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UNITED STATES DEPARTMENT OF THE INTERIOR

QUICKSILVER DEPOSITS OF THE BOTTLE CREEK DISTRICT HUMBOLDT COUNTY, NEVADA

A PRELIMINARY REPORT

GEOLOGICAL SURVEY BULLETIN 922-A

UNITED STATES DEPARTMENT OF THE INTERIOR
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BY

RALPH J. ROBERTS

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(Pages 1–29)

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QUICKSILVER DEPOSITS OF BOTTLE CREEK DISTRICT

HUMBOLDT COUNTY, NEVADA

A PRELIMINARY REPORT

By Ralph J. Roberts

ABSTRACT

The Bottle Creek district in Humboldt County, northwestern Nevada, produced 310 flasks of quicksilver between September 1938 and October 1939. Although underground work aggregates only about 2,000 feet, the outlook for future production appears promising.

The rocks include an older pre-Tertiary group of complexly folded and faulted sedimentary and volcanic rocks and a later group probably of Tertiary age, that is also composed of volcanic and sedimentary rocks. The Tertiary (?) group has been divided into five units. Three of these units--the lower tuffs, conglomerate, and sandstone, the basalt, and the upper tuffs and clays--dip west and are in fault contact with the pre-Tertiary rocks. All are cut by diabase dikes and all are unconformably overlain by rhyolite flows that dip east.

There are two types of ore deposits: cinnabar-bearing faults and cinnabar-bearing diabase dikes. Prior to January 1940 all the production had come from the dikes, but recent development work has shown material of commercial grade in two fault zones. Ore shoots mined in the dikes are commonly small but of high grade and average about 30 pounds of quicksilver to the ton.

In the engineering sense there are no proved reserves, but in the light of past production the probable reserves in known dikes to a depth of 150 feet are estimated at about 3,000 flasks of quicksilver,1/ which can be profitably mined so long as the price of quicksilver remains at $125 or more a flask.

1/ A flask contains 76 pounds.

INTRODUCTION AND HISTORY

The Bottle Creek district is in Humboldt County, Nev., about 65 miles by road northwest of Winnemucca, in T. 40 N., R. 33 E. (fig. 1). The district is accessible throughout the year, although rain and snow occasionally make the last 6 miles of road impassable for short periods. No previous geologic mapping has been done in the area, but the district was briefly visited and some prospects were described by Vanderburg in 1937.[2/]

The district lies in the foothills of the northeastern part of the Jackson Mountains, a northward-trending fault-block range in the northern part of the Great Basin.[3/] Much of the area mapped is a region of waste-covered slopes between the rugged main range to the west and two rhyolite-capped hills to the east. (See pl. 1.) Rock outcrops are sparse and poor. There are no permanent streams, and water for domestic purposes and mining is obtained from springs.

During August, September, and October, 1939, the writer, assisted by Arthur E. Granger, spent 34 days in field work. The geology and topography of 5½ square miles were mapped on a scale of 1:12,000. The underground workings were mapped on a scale of 1:240, or 20 feet to the inch. The operators and miners in the district were uniformly courteous and helpful, and the writer wishes especially to acknowledge the assistance of James and Arnold Scossa, D. J. Wootan, M. S. McCown, Dr. W. C. McAdoo, A. M. Tweedt, H. W. Baldwin, and T. C. Niebuhr. The writer is also indebted to H. G. Ferguson,

2/ Vanderburg, W. O., Reconnaissance of mining districts in Humboldt County, Nevada: U. S. Bur. Mines, I. C. 6995, p. 17, 1938.

3/ Russell, I. C., Geological history of Lake Lahontan: U. S. Geol. Survey Mon. 11, p. 27, 1885.

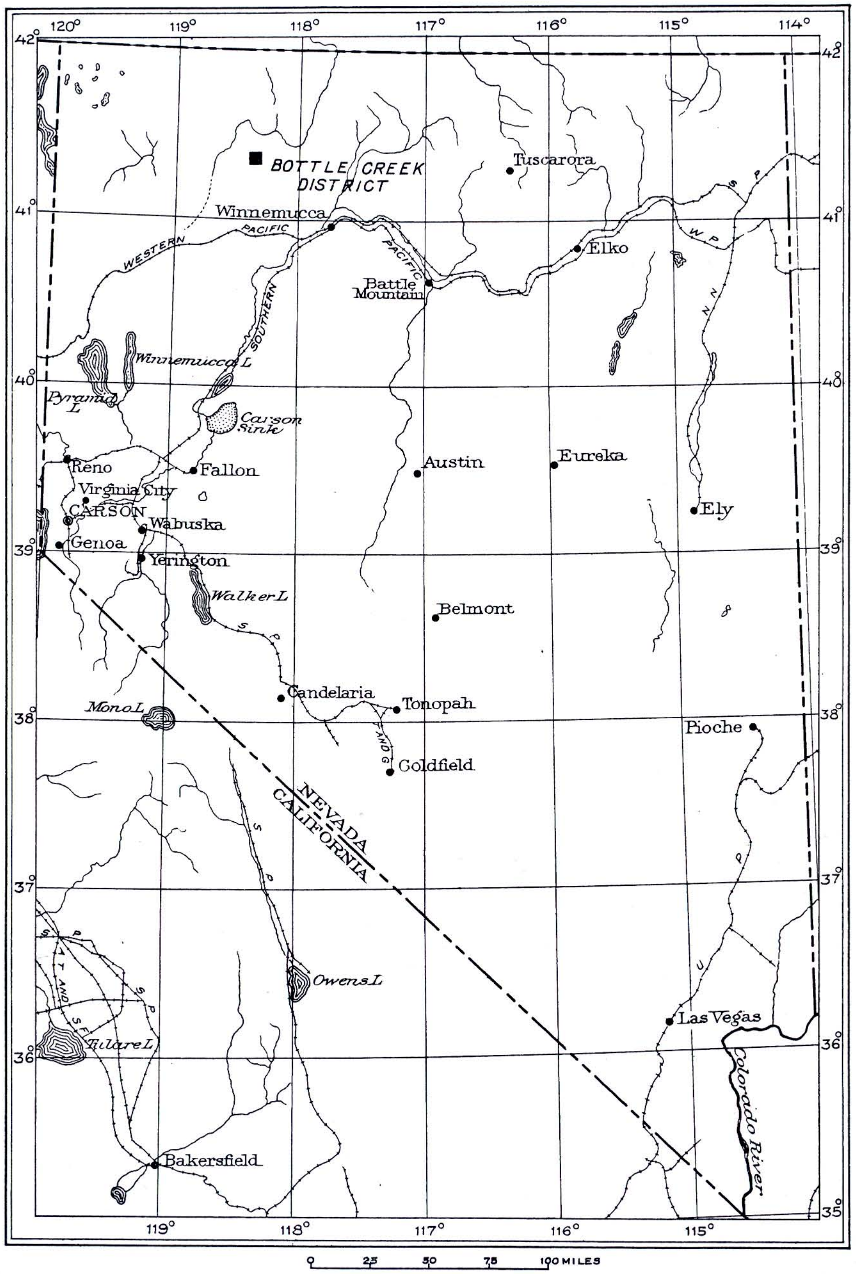

Figure 1.--Index map of Nevada showing location of Bottle Creek district.

T. B. Nolan, and C. P. Ross of the Geological Survey for helpful advice during field work and in the preparation of this report.

Although the presence of cinnabar in the Bottle Creek area has been known since about 1928, 4/ cinnabar lodes were not discovered until September 1936, when James and Arnold Scossa panned cinnabar from stream gravels in Halburg Canyon and traced the cinnabar to the area now included in their Red Ore group of claims. As news of the strike became known, others staked adjoining ground, and cinnabar was discovered on several claims. The first retort was installed by D. J. Wootan, and production began in September 1938. The monthly production of the district from September 1938 to September 1939 is as follows:

Production of quicksilver, in flasks, in the Bottle Creek district, 1938-39

September 1938....	8	April 1939........	13
October...........	18	May...............	33
November..........	20	June..............	33
December..........	29	July..............	36
January 1939......	25	August............	37
February..........	14	September.........	33
March.............	11	Total 1938-39.	310

Late in 1938 and early in 1939 quicksilver ranged in price from $75 to $93 a flask; in September 1939 it rose to $165. 5/ As the district is new and the development is in its early stages, there is no significant relation between output and price of quicksilver.

GEOLOGY

The rocks of the Bottle Creek district (pl. 1) include an older group of complexly folded and faulted sedimentary and volcanic rocks of pre-Tertiary age and a younger group

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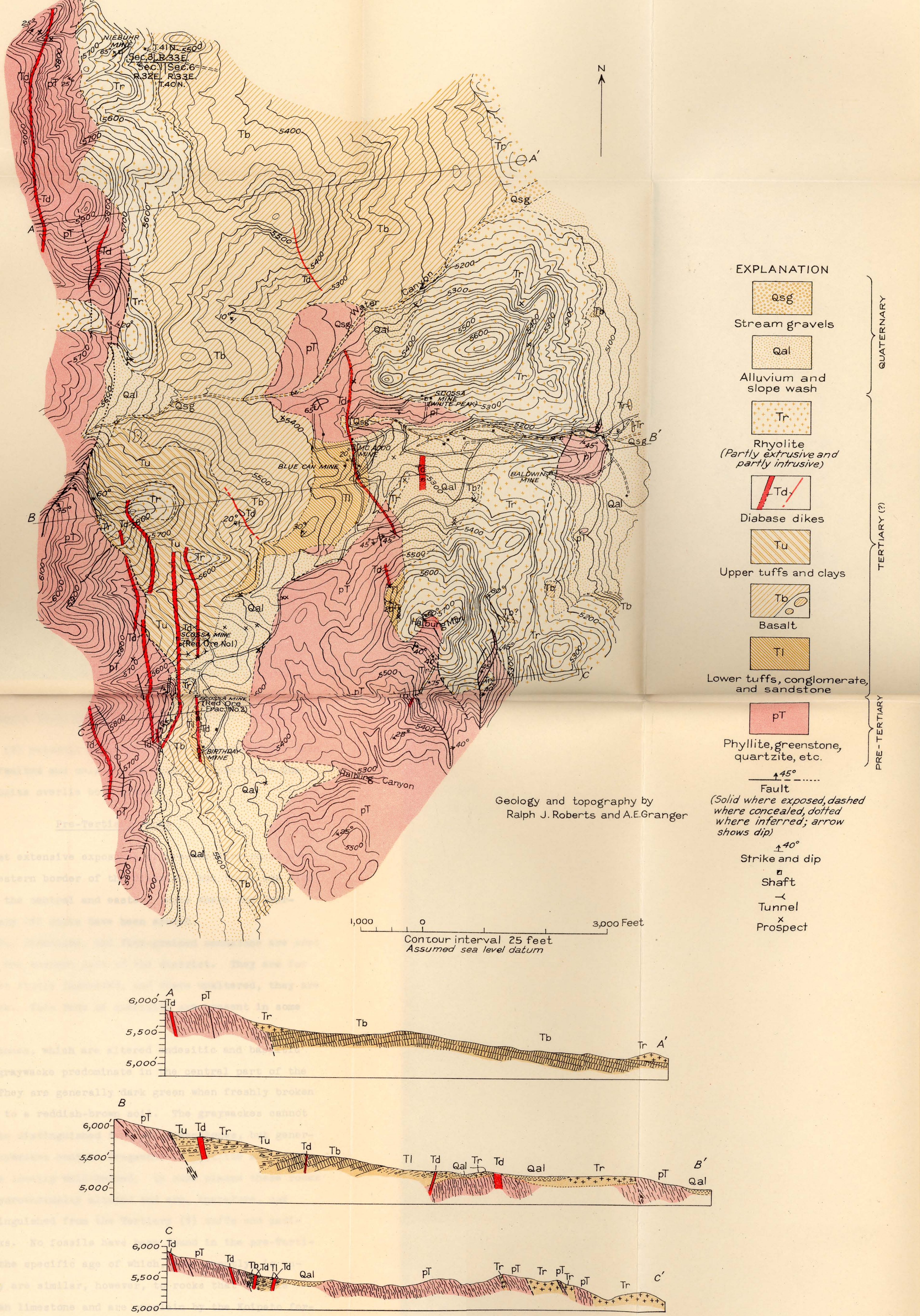
4/ Scossa, James, personal communication.
5/ Meyer, H. M., U. S. Bur. Mines, personal communication.



GEOLOGIC MAP AND SECTIONS OF BOTTLE CREEK DISTRICT, HUMBOLDT COUNTY, NEVADA

1940

of Tertiary (?) volcanic and sedimentary rocks that have been tilted and faulted and only gently folded. Undeformed Quaternary deposits overlie both groups.

Pre-Tertiary rocks

The most extensive exposures of pre-Tertiary rocks are along the western border of the district, but there are also outcrops in the central and eastern parts where the overlying Tertiary (?) rocks have been eroded.

Phyllite, limestone, and fine-grained sandstone are most abundant in the western part of the district. They are for the most part finely laminated, and where unaltered, they are gray to black. Thin beds of quartzite are present in some places.

Greenstones, which are altered andesitic and basaltic rocks, and graywacke predominate in the central part of the district. They are generally dark green when freshly broken but weather to a reddish-brown soil. The graywackes cannot everywhere be distinguished from the greenstones, but generally the graywackes contain fragments of phyllite and argillite and are locally well-bedded. In some places these rocks have been hydrothermally altered and are, therefore, not easily distinguished from the Tertiary (?) tuffs and sedimentary rocks. No fossils have been found in the pre-Tertiary rocks, the specific age of which, consequently, is unknown. They are similar, however, to rocks that overlie Pennsylvanian limestone and are overlain by the Koipato formation of Permian and Triassic age in the Sonoma Range quadrangle to the southeast.

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Tertiary (?) rocks

The Tertiary (?) rocks of the district may be divided into five units. The three oldest units, which may be conveniently called the lower group, include a lower unit of tuffs, conglomerate, and sandstone and an upper unit of tuffs and clays separated by a basalt unit. These three units are cut by diabase dikes, which contain the ore bodies. The lower group and the diabase dikes are unconformably overlain by rhyolite flows. No fossils were found in any of these rocks, but they resemble known Tertiary rocks in adjoining areas.

Lower tuffs, conglomerate, and sandstone.--The lower unit of tuffs, conglomerate, and sandstone is exposed at three places in the central and southern parts of the district, but it is absent to the north, where basalt flows rest directly on the pre-Tertiary rocks. Its basal member, which is exposed only in mine workings, is a red and green clay that contains fragments of partly decomposed greenstone and graywacke. It probably represents the weathered soil mantle developed on the pre-Tertiary rocks. The clay is overlain by massive to well-bedded pink, white, and gray tuffs with intercalated sandstone and conglomerate. The tuffs consist chiefly of rhyolite fragments and quartz and feldspar crystals. The conglomerates contain rounded to subangular boulders of rhyolite and quartzite as much as 6 inches in diameter. The entire lower unit probably does not exceed 500 feet in thickness. It appears to be overlain by basalt without angular unconformity.

Basalt.--Basalt crops out in two areas, a large one in the north-central part and a smaller one in the southern part of the district. In the intervening area the absence of basalt is doubtless the result of either post-basalt erosion or the failure of the basalt flows to cover this

area. The basalt is commonly fine-grained but locally contains phenocrysts of plagioclase feldspar as much as an inch long. In most places it is amygdaloidal. The basalt weathers to a porous light- to medium-brown soil containing fragments of chalcedony and calcite that have weathered out of the amygdules.

Upper tuffs and clays.--The upper unit of tuffs and clays has been mapped only in the west-central part of the district; elsewhere it appears to have been removed by pre-rhyolite erosion. Outcrops are poor, but the unit as exposed in mine workings includes red clays and fine-grained gray tuffs.

Diabase dikes.--Diabase dikes appear to be more abundant in the western part of the district than elsewhere, but this abundance may be in part the result of the better and more extensive exposures in that region. Some of the dikes may be feeders of the basalt flows, which they resemble, but some of them are certainly younger, as they cut the upper tuffs and sediments. Where seen underground, the dikes range in width from 3 to 20 feet, but some mapped on the surface by the tracing of float appear to be as much as 100 feet wide. As the dikes do not crop out prominently they are difficult to trace. Some areas shown as diabase on the map may prove to be fragmentary basalt outcrops.

The dikes strike northward and commonly dip steeply to the east or west. Most of them are fine-grained and amygdaloidal at the borders and medium-grained in the middle. They weather to a brownish porous soil similar to that derived from the basalt.

The dikes are of especial interest in that they contain all the quicksilver ore bodies that have been so far productive.

Rhyolite.--Exposures of rhyolite are fairly abundant throughout the area. The largest outcrops are those on the hills northeast and southeast of the Scossa mine. The rhyolite rests unconformably on all the older formations, and its eruption clearly followed an epoch of tilting and subsequent erosion to a surface of low relief. The rhyolite is massive in most places but locally has well-developed flow structure. Most of it is dense and contains sparse phenocrysts of quartz and feldspar. At the Scossa mine the feldspar phenocrysts are altered and partly leached, leaving rectangular voids in the rock. Although most of the rhyolite appears to consist of volcanic flows, one dike was mapped on the ridge south of Halburg Mountain; and the massive outcrops on Halburg Mountain and the ridge north of the Scossa mine may be intrusive.

Quaternary deposits

Two post-rhyolite formations are distinguished on plate 1. One of these is the gravel and silt that occurs in the present stream beds; the other, composed of dissected alluvial deposits and slope wash, conceals rather large areas of bedrock in parts of the district.

Structure

The Tertiary (?) and pre-Tertiary rocks of the district have been deformed as a result of both tilting and faulting. Individual formations, moreover, have been differently affected by both types of disturbance.

The pre-Tertiary rocks have been most severely deformed. They strike northeast to east, transverse to the general trend of the range, and dip steeply southeast to south. Local contorted minor folds suggest that these rocks are complexly

folded. The lower group of Tertiary (?) rocks dip 10°-40° W. and overlie the pre-Tertiary rocks with marked angular unconformity. The rhyolite flows overlie both pre-Tertiary and the lower group of Tertiary (?) rocks with angular unconformity and dip gently east.

The major faults in the district strike northward and dip steeply east. They appear to be most numerous in two regions--one in the southeastern part of the area, where they cut rhyolite and pre-Tertiary rocks; the other in the western part of the area, where the lower group of Tertiary (?) formations have been faulted against the pre-Tertiary.

Faulting occurred during at least two and possibly three different stages. The earliest stage is represented by some faults that cut the pre-Tertiary rocks. These faults are commonly silicified and show evidence of recurrent movement, but the amount of displacement is not known. They are believed to be older than a second group of faults that cut the lower group of Tertiary (?) rocks, but the evidence is not conclusive. The second stage of faulting, which produced the westerly tilt shown by the lower group of Tertiary (?) rocks, preceded the eruption of rhyolite. One of the faults formed during the second stage separates pre-Tertiary from Tertiary (?) rocks in the southwestern part of the district and appears to have a displacement of more than 1,500 feet. Some faults of the second stage are economically important in that they controlled the intrusion of the diabase dikes that were later the sites of ore deposition. The youngest group of faults cuts both the rhyolite and the older rocks. Displacement along them appears to be small, but some of them have been mineralized.

ORE BODIES

There are two types of ore deposits in the Bottle Creek district: cinnabar-bearing fault zones in rhyolite and pre-Tertiary rocks and cinnabar-bearing diabase dikes. The fault zones had not become productive at the time the district was visited, but later development work has shown the presence of ore in commercial quantity in two of them. The diabase dikes had yielded all the ore mined prior to January 1940. The ore shoots in them are as much as 60 feet long, extend as much as 40 feet down the dip, and have been mined to a width of 8 feet. The high-grade shoots are controlled by "rolls" in the dikes, inclusions of country rock, splits in the dikes, and faults. The distribution of cinnabar within and adjacent to the ore shoots is controlled by fractures.

Cinnabar-bearing fault zones

Three cinnabar-bearing fault zones were studied in the Baldwin and Niebuhr mines. Development work on them, however, was insufficient to determine the extent of mineralization. Two of these fault zones are in rhyolite and contain cinnabar, calcite, chalcedony, and sparse pyrite. The cinnabar and accompanying minerals fill cavities in the fault breccia and replace the rhyolite along flow-bands. The other fault zone, which is in phyllite, contains cinnabar and limonite within the fault and on joints and cleavage planes adjacent to the fault.

Cinnabar-bearing diabase dikes

Fourteen diabase dikes were mapped (see pl. 1). Four of those in the central and southwestern parts of the district have produced ore. None of the others has been explored to

any noteworthy extent, and it is not known whether they are also mineralized.

The Scossa mine is on one dike and the workings of the McAdoo mine and the Blue Can mine are on a second dike in the central part of the district. In the southwestern part of the district the Birthday mine and the workings of the Scossa Bros. on Red Ore Fraction No. 2 claim are on a third dike, and the workings of the Scossa Bros. on Red Ore No. 1 claim are on a fourth.

Mineralogy.--Cinnabar, pyrite, and marcasite are the only sulphides recognized in the ore deposits in diabase dikes. They are commonly accompanied by chalcedony, quartz, and calcite. The cinnabar is for the most part finely crystalline, and in some places is interbanded with chalcedony. Locally crystals as much as a quarter of an inch long may be found in cavities. A little native quicksilver has been reported from the Birthday mine. Cinnabar in some places makes up as much as 7 percent of the ore (about 127 pounds of quicksilver to the ton), but the average ore retorted in 1939 contained less than 2 percent of cinnabar (less than 35 pounds of quicksilver to the ton). Emplacement of the ore and gangue minerals was accomplished almost entirely by the filling of open spaces along fractures; replacement of the wall rocks occurred only locally. The diabase in most places has been only slightly altered by mineralizing solutions, although feldspars adjacent to the ore veinlets have been altered to clay minerals, and small amounts of pyrite, marcasite, calcite, and silica have been introduced locally.

Surficial alteration is generally restricted in depth to 40 or 50 feet but locally extends deeper. Throughout this depth the diabase, especially where mineralized, has been so softened that it may be cut with a pick. Sulphuric acid generated by the oxidation of pyrite and marcasite in the ore and wall rocks appears to have been the chief cause of this alteration. Some enrichment of cinnabar by descending water may have occurred in the zone of oxidation but appears to be of minor economic importance.

Localization of ore bodies.--The localization of the ore shoots thus far mined in diabase is not the result of a direct genetic relation between the dikes and ore, as the mineralization occurred very much later than the intrusion of the dikes. The relatively brittle dike rock was more readily and more thoroughly fractured than its wall rocks, and open fractures in the dikes appear to have acted as channel-ways for the movement of ore-bearing solutions. The relatively soft and plastic tuffs and clays, on the other hand, were less readily fractured and did not ordinarily permit the formation of channels for the mineralizing solutions.

In a few places the dikes are uniformly mineralized and are of sufficiently high grade to be mined throughout their entire thicknesses. Locally the wall rock adjacent to the dike is also impregnated with cinnabar or contains cinnabar in fractures, but such mineralized fractures rarely extend more than 2 feet from the dike. Commonly, however, the ore shoot constitutes only a small part of the dike and almost without exception it occurs along the hanging wall. This localization suggests that mercury-bearing solutions rising in the dike were restricted to the dike by the impervious hanging wall so that they had to deposit cinnabar in the fractures within the dikes.

The fractures in the dikes are of two types: one, composed of contraction cracks formed as the rock solidified and cooled, is of lesser importance; the other, formed by stresses related to later faulting, is superimposed on the

first type and accounts for most of the ore shoots. An abundance of closely spaced fractures appears to be the principal requirement for the localization of ore shoots.

Three sets of contraction cracks are common: one set parallel to the strike and dip of the dike, the other two transverse to the dike and intersecting each other at angles ranging from 45° to 90°. Contraction cracks are commonly narrow and widely spaced. Those parts of the dikes that are cut only by them rarely contain ore shoots, as where the dikes are simple tabular bodies and shearing took place along the walls.

Concentrations of fractures that were formed during faulting after the intrusion of the dikes are commonly limited to such irregularities in the dikes as changes in strike and dip, splits, inclusions of wall rock, and intersecting faults.

The confining effect of the hanging wall is especially well shown in the McAdoo, Blue Can, and Scossa mines, where closely spaced fractures at local flattenings or "rolls" have localized ore shoots (pls. 2, 3, and 4). The dikes above and below the "rolls" are of low grade or are barren.

Inclusions of country rock or splits in the dikes have also caused the localization of ore shoots in the Scossa and McAdoo mines (pls. 2 and 4). They have acted as secondary hanging walls, though in places they are impregnated with cinnabar.

In the Birthday mine (pl. 5) pre-ore faulting appears to have controlled the distribution of ore shoots. Here the dike is broken into segments by faults. Low-grade or barren segments are separated from high-grade segments by faults, which evidently controlled the flow of mineralizing solutions.

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Size and grade of ore bodies.--The ore shoots mined prior to September 1939 range from a few feet to as much as 60 feet in length and extend from 5 to 40 feet down the dip. Their widths range from a foot or less to 8 feet or more. In some places the ore shoots are bounded by faults, but they generally grade laterally into rock too low in grade to be mined and treated.

The ore bodies of the Bottle Creek district are of relatively high grade compared with those in most other quicksilver districts in the United States. The ore retorted has averaged about 30 pounds of quicksilver to the ton, and some stopes have yielded ore averaging more than 60 pounds. Preliminary information furnished by operators in this district indicates that with quicksilver at $76 a flask, ore for the profitable operation of small retorts must contain more than 25 pounds of quicksilver to the ton. A rotary furnace of 30-ton daily capacity may be able to treat profitably ore that contains from 6 to 8 pounds of quicksilver to the ton. With an increase in the price of quicksilver and without a corresponding increase in commodity prices, obviously ore of lower grade can be profitably treated.

Reserves.--At present the Bottle Creek district possesses essentially no blocked-out ore reserves, but its production record leads to the expectation that systematic prospecting will disclose additional ore bodies. Present estimates of their number and their quicksilver content, of course, can only be speculative, but the following statement may be of use as an indication of the possible reserves of quicksilver in the district.

Four of the diabase dikes have so far been partly explored and have been productive. Three of them are in Tertiary (?) rocks and the fourth is in pre-Tertiary rocks.

Altogether they are known to contain sporadic cinnabar for a linear distance of about 3,500 feet, of which only 500 feet has been developed. Prior to October 1939, 310 flasks of quicksilver had been produced from workings within 50 feet of the surface. If it may be inferred that the remaining 3,000 feet of unexplored dikes contains ore bodies of about the same spacing and grade as those mined, it seems reasonable that within the area mapped about 1,500 flasks may be recovered within a depth of 50 feet or less. Although ore is known to extend to a depth of 112 feet in the district, it is not possible to predict how much deeper the cinnabar extends. There are many quicksilver mines in the United States that contain ore bodies at depths of much more than 100 feet. The diabase dikes and fault zones in which ore shoots are localized in the Bottle Creek district are rather persistent laterally, and it is probable that both dikes and fault zones have similar persistence in depth. Thus it seems fair to infer that ore shoots extend at least two or three times as deep as the 50-foot depth from which production was derived in 1939. It is questionable, however, whether the reserves will be proportionately increased, for the spacing of ore shoots along the strike may well decrease with increasing depth.

Ten other diabase dikes were mapped during the examination, chiefly in the western part of the area in both Tertiary (?) and pre-Tertiary rocks. None of them, nor any of the fault zones in rhyolite and in pre-Tertiary rocks, had been sufficiently explored in the fall of 1939 to provide a basis for estimation of possible additional reserves that they might contain. Available evidence, however, suggests that ore bodies may be found in them. Finally, Tertiary (?) rocks similar to those exposed in this district crop out to the south, northeast, and north and may prove to be mineralized.

In summary, the Bottle Creek district, though it may never be as productive as some of the larger California quicksilver districts, is believed to contain appreciable reserves of quicksilver ore in rather small but high-grade ore shoots, which because of their apparent localization in diabase dikes and fault zones, are relatively easy to prospect. A highly speculative estimate of the reserves, based on a price of $125 a flask, is that the dikes in the area mapped will yield a minimum of 3,000 flasks of quicksilver at a depth of 150 feet or less. This minimum may be increased by additional prospecting.

MINES AND PROSPECTS

Mine workings in the district are very irregular because for the most part they follow the ore. The levels are numbered according to their vertical depth below the surface. The workings are shown as mapped in September 1939.

Scossa mine

The Scossa property, owned by James and Arnold Scossa, of Winnemucca, consists of two groups of claims--the White Peak Nos. 1, 2, and 3, in the central part of the district, and the Red Ore Nos. 1, 2, 3, 4, and 5, Red Ore Fraction, and Red Ore Fraction Nos. 1 and 2 about a mile south of the White Peak group.

The claims, the first staked in the district, were located in September 1936. A little assessment work was done on them in 1936 and early in 1937; and in July 1937 they were optioned to the Fulton Quicksilver Co., of Reno, Nev. This company carried on development work including the sinking of a shaft 112 feet deep on the White Peak No. 1 claim and drifting on the 62-foot and 112-foot levels. Several shallow

shafts were also put down on the Red Ore group. In 1938 the claims reverted to the Scossa Bros., who have since further developed the property. A 30-ton Cottrell furnace was put into operation in October 1939.

White Peak group.--Development work in the White Peak group shown in plate 2, includes a 112-foot shaft and about 325 feet of drifts and crosscuts. The shaft, in massive rhyolite, passes into a diabase dike and pre-Tertiary argillite and sandstone between the collar and the 62-foot level. The shaft is timbered, so that the contact of rhyolite with argillite and diabase could not be seen at the time of visit, but the rhyolite probably overlies argillite and diabase unconformably. The argillite in the underground workings (pl. 2) is commonly massive, but in some places it is finely laminated. It strikes about N. 65° E. and dips about 30° SE.

The diabase dike is overlain by rhyolite north of the mine, but a shallow shaft on the flat 1,300 feet south of the Scossa shaft is in a basaltic or diabasic rock that may be the southward extension of the dike. Where seen underground the dike ranges from 15 to 17 feet in width but may be wider at the southern end of the 62-foot level. It is generally cut by three sets of cinnabar-bearing cracks, one of which parallels the strike and commonly dips steeply east, whereas the other two strike transverse to the dike, one set dipping 30°-90° S. and the other dipping 35°-60° N. The cracks are widely spaced except where the dike was fractured by later movement. No faults have been mapped, although the dike is locally sheared along the walls.

The dike fills an irregular fissure averaging about N. 10° E. in strike and dipping southeastward. On the 62-foot level the hanging wall of the dike is fairly straight except for a 4-foot bulge to the east just north of the shaft and a 14-foot bulge south of the shaft where the dike splits. On the 112-foot level opposite the shaft the hanging wall bends to the east in a broad "roll".

The ore bodies so far developed appear to be controlled by the broad "roll" that localized fracturing in the dike. On the 62-foot level between the point 8 feet north of the shaft where the dip of the hanging wall decreases and the point where the drift south of the shaft branches (pl. 2, secs. B-B' and C-C'), ore occurs in the dike along the contact and in the wedge of argillite. No ore had been stoped from this area when the mine was mapped, but later work showed high-grade ore extending into the roof between the shaft and the wedge. Elsewhere on this level cinnabar is chiefly confined to widely spaced fractures and the hanging-wall contact. The ore on the 62-foot level consists of cinnabar, pyrite locally oxidized, calcite, and chalcedony.

On the 112-foot level the crosscut at a point 17 feet east of the shaft is traversed by a vertical fracture zone as much as 2 feet wide. The zone is distinct in the argillite but appears to die out as it passes upward into the dike (pl. 2, sec. B-B'). It contains veinlets as much as 4 inches wide composed of cinnabar interbanded with pyrite, marcasite, calcite, and chalcedony.

The areas most promising for future development appear to lie above and below the 62-foot level on the "roll" and near the argillite wedge.

Red Ore group.--The workings on the Red Ore group consist of several shallow shafts, open cuts, and two short adits in Tertiary (?) diabase dikes and tuffs.

The dike on which the Red Ore Fraction No. 2 claim was located is probably a continuation of the one developed in the Birthday mine a few hundred feet farther south. It cuts tuffs of the lower unit of Tertiary (?) rocks and strikes north and dips 50°-85° W. Cinnabar, iron oxides, and calcite occur along the hanging wall in the tuff and in the tuff inclusion on the east side of the drift on the 17-foot level. Only a little cinnabar was seen in the dike.

Three shafts on Red Ore No. 1 claim are in another dike, which cuts clays belonging to the upper Tertiary (?) unit. The dike strikes a little west of north and dips about 60° W. A few quartz-limonite veinlets containing cinnabar fill cracks in the dike, and cinnabar occurs along the hanging wall. A short adit about 200 feet southeast of the shafts has been driven in tuffs overlain by detrital material that contains cinnabar nuggets. The largest nugget seen was about half an inch in its greatest dimension. Presumably the nuggets were derived from the dike a short distance to the west.

Blue Can mine

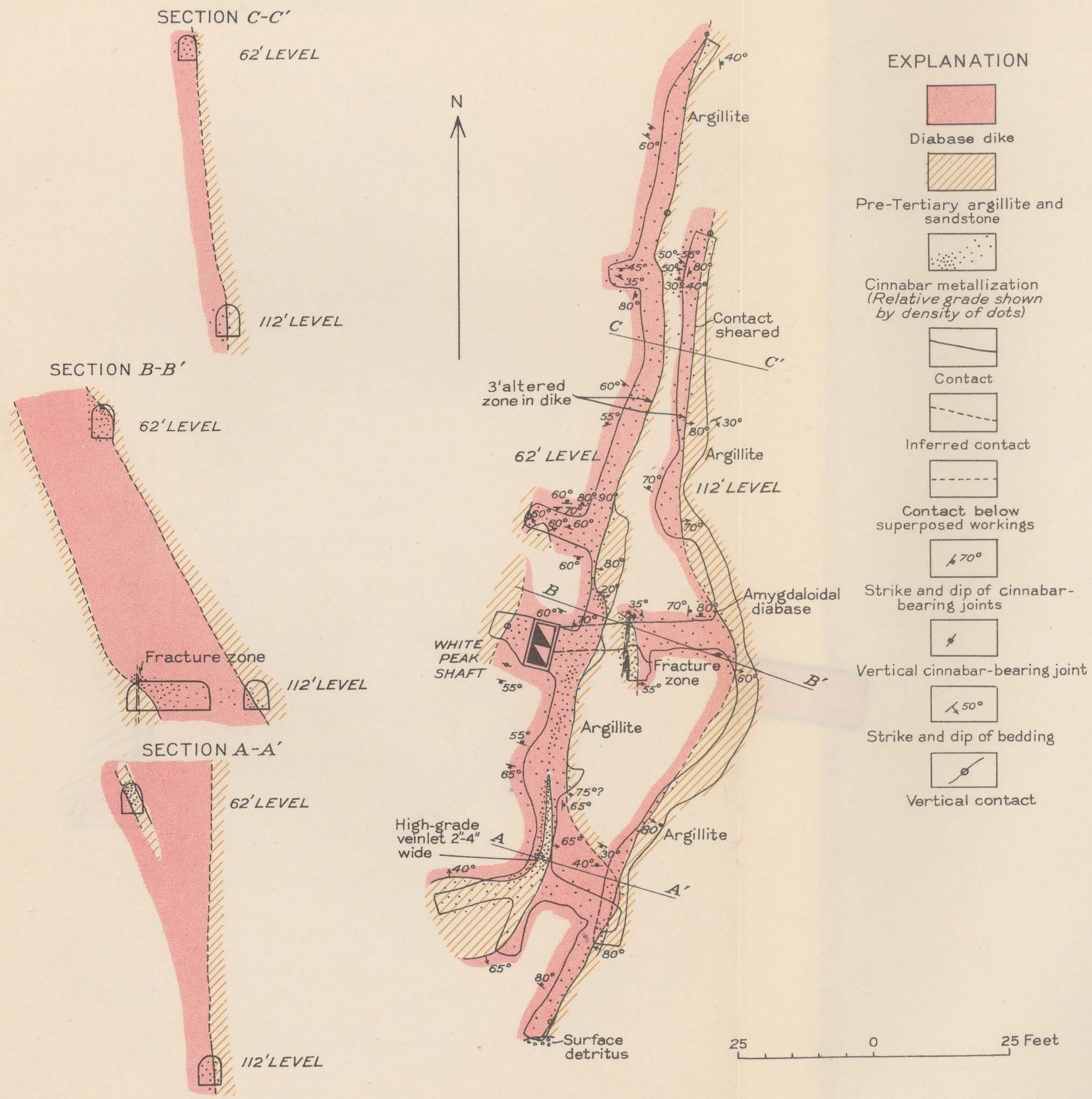
The property of the Bottle Creek Mercury Co. known as the Blue Can or Tin Can mine consists of nine claims adjoining the McAdoo group in the central part of the district. The claims were located in November 1936 by C. P. Hoskins, T. Smith, and Thos. C. Niebuhr, of Winnemucca, and are the Blue Can, Blue Can Nos. 1, 2, 3, 4, 5, and 6, Goodenough, and Bottle Creek Mercury claims. According to Mr. Niebuhr, the property between October 11, 1938, and February 5, 1939, produced 40½ flasks of quicksilver in a two-tube retort from ore averaging 32 pounds of quicksilver to the ton. The property was sold to James O. Greenan, of Reno, Nev., in February 1939 who has since been carrying on development work. In the course of sampling operations five flasks of quicksilver was produced in November and December 1939.

The underground workings in September 1939 included a 40-foot shaft, a 37-foot shaft, a 37-foot winze, and about 500 feet of raises, drifts, and crosscuts.

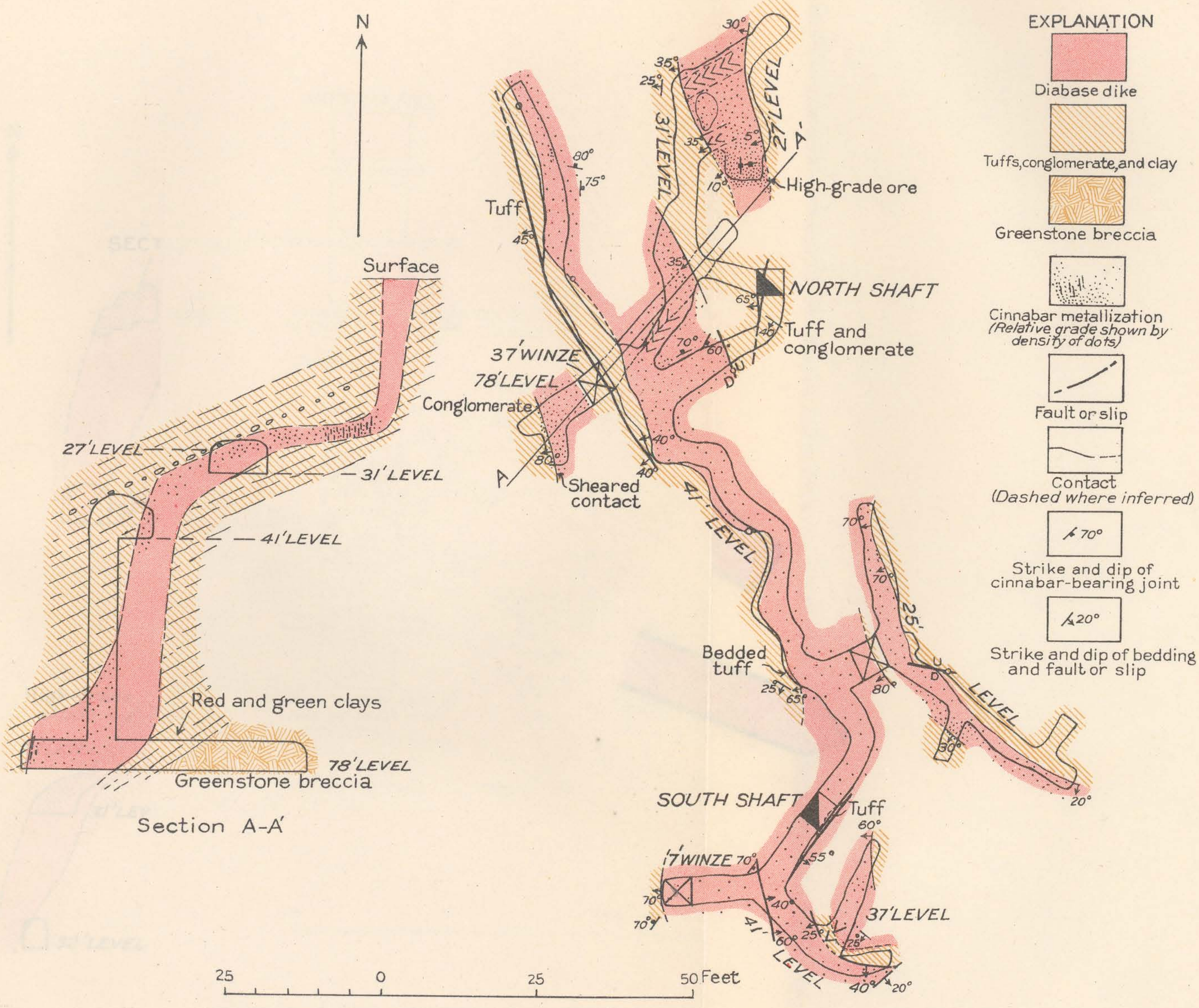
The workings (pl. 3) are in a diabase dike cutting the tuffs and conglomerate of the lower Tertiary (?) unit, which here strike N. 10°-40° W. and dips 25°-35° SW. The tuffs as seen underground are massive to well-bedded and are commonly fine-grained, with local pebbly layers. Conglomerate forms the hanging wall locally between the 27- and 41-foot levels; it contains boulders as much as 6 inches in diameter in a clayey matrix. An altered greenstone breccia in the crosscut east of the winze on the 78-foot level is probably part of the pre-Tertiary series. The breccia is overlain by red and green clays that are in contact with the footwall of the dike.

The dike is traceable on the surface by float for about 1,800 feet north and 1,300 feet south of the North shaft of the Blue Can mine (pl. 1). In the underground workings north of the South shaft the strike averages about N. 30° W. and dips southwest, but west of the South shaft the hanging wall swings to the northeast. The width ranges from 3 feet in the south end of the 27-foot level to more than 20 feet just south of the South shaft. Cinnabar-bearing cracks in the dike were mapped only where they are systematic; in most places the joints are unsystematic.

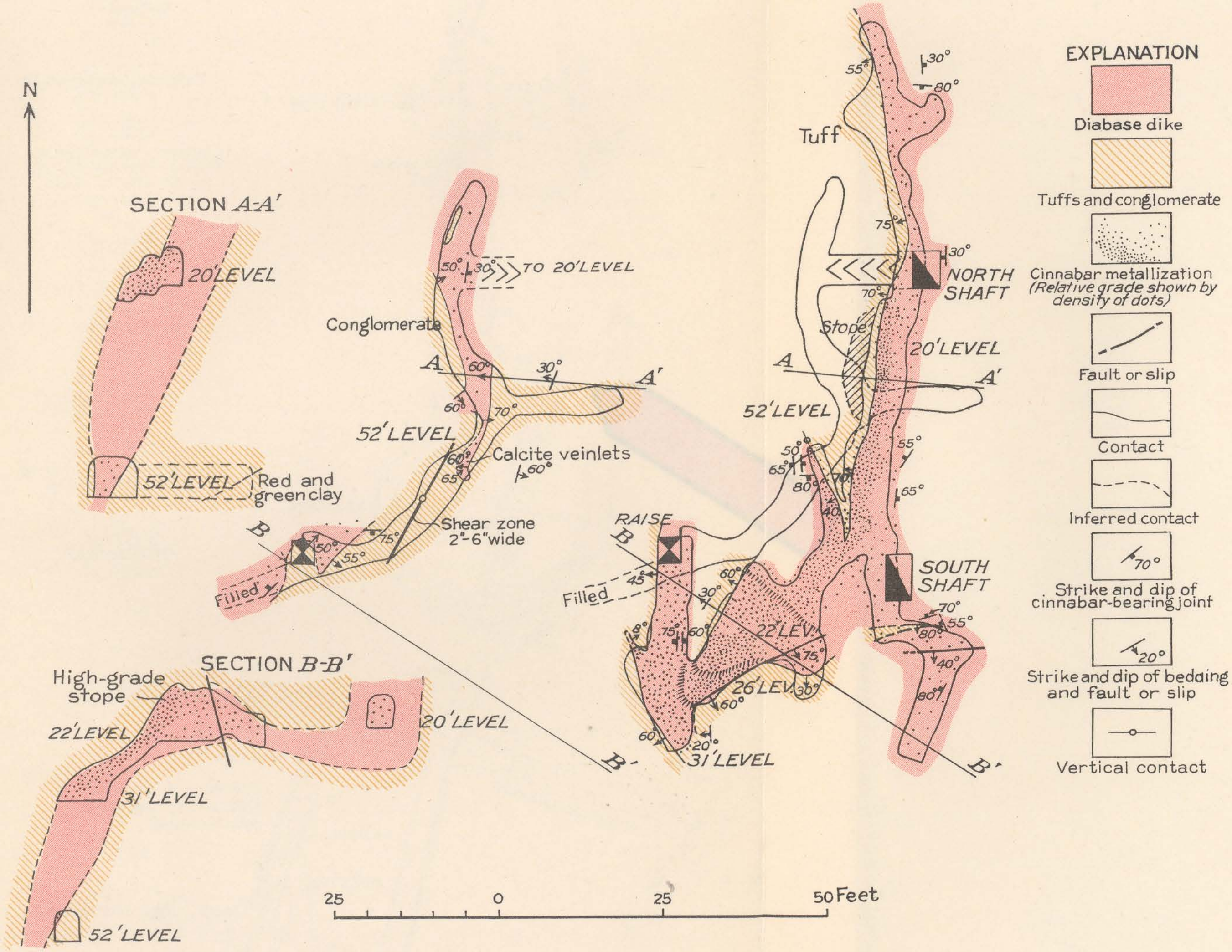
Near the North shaft (pl. 3, sec. A-A') the dike is almost vertical from the surface to the 27-foot level; at the 27-foot level it "rolls" abruptly and is horizontal for about 10 feet, follows beds dipping 25°-35° W. for a distance of about 20 feet, and then steepens to a dip of about 70° at the



MAP AND SECTIONS OF WHITE PEAK WORKINGS OF SCOSSA MINE

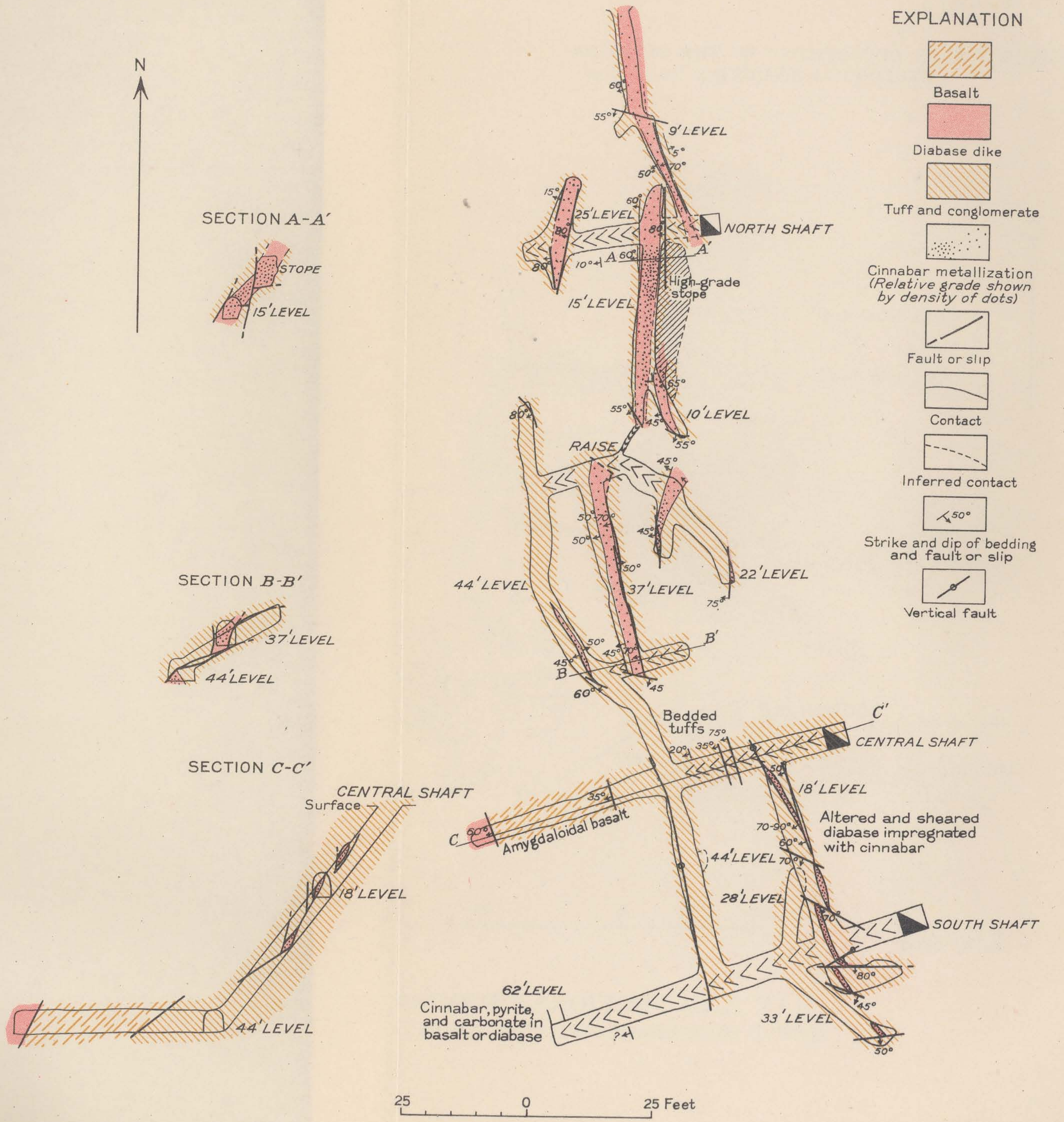


MAP AND SECTION OF BLUE CAN MINE



MAP AND SECTIONS OF MC ADOO MINE

Sections show interpretative geology not shown on plan



MAP AND SECTIONS OF BIRTHDAY MINE

41-foot level. The "roll" extends southward at least as far as the south end of the 25-foot level. Below the 41-foot level the dike dips steeply, but the dip decreases to about 30° just above the 78-foot level. Several faults of apparently small displacement cut the dike. Movement on them was in part post-ore, for cinnabar is locally smeared out on slickensided surfaces.

The ore is confined to the dike and immediately adjacent wall rocks. The ore shoots are controlled by the "rolls" where the dike has a low-angle dip and is more minutely fractured. As in the Scossa mine the ore of highest grade lies along the hanging wall except in the stope on the 27-foot level, where the dike is only 3 feet thick and is mineralized throughout.

The stopes on the 27- and 31-foot levels yielded ore reported to contain as much as 127 pounds of quicksilver to the ton. In the walls of these stopes cinnabar, iron oxides, calcite, and chalcedony fill vertical cracks that strike north and east within the dike. The cracks are closely spaced in this part of the mine, and some contain veinlets of solid cinnabar as much as a quarter of an inch thick.

No ore had been stoped from the 25-foot level at the time of visit, but in the west crosscut high-grade ore occurs along the hanging wall and in the adjacent tuffs. The dike in the drift contains local high-grade spots and a little cinnabar on joints. Its hanging wall is not exposed.

The drift on the 41-foot level follows the hanging wall of the dike, which dips steeply where seen and appears to contain only low-grade material except in the area west of the North shaft.

The dike in the winze to the 78-foot level is mineralized, and the part along the hanging wall may constitute ore. High-grade bunches occur along the hanging wall in the short drift on the 78-foot level. The hanging-wall conglomerate is locally cut by cinnabar veinlets for a distance of about a foot from the contact.

Although only a little ore had been blocked out at the time the property was examined, several areas underground appear to warrant investigation. One of these lies on the 27- and 25-foot levels along the hanging wall to the north and south of the present workings. Another is along the hanging wall on the 78-foot level just above the level. On the basis of showings on the 78-foot level, further exploration appears warranted.

McAdoo mine

The McAdoo property comprising 25 claims is owned by Dr. W. C. McAdoo, of Winnemucca. One group, including the Bluebird Nos. 1, 2, 3, 4, and 5, Bluebird Fraction, Fraction, Anthill, and Rainbow Fraction Nos. 2 and 4, is in the central part of the district. The Anthill No. 1, Red Ore Extension, Blue Eagle Nos. 1 and 2, Pickup Nos. 1, 2, and 3, Tiger Nos. 1, 2, 3, and 4, and Standard Nos. 1, 2, and 3 claims are scattered throughout the southern and eastern parts of the district.

The discovery was made on the Bluebird No. 3 claim by Dr. McAdoo in September 1936, and the discovery shaft was sunk 6 months later. Some of the claims were under option to the Fulton Quicksilver Co., of Reno, Nev., during part of 1937 and 1938, but the option was released. A two-tube retort was put into operation in May 1939, and four more tubes were added in July 1939. One hundred and fourteen flasks of quicksilver had been produced by October 19, 1939.

The underground workings (pl. 4) in September 1939 included two inclined shafts and about 300 feet of drifts, crosscuts, and raises. Most of the underground work has been done on the 20-foot and 52-foot levels.

The workings are in a continuation of the dike developed in the Blue Can mine, about 200 feet to the south (pl. 1). The dike cuts the lower Tertiary (?) unit, which here strikes north and dips 20°-30° W. In this unit a continuation of the conglomerate bed mapped in the Blue Can mine forms the hanging wall of the dike south of the North shaft between the 20- and 31-foot levels; elsewhere in the mine tuffs form the hanging wall. The footwall rocks include clays, tuffs, and conglomerate.

The dike strikes northward and dips westward. On the 20-foot level north of the North shaft it strikes about N. 15° W. and dips steeply southwest. South of this shaft its strike swings to about N. 10° E. and its dip is steeply northwest as far as the branch in the 20-foot level. At this branch the dike flattens and is nearly horizontal on the 22-foot level. Between the 22- and 31-foot levels it again steepens, dipping 45°-60° W.

The dike ranges in width from 4 feet at one place on the 52-foot level to more than 10 feet on the 20-foot level. In most places there are four sets of cinnabar-bearing cracks: two sets parallel the strike of the dike and dip to the east and west; the other two are transverse to the dike and dip north and south. Several small faults were mapped, and contacts between dike and wall rock are locally sheared.

The ore, which is confined almost entirely to the dike, extends from the 31-foot level to the North shaft along the hanging wall. Several structural features appear to have controlled fracturing, which localized the ore. The most effective is the "roll" in the dike, which apparently followed bedding and fractures in the sedimentary rocks between the 20- and 30-foot levels. Another is the wedge of tuff and conglomerate at the point where the 20-foot level branches; and still another is the steplike hanging wall between the wedge and the North shaft. The dike in general is more minutely fractured along the hanging wall than elsewhere. The fault on the south side of the 22- and 26-foot levels may have also aided in controlling mineralization, for only a little cinnabar is found in the dike south of it.

The ore body in the "roll" between the 31-foot level and the point where the 20-foot level branches is from 2 to 8 feet thick and 4 to 15 feet wide and extends down the dip for more than 40 feet. The ore is oxidized and consists of cinnabar, iron oxides, calcite, and chalcedony filling closely spaced fractures. Throughout most of the stope the ore is reported to have averaged between 40 and 60 pounds of quicksilver to the ton and locally to have contained as much as 80 pounds to the ton.

The wedge of tuff and conglomerate that splits the dike at the east side of the "roll" projects downward into the dike about 3 feet below the 20-foot level. It is mineralized in some places, and high-grade ore occurs in the adjacent dike. From this wedge to the North shaft ore said to have averaged 55 pounds of quicksilver to the ton was stoped along the hanging wall. The ore extended about halfway across the drift in this area.

The drift north of the North shaft disclosed a little cinnabar along the contact of the dike and in the adjoining tuffs. No ore had been stoped from this area at the time of visit.

Although the dike is irregular on the 52-foot level, only a little cinnabar was seen. Joints at the bottom of the shaft and near the raise are mineralized, but elsewhere the dike and tuffs are barren.

Birthday mine

The Birthday mine is owned by D. J. Wootan, M. S. McCown, G. Wootan, and M. Wootan. The property includes eight claims, of which the Birthday, Birthday No. 1, Lone Star Fraction, Mercury King, Amador, and Perhaps claims are in one group in the southwestern part of the area mapped. The Last Chance and Hector claims, in the central part of the district, adjoin the Scossa White Peak group.

The claims were located in October 1936 by D. J. Wootan. Ore was discovered on the Birthday claim in June 1938, and the North shaft was sunk soon afterward. A two-tube retort was put into operation in September 1938, and two more tubes were added in September 1939. The property produced 47 flasks of quicksilver in 1938 from a two-tube retort, and 165 flasks in 1939, when two tubes were operated until September 15 and four tubes thereafter.

The Birthday claim is now developed by three inclined shafts, the North shaft 56 feet deep, the Central shaft 57 feet deep, and the South shaft 100 feet deep. About 400 feet of crosscuts, raises, and drifts had been driven when the property was mapped. The workings are in a faulted diabase dike that cuts tuffs of the lower Tertiary (?) unit and the overlying basalt. These rocks strike north and dip 10°-25° W.

The tuffs and basalt have been intensely sheared and altered in most places. Another dike where seen in the crosscut east of the Central shaft was not mineralized.

The mineralized dike is less than 10 feet wide in the workings. Commonly one or both of its walls are faulted. It strikes north to N. 20° W. and dips 45°-50° W. Where intensely faulted and mineralized the dike is altered. Its feldspars have been changed to clay minerals and its original dark minerals have been so thoroughly leached that the rock resembles the enclosing tuffs.

The ore bodies, which are confined to the dike and adjacent wall rocks, appear to have been controlled by faults or slips, which may be divided into three groups: two of them are commonly parallel with the dike and strike north to N. 20° W., one dipping steeply east and west and the other dipping gently west; the third group strikes N. 45° W. to west and generally dips steeply southwest. Single faults are commonly curved, and in places faults of one group curve and join those of another group. The faults are generalized on plate 5. Displacement along individual faults appears to be small, but the aggregate movement has caused the dike to be broken into segments that lens out along the strike and down the dip. Faulting has been most intense in the southern part of the workings. The faults were probably formed at the time when the major faulting separated Tertiary (?) and pre-Tertiary rocks a few hundred feet to the west. They represent readjustments in the downthrown block. Some movement took place after ore deposition, however, for cinnabar is locally smeared out on slickensided surfaces.

The ore shoots are commonly limited by faults. The largest shoot mined was south of the North shaft on the 15-foot level (pl. 5, sec. A-A'). Here ore was stoped for 32 feet

along the drift from a block 3 to 4 feet by 6 to 12 feet in cross section. The dike is offset a few inches by two slips that dip gently to the west. The ore mined was of high grade, containing as much as 60 pounds of quicksilver to the ton.

The dike on the 37-foot level yielded a little ore from sheared and faulted lenses in the roof. A high-grade lens about 10 feet long was mined on the 22-foot level. Three small lenses (pl. 5, sec. C-C') were disclosed in the Central shaft. None of them have been stoped.

The lenses on the 18-foot level were small but of high grade. Altogether five lenses, ranging from 2 to 16 feet in length and commonly less than 3 feet in width, were stoped. One extended down to the 28-foot level, but the others were confined to the 18-foot level.

At the time the mine was mapped ore was found in the South shaft on the 62-foot level about 100 feet down the incline. Here the ore occurs in a sheared basaltic or diabasic rock, but, as the shaft is timbered, the relation of this rock to the tuffs could not be determined. The ore zone is as much as 2 feet wide and is faulted on both sides.

The cinnabar is accompanied by pyrite, calcite, and chalcedony. The ore is oxidized down to the 44-foot level. The minerals fill vesicles and fractures in the diabase and locally impregnate the diabase and adjacent tuffs.

Although the ore bodies are small and are much faulted, exploration to the south between the 18- and 62-foot levels and to the north between the 44- and 62-foot levels seems warranted.

Baldwin mine

The Baldwin group of 12 claims in the eastern part of the district includes the Blue Bucket, Blue Bucket Nos. 1, 2, 3, and 4, Blue Bucket Fraction, Blue Bucket Fraction No. 1, Black Beauty, Senator, Senator No. 1, Apex, and Sunflower claims. They are owned by H. W. Baldwin, of Winnemucca, and the estate of John C. Duryea and were located in September 1936. For a time in 1937-38 they were under option to the Fulton Quicksilver Co., of Reno, but the option was released. In December 1939 the group was optioned to James O. Greenan, of Reno, who has since been carrying on development.

The workings, chiefly on Blue Bucket Nos. 1 and 3 claims, consist of a 28-foot shaft and a connecting drift and a short adit, all in rhyolite.

The shaft is in a flow-banded rhyolite that is locally sheared and brecciated. The most prominent breccia zone strikes N. 55° E. and dips 80° SE. and is as much as 1½ feet wide. Cinnabar, accompanied by chalcedony, calcite, and a little pyrite, occurs in and adjacent to the breccia zones, filling spaces around rhyolite fragments and locally replacing the fragments.

Two faults trending N. 75° E. and dipping steeply southeast were mapped in the adit about 50 feet southeast of the shaft. A little cinnabar was noted on fractures in the rhyolite between the faults.

Further exploration since the property was visited has disclosed ore in rhyolite about 300 feet southeast of the shaft.[6/] The ore is said to average about 25 pounds of quicksilver to the ton over a width of 10 feet. A specimen sent to the writer shows cinnabar in a silicified and brecciated flow-banded rhyolite.

6/ Baldwin, H. W., and Donaldson, W. G., personal communication.

Niebuhr mine

The Niebuhr property, owned by T. C. Niebuhr, of Winnemucca, is in the northwestern part of the district near the common corner of Tps. 40 and 41 N., Rs. 32 and 33 E. It consists of seven claims: Sun-Set, Sun-Set Nos. 1 and 2, Big Four, Big Four No. 1, Alice Bell, and Alice Bell No. 1. Cinnabar was discovered on the Sun-Set claim in March 1939. No quicksilver had been produced at the time of visit, but Mr. Niebuhr reports that a two-tube retort was installed and a flask of quicksilver was produced from about 5 tons of ore treated in January 1940.

The workings on the property at the time of visit included a 17-foot shaft and several open cuts. The shaft, in massive rhyolite, is traversed by a fault zone 2 to 3 feet wide that strikes about N. 55° E. and dips 65° SE. Cinnabar coats rhyolite fragments in the fault zone and locally impregnates the finely crushed matrix. According to Mr. Niebuhr, solid cinnabar "bunches" weighing as much as 2 pounds have been found in the fault zone.

In an open cut about 1,400 feet northwest of the shaft phyllite striking N. 55° W. and dipping 25° NE. is cut by a fault zone striking about N. 60° W. and dipping 70°-90° SW. Cinnabar accompanied by iron oxides occurs in the fault zone and in adjacent cracks and on cleavage planes.

A diabase dike that crops out about 100 feet east of the open cut (pl. 1) was traced for about 400 feet to the north and about 3,500 feet to the south of the open cut. Inasmuch as this dike occurs close to the fault zone, it warrants exploration.

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