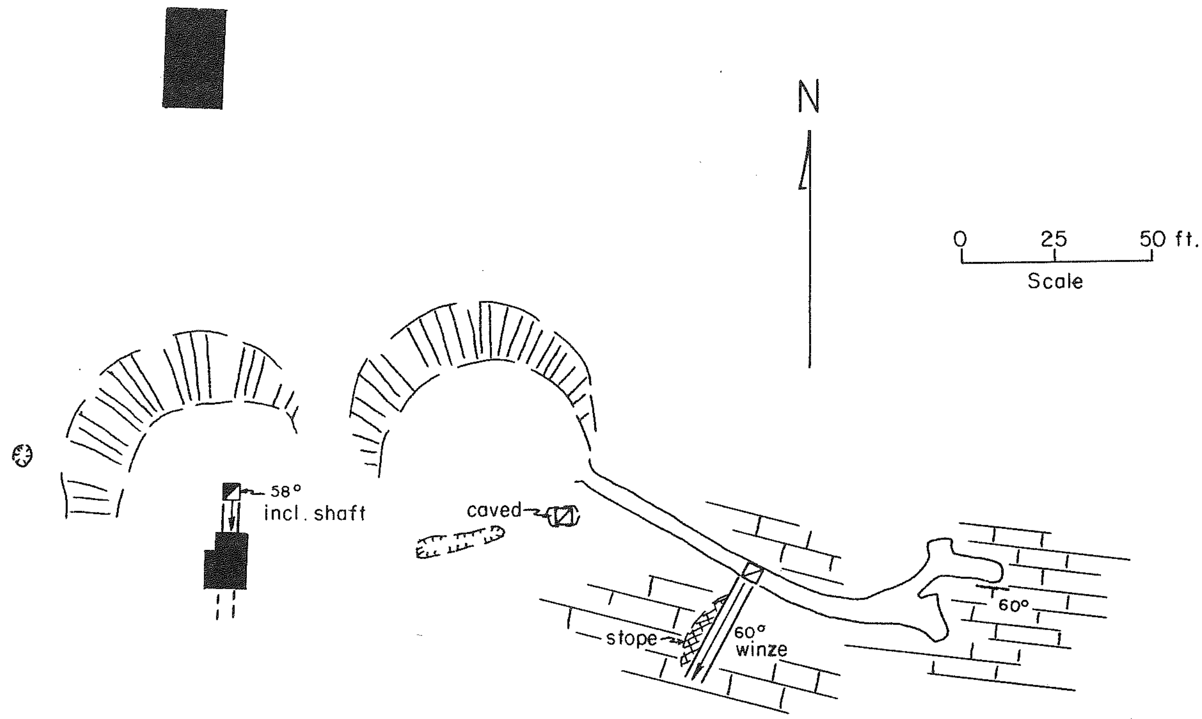


Figure 33.–Porter mine, Red Lion district (map courtesy of K. S. Stout)

mine was reported as having a narrow vein containing low-grade gold ore, little of this material was ever produced. Activity in the district ceased shortly after the visit by Emmons and Calkins, probably by 1910, and there has been nothing but minor prospecting since that time.

Gould-Corry lode and adjacent properties.–The Gould-Corry lode (Fig. 36) is on exposures of Hasmark Limestone adjacent to its contact with the granodiorite of the Philipsburg batholith. Development to date consists of two shallow vertical shafts and one 65-degree inclined shaft, none of which exceeds 30 feet in depth. Mineralization is of two types. The two vertical shafts were sunk to prospect quartz-limonite replacement lodes in the host limestone. These lodes seem to have been localized by northwest-striking cross fractures. The inclined shaft, which is farther north, explores a garnet-epidote tactite zone, which contains limonite, malachite, quartz, and minor scheelite. In addition to copper and tungsten, the ore carries minor amounts of gold and silver. Continuing eastward, the Nut Pine and Bager lodes follow the same general trend of mineralization. Development on these claims is confined to shallow pits and trenches, which expose quartz-limonite vein matter that contains generally small amounts of the precious metals.

Northern Cross mine.–The Northern Cross mine is on a group of claims at the head of the easternmost fork of Warm Springs Creek. The mine is developed by a series of adits and possibly a shaft, all in sheared limestone of the Madison Group (Fig. 37). Emmons and Calkins (1913) reported the ore to be in quartz-pyrite (limonite) vein matter, which contains low values in gold. Specimens collected by the writer from the dump of the uppermost level also contained malachite, suggesting that the primary ore included some copper sulfide, most likely chalcopyrite. All workings were inaccessible when visited (1969), and there was no indication of activity in recent years.

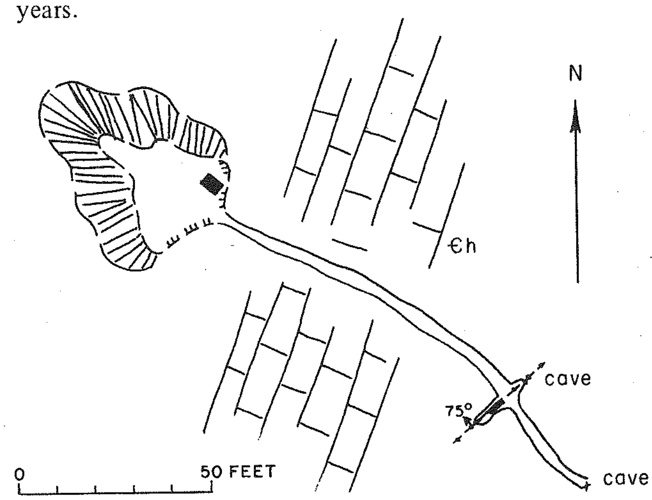


Figure 34.–Mine workings, Julie lode, Red Lion district (F. N. Earll, July 1968)

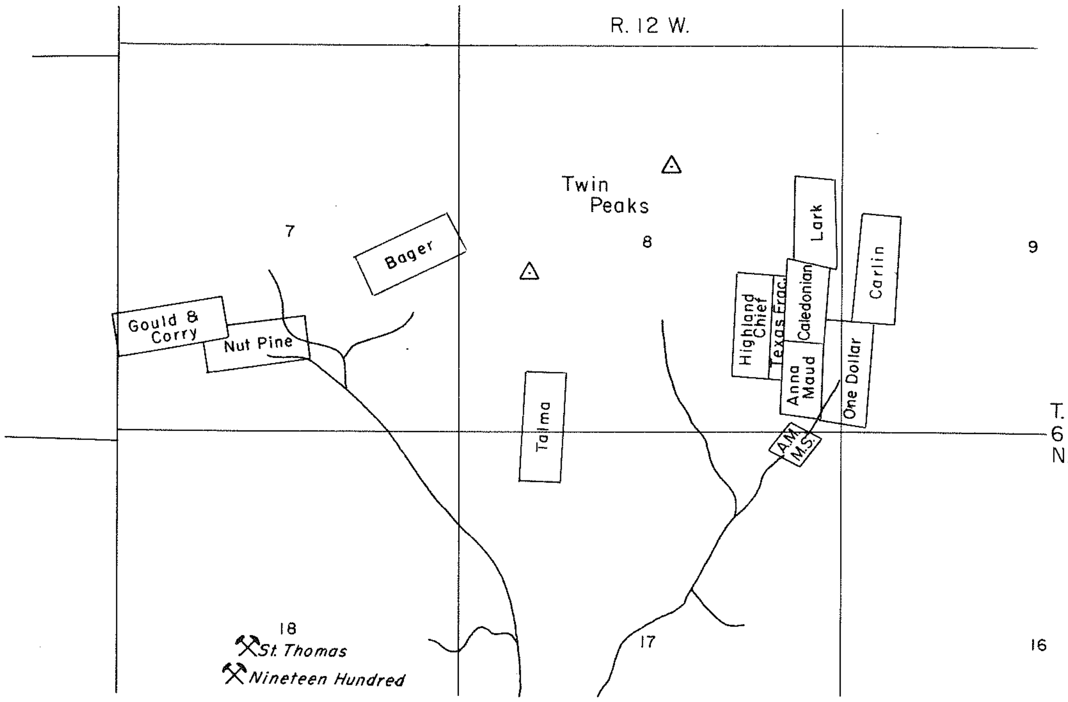


Figure 35.–Claim map, Twin Peaks (Northern Cross and Gold Bar Basin) district

St. Thomas and Nineteen Hundred mines.–Although these properties have been abandoned for many years and there is no physical evidence upon which to establish claim names, the more northerly adits (Fig. 38) are thought to have been the St. Thomas mine, and the lower and more southerly adits probably constitute the Nineteen Hundred mine. Described briefly (Emmons and Calkins, 1913), they are on the southwest-facing slope of a ridge composed of quartzite of the Missoula Group, along the westernmost fork of Warm Springs Creek.

One adit in the upper (St. Thomas) group was open and disclosed a narrow quartz-limonite vein, which strikes N. 35° E. and dips 54° SE. A winze-like stope extends downward from the level for an unknown distance along the vein. A selected sample of the vein matter contained slightly more than one ounce of gold per ton. The only other accessible opening was the lowermost (Nineteen Hundred) adit. Here several hundred feet of branching tunnel had been driven in an obvious and apparently fruitless effort to find the downdip extension of ore encountered above. There were no raises or stopes, or any evidence of mineralization in this lower adit.

POWELL COUNTY

RACETRACK DISTRICT

The first claim in the Racetrack district, the Avondale placer, was located by Benjamin Daniels in 1895, but there is no record of further activity until 1901, when one additional placer and ten lode claims were located, most of them by members of the Daniels family. Claim staking continued at a rapid rate, and by the end of 1905 a total of 89 lode and 40 placer claims had been located. Other names for the district, used by various locators, include Racetrack Creek, Daniels, and Danielsville, but it is interesting to note that claims filed by members of the Daniels family, who established the district, consistently refer to it as the Racetrack district.

Despite the feverish activity by claimants, production from the district remained virtually nil for the first 20 years. The small community of Danielsville was established, and a mill was constructed across Racetrack Creek

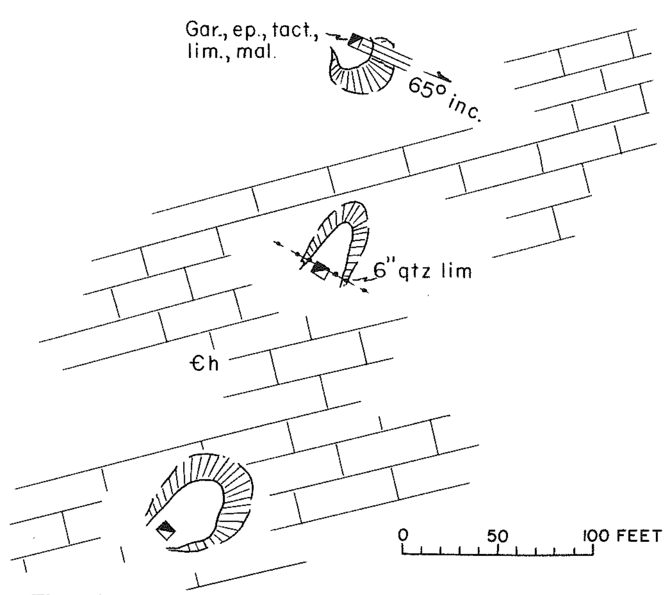


Figure 36.–Gould-Corry lode, Twin Peaks (Gold Bar Basin district) (F. N. Earll and J. N. Earll, June 1967)

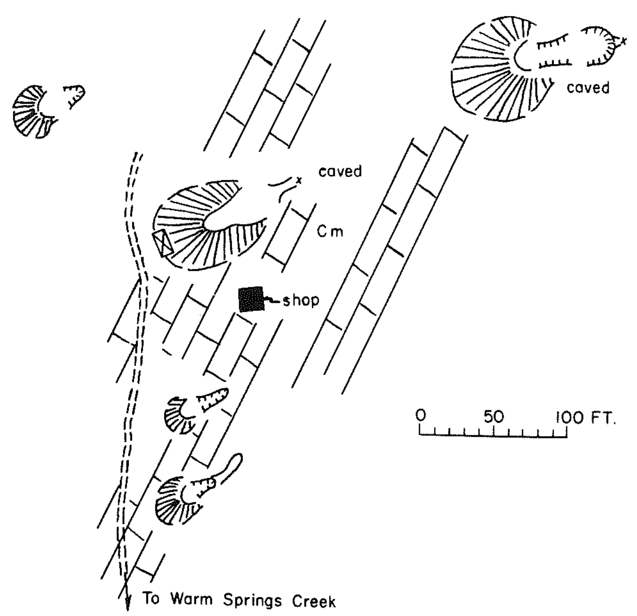


Figure 37.–Northern Cross mine, Twin Peaks (Northern Cross) district (F. N. Earll and J. N. Earll, June 1969)

from the town, on the Amazon millsite claim, in about 1905. Government records note only a "few" ounces produced in 1910, and a "little" bullion from an "arrastre" at Danielsville in 1914. It seems probable that the "arrastre" was actually a Huntington mill, installed at Danielsville about 1905 by Martin Winston (personal communication, U. M. Sahinen). Although many old mining districts have had considerable unrecorded early production, this does not seem possible for the Racetrack district. The amount of placer gravel worked was minimal, and there are no extensive underground developments dating from the years before World War I. It seems unlikely that the Danielsville mill ever treated more than test lots of ore; there is no indication that tailings accumulated below the mill.

The district enjoyed a minor resurgence in 1916 when several old claims were relocated, including the five on the mountainside south of Danielsville that were subsequently taken to patent. Again, however, the area stubbornly refused to release more than token amounts of metals.

The principal producer of the district, the Dark Horse mine, was first located in 1918 by Thomas Daniels, but for many years it recorded no production. The most

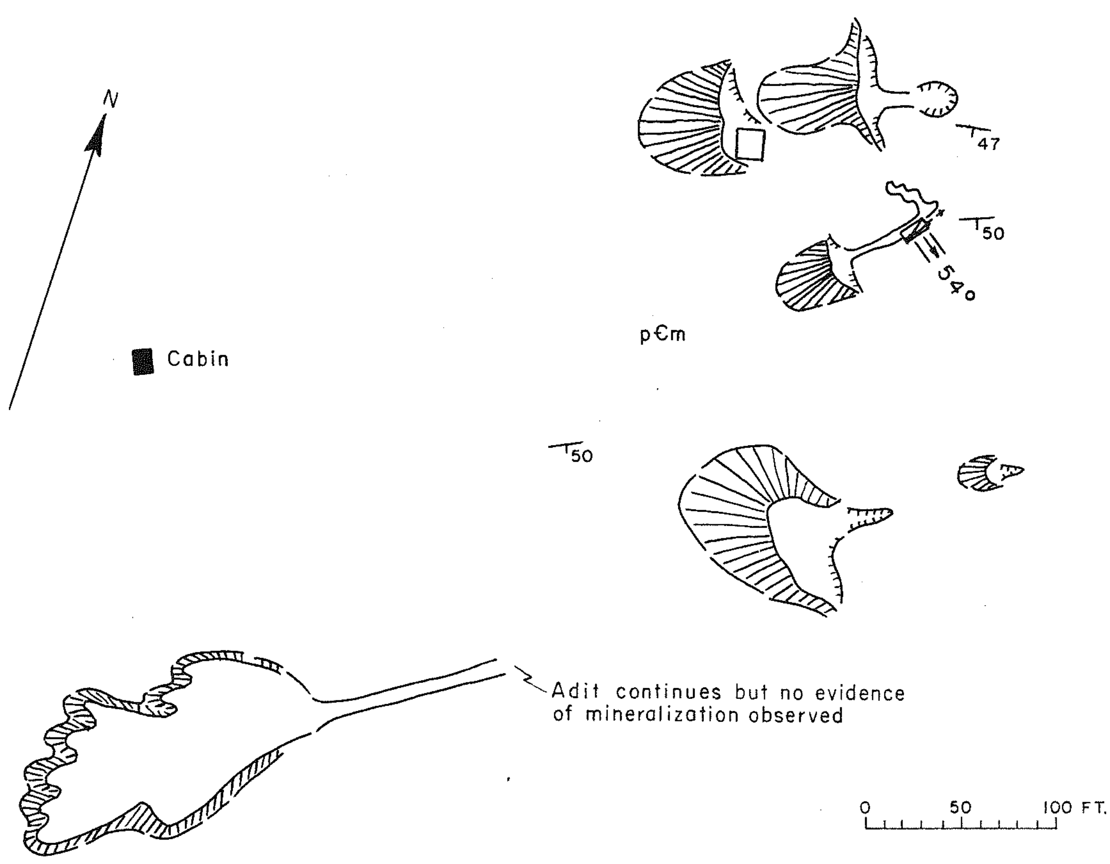


Figure 38.–St. Thomas and Nineteen Hundred mines, Twin Peaks district (F. N. Earll and T. F. Harriss, July 1966)

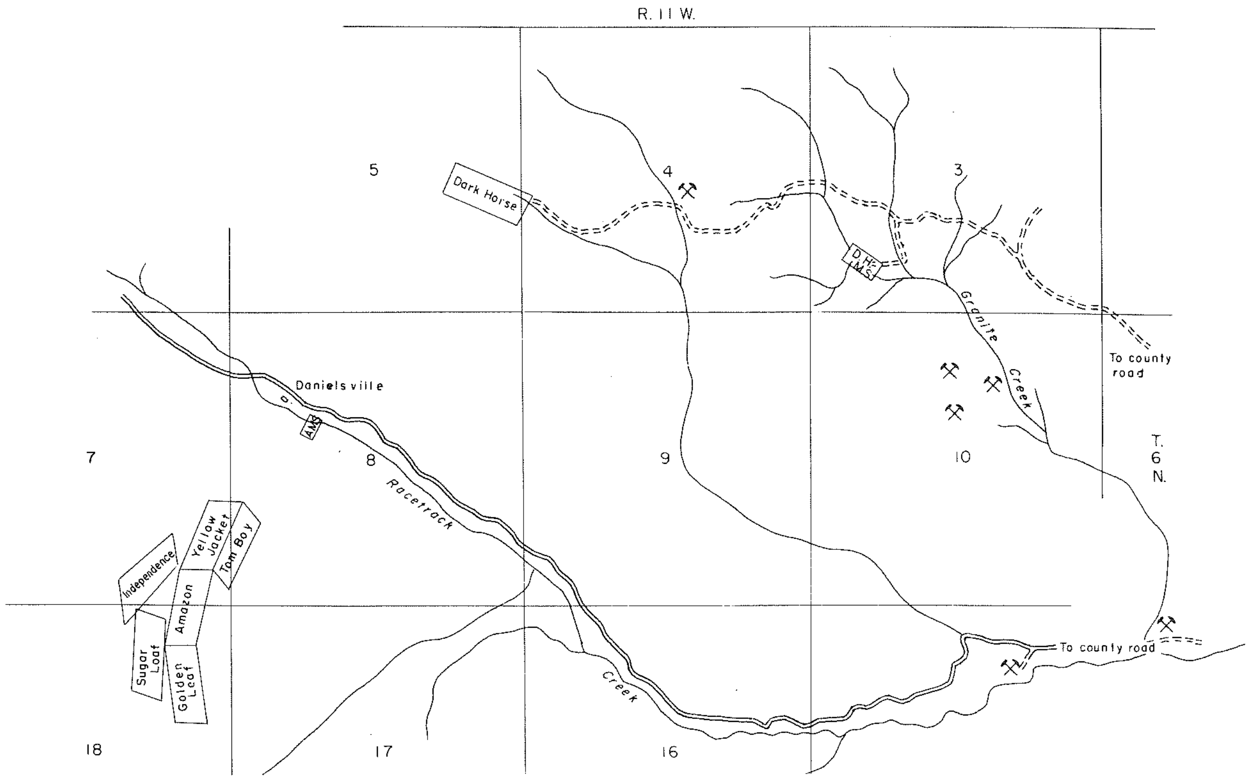


Figure 39.–Map showing mines in Racetrack (Danielsville) district

active period for the district was the depression years, 1931 to 1940. During this time there was a small but fairly steady production, most of it from the Dark Horse mine but some from the Amazon.

Amazon mine.–The Amazon mine is high on the north-facing slope of a mountain, about a mile south of Danielsville (Fig. 39). All of the mine workings are in the coarse hornblende quartz diorite of the Racetrack Pluton. The principal development is by a series of short adits (Fig. 40). The main or 250-level adit, near the mine shop and other facilities, is caved at the portal and inaccessible. Dump volume suggests about 450 feet of workings.

Ore occurs as narrow fissure fillings in the quartz diorite host rock. At and near the surface the fissure filling is composed of quartz and limonite, the latter presumably derived from the oxidation of pyrite. The only ore that could be found in place was in a narrow vein exposed in the uppermost adit. This material contained only trace quantities of gold and silver.

Dark Horse mine.–The Dark Horse mine is near the head of a small tributary of Racetrack Creek in the SE¼ sec. 5 (Fig. 39). The workings are in somewhat metamorphosed limestone of the Hasmark Formation, part of a small roof pendant in the porphyritic quartz diorite of the Mount Powell batholith. A series of adits and shallow shafts developed veinlike lodes in the limestone near and approximately parallel to the contact with intrusive rock, which crops out 100 to 300 feet to the south (Fig. 41).

Minerals consist almost entirely of quartz and limonite, but include some manganese oxide, and have formed small replacement lenses and lodes in the limestone host rock. None of the workings were accessible in 1965, but surface evidence suggests that all workings are confined to the oxide zone. Records suggest that the ore averaged slightly less than 1 ounce of gold and about ½ ounce of silver.

The Dark Horse mill is about a mile east of the mine, on Granite Creek. Although in very poor condition, most of the mill equipment is still in place, probably because of its remote location. The plant has a 2-stamp Fraser and Chalmers mill powered by an overshot water wheel, which although inoperative was still in place in 1965. The machinery is said (personal communication, W. H. Gustafson) to have been brought from the Silver Queen mine in the Lost Creek district.

Other mines and prospects.–Many small prospects are to be found in the district. A few that have had a reasonable amount of work done on them are indicated on the district map (Fig. 39).

At a small mine just south of the Racetrack Creek road, in the NE¼ sec. 15, principal workings consist of one adit, which extends in a S. 65° W. direction. When

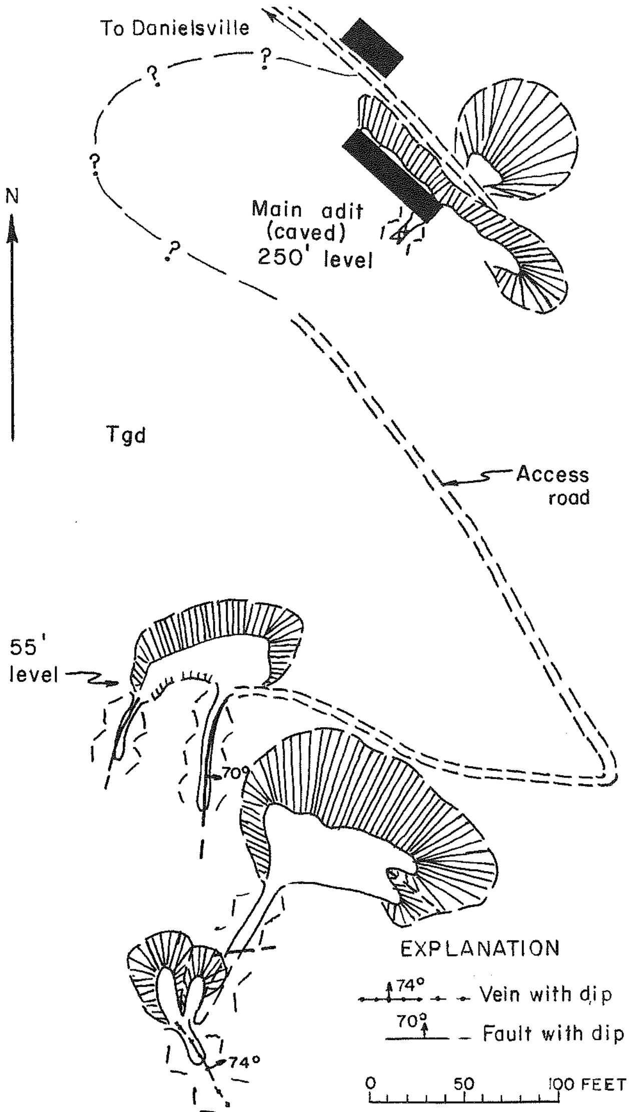


Figure 40.–Amazon mine, Racetrack district (F. N. Earll and Robert Reese, 1965)

visited, the adit was filled with water and could not be entered, but dump volume indicated a length of 30 or 40 feet. A series of shallow pits and trenches on the hillside above the adit level traces the path of the vein. Ore seems to have been very scarce. A careful search of the dump turned up one small piece of quartz containing minor pyrite, chalcopyrite, and galena.

Several minor prospects dot a hill just west of Granite Creek in the N½ sec. 10. Workings observed included two short adits and a shallow shaft. Samples of exposed minerals indicate traces of gold and silver and a small amount of copper in oxidized quartz-limonite vein matter.

A shallow shaft was being refurbished in 1965 at a prospect near the center of sec. 4. A sample showed traces of gold and silver and some tungsten (scheelite).

OTHER MINES AND PROSPECTS

A great many small mines, prospects, and claims in the Southern Flint Creek Range have not received mention in the preceding pages. Although it would be an impossible task to describe all of these, a few of the more prominent ones are briefly described in the following paragraphs.

PROSPECTS NEAR THE MOUTH OF FOSTER CREEK

A patented claim named the Iron Clad lode was located on a low hill just west of the mouth of Foster Creek, about a mile north of Highway 10A. Workings consist of a caved adit estimated to have been 30 to 40 feet in length, a shaft 40 feet in depth, and several small pits. The work was done to explore a north- to northwest-striking shear zone in the Flathead Formation, which contains quartz and limonite. Production from the property, if any, was minimal.

Lower on the hillside, about half a mile southeast of the Iron Clad, an unpatented prospect was most recently located as the T.C.M. claim. Here, development is along a small shear that strikes N. 10° W. and dips steeply west in Hasmark Limestone. Mineralization produced quartz-limonite replacement of the limestone. The workings include a short caved adit on the outcrop, and a shaft 63 feet deep a short distance up the hillside to the north.

On the east side of the mouth of Foster Creek, high on the palisade of limestone that rises north of Highway 10A at that point, a series of adits includes seven more-or-less accessible ones containing an aggregate of about 1,150 feet of tunnel. These and several shallow pits seem to have been aimed at following minor limonite staining in the sheared limestone along and adjacent to a gently dipping fault (Fig. 42). No indication of significant mineralization was noted.

PROSPECTS ALONG STUCKY RIDGE

A series of patented claims along a prominence known as Stucky Ridge, in sec. 7 and 17, T. 5 N., R. 11 W., can be reached by a road that branches from the Levengood Gulch road about 2 miles west of Anaconda (Fig. 43). Two pits or quarries have been opened on the White Chief lode, which is located within the Summit placer. The pits are in shattered iron-stained Quadrant Quartzite. A rough estimate suggests that 20,000 tons of material has been removed and was probably sold to the smelter as silica flux, although it may have contained small amounts of the precious metals.

The Lone Bill lode, located 1½ miles northwest of the White Chief is on exposures of metamorphosed shale of the Missoula Group. Two shallow discovery shafts on the claim showed no evidence of production or even of significant mineralization.

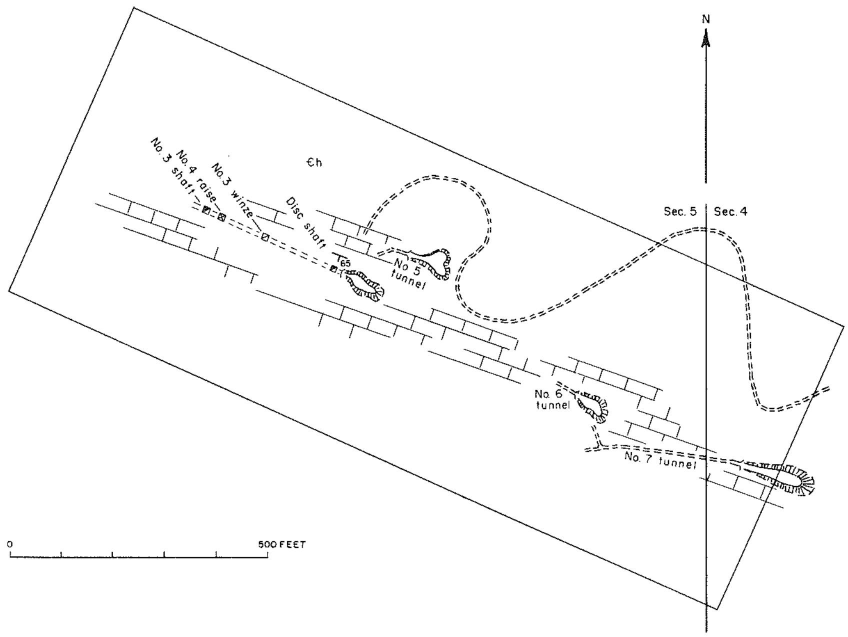


Figure 41.–Dark Horse mine, Racetrack district (map courtesy of Mrs. A. R. Gustafson, owner)

The High Grade 1 and 2 claims (Fig. 43) were not visited, but examination of air photos of the area disclosed no evidence of mining or of extensive development.

TUNGSTEN PROSPECTS NEAR POSEGA LAKE

Tungsten was discovered along the ridge south of Posega Lake in sec. 14, T. 6 N., R. 12 W. in 1909. This was a period of awakening interest in tungsten, the beginning of a boom that was to continue until the close of World War I.

Development at the Posega Lake prospects seemingly followed the all-too-frequent custom of beginning with construction of a mill and then searching for ore to feed the mill. The mill building, still standing in 1965, was well constructed of massive hand-hewn timbers at great cost in human effort and probably considerable cost in dollars. The search for ore was less successful. Minerals Yearbook for 1917 noted that a small amount of concentrate was shipped by the National Silver and Tungsten Company from a property a few miles north of Anaconda that year. The company was reported to be constructing a mill, presumably the one at the head of Thornton Creek near the tungsten prospects. This was the first and the only production. Examination of the millsite indicates that no more than a few hundred tons of ore was ever processed.

Mine development includes one adit, now caved, which may have been advanced several hundred feet, plus numerous shallow pits and trenches. No mine ever developed from the work.

IRON DEPOSITS

The presence of iron ores in the Southern Flint Creek Range has been recognized since the early years of development. First published mention of these deposits was by Emmons and Calkins (1913), who briefly described the magnetite deposits at Cable, Southern Cross, and Olson Gulch. The U. S. Bureau of Mines was sufficiently impressed with the possibilities of these iron concentrations that they engaged in a program of sampling, drilling, and testing of the material in the Southern Cross district in 1943 (Wimmler, 1946). Holser (1950) studied the magnetite bodies in the Cable mine, and to a lesser extent in adjacent areas, and mentioned the presence of small magnetite lenses in the Madison Limestone southeast of Fisher Lake, in Granite County. Since then, there have been reports of magnetic anomalies elsewhere in the range, which may indicate the presence of still more bodies of this type.

Iron ores of the Southern Flint Creek Range are of two types; oxidized ores composed in large part of limonite and hematite, which are the oxidized residue of primary sulfide replacement of limestone, and contact metasomatic magnetite bodies. In general, the oxidized ores have been gold bearing, and were mined for their content of the precious metals. Of greater interest here are the magnetite bodies, which have not been exploited to any great extent. The U. S. Bureau of Mines study, while in no way intended to fully outline the iron-ore reserves of the area, did indicate the presence of five lenses of magnetite ore within the Southern Cross district. Similar lenses have long been known in and near the Cable mine as well.

Production of iron ores from the range has been very minor, primarily because there has been no ready market for such ores, and there is no reason to anticipate any serious development of iron ores unless there is a major change in market conditions. Emmons and Calkins (1913) noted that the Black Chief mine, in the Olson Gulch district, had shipped several thousand tons of magnetite ore for flux at some time prior to their visit to the property in about 1906. Wimmler (1946) noted a similar production of several thousand tons from the Pomeroy mine, in the Southern Cross district, between 1921 and 1923. This too was sold as smelter flux. No other iron production is known to this writer, although there may have been minor contributions from other properties that have not been recorded.

NONMETALLIC DEPOSITS

The impact of nonmetallic products on the overall economy of a region seems frequently to be overlooked. The Southern Flint Creek Range, to take a case in point, is generally thought of as an area that is of value primarily for its gold deposits. Silver, copper, lead, and tungsten would be considered secondary products of lesser value, which indeed they are, but little thought may be given to the value of nonmetallic production. Actually limestone, just one of the several nonmetallic products, has been one of the major commodities, easily exceeding the combined total value of the lesser metals listed. Further, although metal production has been at a virtual standstill for many years, limestone production has continued unabated, and can reasonably be expected to continue at a steady pace into the foreseeable future. Add to this the available reserves of other nonmetallic products that are as yet undeveloped or only partly developed, and the true value of nonmetallics to the economy of the region begins to come into focus.

CLAY

Very little clay has been mined in the Southern Flint Creek Range area, although several deposits of relatively low-grade material are known. Sahinen (1963) noted that some siliceous fire clay has been produced from a pit on Lost Creek. It is probable that the pit is the one in the NE¼ sec. 15, T. 5 N., R. 11 W., where a considerable amount of material matching this description has been removed. Sahinen and others (1958) also briefly described a low-grade shaly clay found in sec. 25. T. 5 N., R. 11 W. along Lost Creek. Tests showed that this material would be suitable for making common brick if blended with other clays, but no development of the deposit has taken place to date.

LIMESTONE

Limestone, including magnesian limestone, is certainly the second most valuable mineral product of the Southern Flint Creek Range, if indeed it is not the most valuable. Most of the production has come from The Anaconda Company's large quarry at Brown's siding, about 5 miles west of the town of Anaconda, but lesser contributions have been provided by other sources.

BROWN'S QUARRY

The Frank Brown placer on which the quarry is excavated was filed on in 1894, about 10 years after the movement of smelting operations from Butte to Anaconda, when the company found it desirable to have a source of limestone flux somewhat closer to the smelter than were the sources they had used previously. The claim is located along exposures of massive Madison Limestone, a convenient 5 miles west of town and about 6 miles from the original smelter site. The company-operated Butte, Anaconda, and Pacific Railroad, which brought ore and now brings concentrates to the smelter, was extended to the quarry to provide transport. In later years the railroad was extended another 13 miles to Southern Cross, but that extension has since been abandoned, and it begins to look as though the rails will never reach their avowed western terminus, the Pacific Ocean. Although the quarry has not been in continuous operation since 1894, it has been and remains the smelter's principal source of limestone flux and lime (quicklime).

Geology and operations at Brown's quarry were described by Perry (1949). No figures on total production of the deposit are available, but The Anaconda Company has stated that it utilized 311,632 tons of material from the quarry during 1968 (personal communication, R. G. Ingersoll, Jr.). This figure can probably be taken as a reasonable approximation of annual production in recent years, but this is roughly ten times the production rate indicated by Perry as being normal 20 years ago.

DIAMOND PLACER QUARRY

Another limestone quarry that was active during the early years of development of the area was the Diamond placer. The quarry is on the Diamond placer claim, at the confluence of Lost Creek and Timber Gulch, near the eastern end of the Lost Creek mining district (Fig. 14). In describing this property, Perry (1949) unfortunately used a map that had the upper portion of Lost Creek, that portion west of Lost Creek Falls, erroneously labeled Hoodoo Gulch. As a result, he gave the location as being at the confluence of Lost Creek and Hoodoo Gulch, a meeting that never was and an error that has been repeated in at least one other publication.

The Diamond placer was located in 1894, and patent was issued in 1903. The quarry is on exposures of magnesian limestone of the Madison Group, and while in operation, had a kiln where limestone was calcined prior to being hauled to market. Lime from this kiln was used for construction in both Anaconda and Deer Lodge about the turn of the century. No estimate of total production has been attempted, but overall pit dimensions are not large.

OTHER LIMESTONE DEPOSITS

The author is not aware of any other properties within the Southern Flint Creek Range area where limestone has been produced, but a great abundance of material is available in reserve in case a need for it should develop. Chelini (1965), in a study of limestone, dolomite, and travertine deposits in Montana, carried out an extensive program of sampling and analysis of limestone, which included several sites along Warm Springs Creek, west of Anaconda. This program established the existence of extensive reserves of limestone suitable for most industrial purposes at points along Highway 10A between Anaconda and Georgetown Lake. No detailed estimate of the reserves was attempted, but the figure would certainly fall in the range of hundreds of millions of tons.

PHOSPHATE

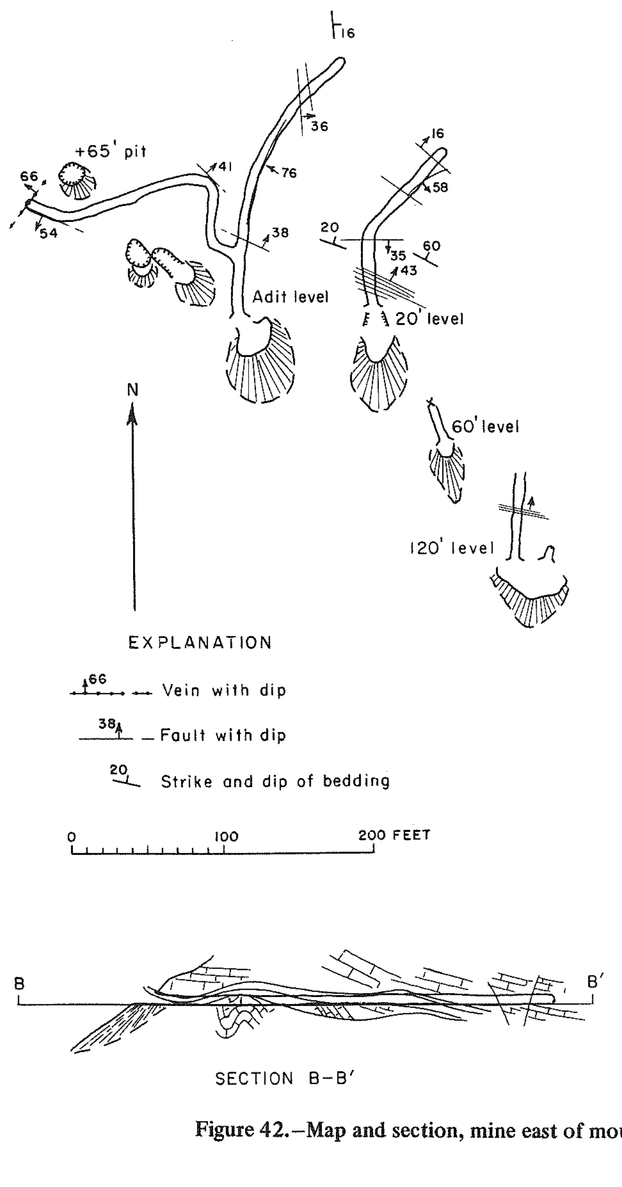
Phosphate rock, which occurs in the Phosphoria Formation and which has been one of the principal mineral commodities produced from the northern part of the Flint Creek Range, has yet to be found in commercial quantities in the southern part of the range. One reason for the lack of commercial phosphate in the southern part of the range is the fact that the lower phosphatic member of the formation thins progressively southward. Another reason is the fact that most of the outcrop of the formation is a linear belt in the highest and most inaccessible part of the range. This factor is certain to have discouraged prospecting in the area, and it would serve to make otherwise workable deposits noncommercial because of greater costs of operation and transport.

SAND AND GRAVEL

Relatively little sand and gravel has been produced within the area, because abundant supplies are available in the recent alluvium of surrounding areas. Should the market for such material increase to the point that existing supplies were depleted, new sources could be developed from the terrace gravels and morainal deposits along Warm Springs Creek. One small gravel pit was noted about 1½ miles up the Lost Creek road. Production has been minor, however, the material seemingly being used only locally as road metal.

SILICA

Silica has been produced from several places in the Southern Flint Creek Range. Most of the product has been sold as smelter flux, but at one property an attempt



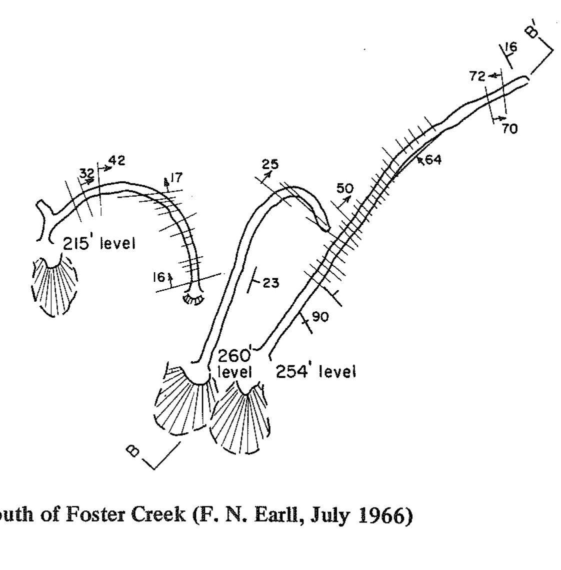


Figure 42.–Map and section, mine east of mouth of Foster Creek (F. N. Earll, July 1966)

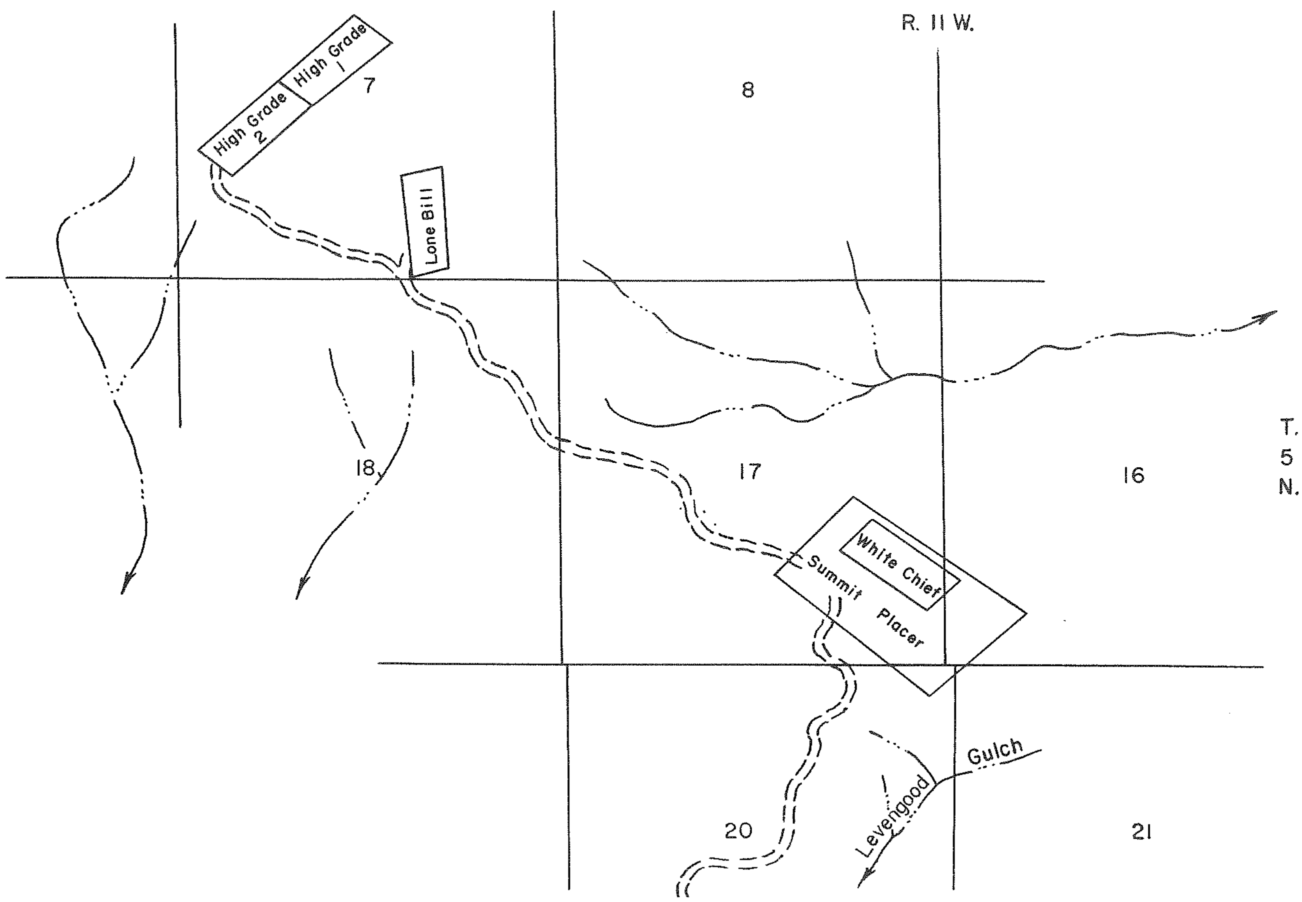


Figure 43.—Map of Stucky Ridge claims

has been made to market a high-purity product to the silicon-alloy industry. Extensive reserves of both types of product seem to remain undeveloped.

BLUE EYED NELLIE CREEK QUARRY

The largest silica quarry in the area is on the east side of the small creek that drains the Blue Eyed Nellie mining district, near the center of the NW¼ sec. 24, T. 5 N., R. 12 W. (Fig. 2). The quarry is developed upon an outcrop of Quadrant Quartzite, which is shattered by joints and faulting. Rough measurements of the pit indicate that about 85,000 yards (181,000 tons) of material has been quarried. A large stockpile of crushed and sized material remains in storage on the property.

SNOW WHITE SILICA MINE

The Snow White silica mine is in the NW¼ sec. 27, T. 6 N., R. 11 W., high on the divide west of the Modesty Creek placers. The property has been well described by R. N. Roby (Chelini, 1966). The quartzite, much of which is snow white as the claim name implies, is seemingly in the upper part of the Missoula Group and is somewhat purified by metamorphism induced by nearby intrusive activity. The contact with Wallace Limestone is just west of the deposit, and a small diorite stock is exposed to the east. Since Roby's visit to the property in 1963, an improved gravel road has been constructed to service the mine, and a small tonnage of material has been mined and processed.

SUMMIT PLACER QUARRY

The Summit Placer property has been described with other prospects along Stucky Ridge, under the heading "Other mines and prospects". It seems probable that the product was primarily of value as silica flux.

OTHER SILICA DEPOSITS

Fluxing grade silica is exposed at many places in the range. Small quantities of this material have undoubtedly been produced from several such locations, to be sold to the smelter at Anaconda. Two such pits were noted along the east side of Olson Gulch where small remnants of Quadrant Quartzite crop out (Fig. 21). Both pits are small, production from each being roughly estimated at 10 to 20 thousand tons.

High-purity silica is far less common. One site, where fairly extensive exposures of silica that seems reasonably pure on casual inspection were observed by the writer, is in the southwest corner of sec. 22, T. 6 N., R. 11 W. Here, again, rocks in the upper part of the Missoula Group are near intrusive rocks, the emplacement of which may have driven off some of the impurity that is normally present in the quartzose strata.

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